Preservice Elementary Education Students’ Beliefs Regarding the Teaching and Learning of Mathematics

Elsa L. Geskus

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PRESERVICE ELEMENTARY EDUCATION STUDENTS' BELIEFS REGARDING THE TEACHING AND LEARNING OF MATHEMATICS

by

Elsa L. Geskus

A Dissertation Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Doctor of Education Department of Educational Leadership

Western Michigan University Kalamazoo, Michigan August 1994
This dissertation analyzes the entering and exiting beliefs of preservice elementary education students in three domains. The domains are: (1) the nature of teaching mathematics, (2) the nature of learning mathematics, and (3) the nature of the underlying source of their success or failure in mathematics. The data collection for this study was comprised of two questionnaires. The first questionnaire with 72 items used a five point Likert scale. The second questionnaire took 10 of the Likert items and formatted them as an open-ended response questionnaire. Students were to respond favorably or negatively to the statements and provide support for their answers. The students were surveyed during school year 1993-1994; entering students at the beginning of their mathematics coursework, and exiting students during the last week of their fourth course in mathematics. Their program consists of three content classes and one methods class in mathematics.

Each of the domains were composed of several sub-topics. The nature of teaching mathematics surveyed beliefs on manipulatives, instruction, classroom behaviors, testing, and good teaching practices. The nature of learning mathematics surveyed beliefs on problem solving, memorization of mathematics, and uses of technology. The nature of self regarding mathematics surveyed beliefs of one's attitude toward being successful in mathematics and what are requirements for being good at mathematics.
There was support for the hypothesis that there is a change in beliefs of preservice elementary teachers after completion of their elementary mathematics coursework. Interpretation of the data originated from the open-ended written questionnaire and the difference of the mean scores of the two groups. The instruments used, mean scores, and written responses are displayed in the dissertation.
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Preservice elementary education students’ beliefs regarding the teaching and learning of mathematics

Geskus, Elsa Louise, Ed.D.
Western Michigan University, 1994

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Elsa L. Geskus
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CHAPTER I

INTRODUCTION

Mathematics instruction in the 1980's can be summarized as a "back to basics" movement. As part of this process, computation became the primary instructional focus. However, this approach was not without its difficulties. In A Nation at Risk: The Imperative for Educational Reform, 1983, produced by the National Commission on Excellence in Education, it was noted that this type of mathematics instruction had several significant deficiencies for American students. Specifically, these included a lack of reasoning and thinking skills, minimal development of problem solving strategies, and limited use of technology. Interestingly enough, the major force behind this awareness did not come solely from the leadership of educational institutions but developed out of a consensus of teaching professionals and American businesses. This awareness accelerated a change process from isolated skills to conceptual understanding of abstract principles and problem solving.

The need for broad curriculum changes was also emphasized in Everybody Counts: A Report to the Nation on the Future of Mathematics Education (1989). This publication insists that curriculum changes must occur to develop the mathematical power within students. Mathematics curriculum must progress from computational activities and mastery of facts to an integration and practical use of mathematical concepts demonstrated through activities in daily life that are essential for survival in a rapidly advancing technological world. The philosophy of the report stated:

Virtually all young children like mathematics. They do mathematics naturally, discovering patterns and making conjectures based on observation. Natural
curiosity is a powerful teacher, especially for mathematics. Unfortunately, as children become socialized by school and society, they begin to view mathematics as a rigid system of externally dictated rules governed by standards of accuracy, speed, and memory. Their view of mathematics shifts gradually from enthusiasm to apprehension, from confidence to fear. Eventually, most students leave mathematics under duress, convinced that only geniuses can learn it (p. 43).

Two national reports underscoring the need for curriculum reform have been published by the National Council of Teachers of Mathematics (NCTM) after extensive curriculum research and study. The NCTM report, Curriculum and Evaluation Standards for School Mathematics (1989), received immediate national attention by many educational and business organizations. The educational standards call for a shift in emphasis from a curriculum dominated by an emphasis on memorization of isolated facts and procedures, and proficiency with paper-pencil skills to one which emphasizes conceptual understandings, multiple representations and connections, mathematical modeling and mathematical problem-solving (p. 125).

The Professional Standards For Teaching Mathematics (1991) was published by NCTM to promote a new vision for the teaching and learning of mathematics through professional development.

These national reports highlight the potential future of mathematics instruction. Improvements in technology and the changing role of mathematics in society require mathematics that goes beyond basic skills. The "shop keeper" arithmetic, emphasizing paper and pencil calculation, was needed in the past (Romberg, 1989). Today the demand is different.

Mathematics educators today must use knowledge as a tool to solve problems. The change in the structure of business and society demands it. The dilemma occurs in the current teaching of mathematics. While business and research underscore the need for change from isolated skills to conceptual understanding and thinking skills, current mathematics teaching still holds mathematics as a separate skill subject area. Mathematics curricula needs to develop higher order thinking connections with problem...
solving strategies across all school subjects. These strategies and connections need to permeate a child’s daily learning experiences.

The shift of focus in curriculum needs to be supported by changes in instructional practices. However, the fact remains that there is a lag in implementation in classrooms. Teachers surveyed in the 1985-86 National Survey of Science and Mathematics Education reported that the primary mode of instruction was lecture. This primary mode of delivery for instruction was used by 65% of K-3 teachers and by 82% of grade 4-6 teachers. In addition, hands-on activities, such as using manipulatives, was only evident in 63% of mathematics instruction at the K-3 levels. This percent decreases dramatically in grades’ 4-6 in which teachers reported using manipulatives only 31% of the time.

Students also responded to this questionnaire. Grade 7 students reported that almost every day 82% of the mathematics class period was lecture, 81% of the students worked problems alone, 77% reported using the textbook exclusively, and 69% did homework during class time. Clearly this type of instructional focus does not reflect the curriculum changes advocated by the current studies in mathematics education. Further, the results of the 1986 National Assessment of Educational Performance (NAEP) data indicates that 65% of seventh grades never work problems in groups, 78% never have mathematics laboratory activities, and 81% never work on mathematics projects.

The 1992 NAEP results are similar to the 1985 NAEP results. For this instrument, about one-third of the questions and almost one-half of the students’ response time was devoted to questions asking students to respond in their own words. The responses were short answer or more complicated answers requiring drawings or giving examples to complete the answer. For those questions requiring a short answer,
42% answered correctly for grade 4, 53% for grade 8, and 40% for grade 12. For problems requiring a more thorough response, satisfactory answers were provided by only 16% of students at grade 4, 8% at grade 8, and 9% at grade 12. Little evidence of understanding mathematical concept was exhibited. Results indicated that one-third to two-thirds of the students responded incorrectly to extended questions that required a multiple step process to complete the problem with almost one-fifth of the population leaving their papers blank (Dossey, Mullis, & Jones, 1993).

From the NCTM recommendations and suggestions for performance assessments, evidently to evoke change in mathematics education will require a change in teacher thinking. These changes include implementation of a new curriculum emphasizing working problems in groups, mathematics laboratory activities, or projects in mathematics.

Effective teachers are those who can stimulate students to learn mathematics. To understand what they learn, they must enact for themselves verbs that permeate the mathematics curriculum: "examine," "represent," "transform," "solve," "apply," "prove," "communicate." This happens most readily when students work in groups, engage in discussion, make presentations, and in other ways take charge of their own learning (National Research Council, 1989, p.59).

Purpose of the Study

To bring about the change in teacher thinking necessary to support classroom reform, institutions of teacher education must create programs of study that address the impact of the recommendations related to mathematics curriculum and instruction. According to the guidelines of the Michigan Council of Teachers of Mathematics (MCTM) the educational program of preservice teachers should develop knowledge of pedagogy and processes through experiences with instructional approaches such as: (a) multiple representations of mathematical concepts, (b) demonstrations of use of
technology, (c) problem solving strategies, (d) connections in mathematics to other subject area curriculums, (e) model lessons using appropriate manipulatives, (f) various assessment techniques, and (g) independent and collaborative learning (1991, p. 4). The additional goal, the development of teaching techniques and skills, can only be accomplished by field experiences that include experiences with tutoring, teaching small groups, or teaching whole groups (1991). Such a program will assist the prospective teacher with development of communication skills with elementary students and take learned theory into actual practice.

Students come to the university setting with an inherent set of beliefs about the role and function of teaching and learning. This belief system, rooted from years of observation of their teachers in classrooms from kindergarten through high school, acts as a filter for experiences during university coursework (Ball, 1988a; Ibrahim, 1990; Lappan & Even, 1989). Preservice elementary teachers accept, reject or assimilate the various roles of teachers based on those K-12 experiences (Weinstein, 1989). The university educator's task is to reshape these beliefs within the parameters of the standards and outcomes necessary for a future teacher in the twenty-first century.

With this basis as a recommended program for preservice elementary teachers the author researched beliefs of preservice elementary teachers in a mid-size institution of higher learning in the Mid-West. Beliefs of students entering and exiting an elementary mathematics program that is aligned with the recommendations from NCTM and MCTM are described. These teacher preparation programs result in a mathematics and science minor, including three contents and one methods course, that attempts to implement the NCTM Standards. The purpose of this study was to investigate changes in beliefs regarding the teaching of mathematics, the learning of mathematics, and the
underlying source of their success and failure in mathematics after completion of the
elementary mathematics coursework.

The Need for the Study: The Importance of Beliefs of Preservice
Elementary Teachers About Mathematics

Preservice elementary teachers hold their own ideas concerning teaching and
what constitutes a good teacher. From personal observations of their classroom
teachers, they have developed perceptions and beliefs about the functions of the
profession called "teaching." Additionally, beliefs about specific subject content may
be bound by success in that subject during their own school years. Therefore,
approaches to teaching subjects are bounded by experience (Ball, 1988a; Lappan &
Even, 1989).

Preservice elementary teachers may view elementary children as possessing
little knowledge of mathematics when entering school. However, children come to
school possessing a great deal of knowledge. Some of the knowledge is founded on
correct principles; other parts lack substance. All of the bits of pieces of knowledge
interact together to form understanding of concepts. Preservice elementary teachers
need to understand the knowledge base of children and how that knowledge influences
what children learn. Teachers must understand how children learn mathematics from
instruction along with how to instruct children (Carpenter & Peterson, 1988).

Children hold beliefs about mathematics that may contain errors or
looked at how young children make decisions regarding appropriate methods for
solving problems in mathematics. Children made decisions based upon their beliefs
about the legitimacy of certain methods as learned from instruction by teachers. Also
studies by Clay and Kolb (1983) cited by Underhill indicated that children were secure
in their belief that using rules of mathematics would obtain a correct answer in a short amount of time. These children saw mathematics as memorization, algorithms, and an exact answer. However, children who had been instructed using exploration to problem-solve, continued to explore to find patterns that explained the task at hand. Within this exploration, teaching had become a process to establish new beliefs and alter existing beliefs. To facilitate this process, teachers must teach differently than in previously modeled instruction. Instruction must go beyond the core properties of the content and begin to integrate how children learn this content. Student understanding of content is largely determined by the tasks and assignments implemented by the teacher (Doyle, 1988).

Romberg, when interviewed by Lockwood (1991), viewed the position of NCTM Standards as analogous to Edward Deming's Total Quality Management (TQM) in terms of quality control. Educational quality needs to be a central focal point. In realigning existing programs to reflect the NCTM Curriculum Standards and MCTM Goals for Preservice Teachers, mathematics educators must question teacher preparation to ensure that it attempts to incorporate the new knowledge of pedagogy and the beliefs about the teaching and learning of mathematics. To enact curriculum changes, one can begin with the vision of the Standards. A first beginnings for systemic change needs to occur in teacher education programs. This training should restructure preservice elementary education student's beliefs about the subject matter called mathematics for elementary children.
CHAPTER II

REVIEW OF LITERATURE

Introduction

The need for a solid foundation in mathematics as well as in classroom procedure is necessary in any preservice education program. Fullan reports that there is little research on the effectiveness of subject methods courses and teaching of those courses (1991). However in a research study completed by Hollingsworth in 1989, Fullan suggests a required foundation for elementary teachers. This foundation focused on subject matter-content and how to teach the content, classroom management techniques, and knowledge of the theories of how children learn. Similar foundations are proposed by Goodlad (1990b) for teacher education programs. Expectations include preparing young students for a political democracy, providing teachers with appropriate tools and subject-matter knowledge, promoting a strong base in pedagogy, and building theories to run schools for the future.

These foundations must be applied to mathematics education. Publications of the National Council of Teachers of Mathematics (NCTM) provide a vision of mathematics instruction for the twenty-first century. The Professional Standards for Teaching Mathematics (1991) is a companion document to the Curriculum and Evaluation Standards for School Mathematics, released in 1989. The focus of the 1991 publication is teaching. Divided into several sections, the document addresses issues such as: goals in learning mathematics, goals for environmental changes in the classroom, goals regarding professional development opportunities, and recognition of
teachers for their emphasis on mathematics education. Within this discourse is a section addressing the experiences that are essential ingredients of a preservice elementary education program. These experiences should focus on: (a) problem solving, (b) communication, (c) reasoning, (d) connections (in math and in other subjects), (e) the disposition to do mathematics, (f) the confidence to learn mathematics independently, (g) the development and application of mathematical language, (h) a view of mathematics as a study of patterns and relationships, and (i) a view of mathematics through a historical and cultural approach (1991, p.135).

While many of the currently defined goals of mathematics educators are found in the objectives of mathematics courses, consideration must be given to students' beliefs and what has transpired through their prior schooling experiences that have contributed to these beliefs. Some faculties believe college students entering the mathematics program have an embedded belief about mathematics that pivots on procedural learning, namely, that learning mathematics is accomplished by learning rules and procedures and demonstrating these to the teacher. To understand mathematics an elementary child must (a) be shown how to do computations and memorize the facts, (b) be given traditional paper-pencil written tests of computational problems for assessment, and (c) be taught that mathematics is very difficult and textbook oriented to be successful.

Reputable national surveys have reported the need to restructure mathematics education instruction. However, unless the mind sets of future educators change, the implementations of new paradigms within the classroom are impossible. Future elementary mathematics teachers can only be impressed with the need for change after they have experienced first hand the effects of a paradigm shift in the teaching of mathematics. Hopefully a change in the methods of instruction in mathematics
education programs will precipitate a change in beliefs concerning mathematics in classrooms of the twenty-first century.

**Background and Setting of Preservice Elementary Teachers**

In 1986-87 an extensive survey of the mathematics preparation of preservice elementary and secondary students in Michigan was conducted by the Teacher Preparation Committee of MCTM. The results indicated a variety of preparation programs. For elementary certification at four-year institutions, required mathematics credits ranged from 0 (2 institutions) to 11 (1 institution). The content of the courses ranged from basic mathematics, algebra, to college algebra, to content and methods courses designed specifically for preservice elementary teachers.

The MCTM survey further revealed that students enrolled in a preservice elementary education program usually complete a degree in four to five years. Courses revolve around subject-matter contents and methodologies of teaching the content. While most students are chronologically traditional college ages (18-22) there is an audience of non-traditional students. The non-traditional students usually have had other occupations or have delayed college for various reasons.

One difficulty for new learning of a preservice elementary education student is the lack of alignment of past observations of schooling with the new methodologies and teaching strategies. The role of university instructors becomes one of creating a disequilibrium by questioning beliefs of preservice elementary education students. The challenge is to prepare students for future teaching positions that require new behaviors for the classroom.
Beliefs

What Are Beliefs?

Beliefs are defined by researchers within the context of study. Fishbein and Ajzen (1975) define beliefs as "the information a person has about an object" (p. 112). This is within a formal theoretical discussion of beliefs. In a mathematical context, McLeod & Ortega, defined beliefs as "relatively stable, highly cognitive, and of low affective involvement" (1993, p. 29).

Pajares (1992) views the study of beliefs as the foremost indicator of what will become the increasing major focus for teacher effectiveness research. His writing is a synthesis of more than one researcher's meaning about beliefs and how this meaning differs from knowledge. This view is based on assumptions that beliefs are what individuals use to make decisions throughout their lives. These held beliefs influenced the behaviors of teaching within the classroom. Pajares' discourse holds that defining beliefs is a juxtaposition of numerous terms. Some that are included under a broad concept of belief are:

- attitudes, values, judgments, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action strategies, rules of practice, practical principles, perspectives, repertoires of understanding, and social strategy (p. 309).

Under research consideration, Pajares suggests that educational beliefs of preservice teachers play a part in their knowledge base and subsequent teaching behaviors. Without changing or causing conflict in preservice elementary education students' beliefs, status quo becomes the outcome. Research of preservice elementary education students' beliefs is critical since many studies focus on practicing teachers and student outcomes without going back to original stakeholders whose beliefs need to be challenged. Studies on preservice elementary education students' beliefs are needed.
to assist in their own cognitive and affective outcomes that are constructed during university coursework. Pajares' recommendations are supported in his synopsis by Schommer (1990) and Pintrich (1990).

Abelson (1979) describes several features of belief systems that differentiate from knowledge systems based on his review and synthesis of the literature. The seven features are: nonconsensuality, existence beliefs, alternative worlds, evaluative components, episodic material, unboundedness, and variable credence. When belief systems are not consensual, individuals hold different beliefs based upon the bank of experiential background. Belief systems that include representations from alternative understandings may represent a belief "as it is" and "as it should be" concurrently. An example of alternative thinking is knowing procedural rules for problem-solving under an old paradigm and knowing new strategies for problem-solving which are connected with conceptual understanding of mathematics.

One feature of a belief system is the reliance upon evaluative and affective components. Experiences that create the belief base have a built-in evaluation of "goodness" or "badness" based upon that individual's integration of the experience. Another belief system feature includes substantial amounts of experiential materials. This base is built from personal experience, cultural systems, folklore or propaganda. A final feature is the varying degree of certitude of beliefs that are held by individuals. An individual can be extreme in the extent of a belief, almost to a passion. This differs from a knowledge system since in the latter a fact has no degree of belief. It is accepted as such. It would be illogical to "know a fact strongly."

In summary, Abelson indicates that these, and other features, observed in isolation singularly, are not sufficient to guarantee a distinction between beliefs from
knowledge. However, in combination they are stronger indicators of what might be a
given belief system.

Translating beliefs into the context of mathematics focuses upon specific
elements. A belief system can be described as "loosely bounded systems with highly
variable and uncertain linkages to events, situation, and knowledge systems" (Nespor,
system relating to mathematics. He states "students may develop these beliefs as a
result of their experiences with mathematics which then" become one's belief system.
This system is a broad framework for beliefs rather than specific concepts about
mathematics as held by an individual. Some specific examples that are held by
preservice elementary teachers are: mathematics is bound by rules (Carpenter,
Fennema, Peterson, Chiang, & Loef, 1988) and mathematics is best learned by
memorizing facts, rules and procedures to apply to textbook exercises (Wilcox,

Nespor (1987) studied teachers' beliefs to form a framework of teacher
thinking. His study interviewed eight teachers across the course of a semester.
Classes were videotaped to construct actual dialogue of the teachers. This dialogue
became the basis for further individual interviews. Nespor's descriptions of beliefs
build from Abelson's definition of a belief system. Nespor's descriptions consisted of
four features: existential presumption, alterativity, affective and evaluative loading,
and episodic structure. These were used to distinguish between beliefs and knowledge.
To create a belief system, the features of nonconsensuality and unboundedness were
added. A foundation of his study was that teachers' beliefs play a primary role in
defining teaching tasks. Along with this was the concept that organizing knowledge
and information relevant to teaching was a necessary component of a belief system.
His results indicate that if one is interested in why teachers operate within their classrooms the way they do we must pay more attention to the goals they aspire to and their subjective analysis of classroom practices.

Implications for educators are to address preservice elementary education students' perceptions and beliefs by one of two methods. One approach would be to address teaching as a set of pedagogical methods that must be strictly adhered to and thus shape beliefs. A second is to mold or shape teachers' beliefs themselves. Here instruction would focus on making prospective teachers aware of their beliefs and assist in developing criteria for the adequacy or validity of these beliefs. The root problem is that we do not know very much about the origin of preservice elementary education students' beliefs, how they are supported through experiences, or how to convert existing beliefs to new beliefs.

Perceptions and Knowledge

For many students, "to know" mathematics means to identify the basic concepts and procedures of mathematics. This translates to knowledge of arithmetic such as rules of operations for addition and subtraction. For others, knowledge means to "do." While working or discovering some aspect of mathematics in class, one begins to know (Romberg, 1989a).

Knowledge is defined by Perret-Cleimont as an "accumulated experience structured according to cultural or scientific traditions, recorded with symbolic measure in material forms" (1992, p. 333). This knowledge base is formed from elements comprised by institutional, cultural, and ideological factors.

Shulman (1986a) studied different categories of teacher knowledge and how this knowledge translates into different roles in instruction. His findings resulted in a
discussion of a concept called "pedagogical content knowledge." This is defined as follows:

The understanding of how particular topics, principles, strategies, and the like in specific subject areas are comprehended or typically misconstrued, are learned and likely to be forgotten. Such knowledge includes the categories within which similar problem types or conceptions can be classified (What are the ten most frequently encountered types of algebra word problems? least well-grasped grammatical constructions?), and the psychology of learning them (p.26).

This pedagogical content knowledge includes knowledge, both conceptual and procedural, that a student brings to the learning situation. This knowledge contains the learning of the topic, the misconceptions of the topic, and the transition stages from introduction to mastery of the topic (Carpenter et al., 1988). The assessment of the knowledge through this transition is part of the structure of the pedagogical content knowledge.

Clearly the research points out that much of mathematics education is based, for the preservice teacher, on prior knowledge or the beliefs the preservice teacher brings to the university setting. Research has also demonstrated the need to change mathematics curriculum and instruction currently practiced in elementary classrooms (Civil, 1990). Therefore it is obvious that research is needed to assess how preservice beliefs can be influenced in order to change those beliefs of future teachers and thereby promote a mathematical learning environment for the children of future classrooms.

Why Study Beliefs of Preservice Elementary Education Students

The concern of the curriculum reformer is that the status quo or the "way I was taught is the way I will teach" will continue when research has demonstrated the need for new pedagogy. Curriculum restructuring has supported a call for reform from instruction that emphasizes rote procedures to understanding the conceptual framework
of the content. Goodlad (1990b) describes teacher candidates as "apprentice-by-observation" since for twelve to sixteen years they have internalized the values, beliefs, and practices of former teachers. Prospective teachers, unless challenged to become introspective and questioners of their existing beliefs, will perpetuate the view of mathematics to their future elementary students (Wilcox et al., 1991). The author's assumptions regarding the nature of prospective teacher's belief structure are based on observation from college classroom teaching and years of inservice and curriculum work with practicing teachers.

Brousseau and Freeman's (1988) study examined educational faculty members' methods of defining desirable teacher beliefs. Research questions for discussion included (a) do teacher education faculty members share common desirable teacher beliefs, and (b) how do they emphasize these beliefs in their courses. Five undergraduate programs with 79 faculty members completed belief questionnaires. Additionally, 1,321 students enrolled in an introductory educational psychology course from 1985-1987 responded to an entry-level survey. Findings indicated faculty members usually reinforced prevailing beliefs that faculty judged as appropriate. Beliefs that were judged as inappropriate were not challenged nor were students encouraged to develop new beliefs based upon informed positions on specific educational issues. The authors suggest that educational beliefs should become a definite element of teacher education curricula.

Studying what are the entrance beliefs that preservice elementary education students bring to their college mathematics coursework compared to their exiting beliefs, creates a base for discussion by mathematics educators. This base will assist mathematics educators in providing the experiences needed during a course of
instruction. That instruction establishes the environment that allows for goals recommended by national organizations and current research about effective teaching.

Closely associated with preservice elementary education students' beliefs are their attitudes about mathematics. McLeod & Ortega (1993) suggests that attitudes towards mathematics develop in two different ways. One way is through repeated emotional reactions to experiences in mathematics. If working with multiplication algorithms is perceived as difficult then repeated work with algorithms will automatize the response to algorithm assignments. The second way is the transferring of an emotion to another area within the same content. A child may take a negative attitude towards algorithms and transfer that to problem solving situations that require the use of algorithms. The question for mathematics educators of preservice elementary teachers becomes: Will their attitudes toward subject matter, namely mathematics, promote or discourage the implementation of a problem-solving focused curriculum for their future elementary students? Does an attitude that mathematics is difficult together with a belief that mathematics is formula based, complicated, and rule bound limit the experiences that are essential for children? Do these attitudes exist because their teacher was bounded by a limited knowledge or experience base, and therefore was not able to demonstrate that mathematics teaching is open to many ways of instruction, use of approaches, and rich in the discourse of language and problem solving?

With further study, mathematics educators can look at whether time is an assist in changing beliefs. The change of beliefs supporting procedural knowledge and rote instruction to those supporting conceptual understanding and individual construction of learning is required if preservice students are to become reflective educators for the twenty-first century.
Research on Beliefs About Mathematics

Within the last decade there has been greater interest in formal research on the beliefs of teachers about teaching and about specific subject matter content. Results of this research suggest that several basic premises are important in the study of beliefs. They consist of knowing students' and teachers' beliefs, knowing differences between teachers' and students' beliefs, and knowing how to change both the learners' and the teachers' beliefs (Underhill, 1988b). Much of the research has focused on post graduate elementary teachers working in classrooms. Underhill (1988b) reports on a study by Dionne (1984) in Canada of 33 teachers. Statements gleaned from the study suggest that if teachers do not understand the developmental range of students' beliefs it is difficult to meet their academic needs. Also, if teachers teach under a traditional or formalistic approach, instruction is usually not developmentally appropriate for the learner. Dependent upon the approach used relationships between conceptual and procedural learning may or may not take place.

To be more effective in teaching mathematics, teachers need to understand the big picture of a particular topic and the relationships between the sub-topics of the content (Grossman, Wilson, & Shulman, 1993). This knowledge base in many instances also becomes the belief base of teachers. Several researchers suggest that teachers' thoughts on how to teach, how knowledge is learned, and how one teaches in a classroom, are related to their beliefs about teaching and learning. A major belief of beginning teachers is related to the subject matter they are teaching. This relationship includes what they will teach as well as how they will teach the subject. A second area is a teacher's personal framework towards the subject that is to be taught. Knowledge of subject matter is just the beginning of the understanding of the complex activity
called teaching. Understanding curriculum, its context, pedagogy, and child development are all pieces that integrate with beliefs.

**Changes in Preservice Elementary Education Students' Beliefs**

Over half of the students interviewed by Goodlad (1990b) maintained that their basic beliefs and tenets of teaching remained unchanged throughout their coursework in educational programs. As work progressed towards a field practicum experience, there were some changes in their views about schooling and teaching. Student views became more realistic and practical concerning teaching. Goodlad suggests that the perceived change was change from simple to complex beliefs in the category of "what is schooling." Faculty, on the other hand, believed that students' beliefs had changed considerably as students progressed through coursework. Goodlad conjectures that teaching is formed as "pedagogical bag ladies and bag men," seeking more discrete bits of knowledge to stash away, than the inquiring reflective practitioner looking for avenues of theories for instruction and the practice of those theories (p.225).

The change in theory and practice must center on three pivotal axes, conceptual understanding, procedural knowledge and problem-solving. Conceptual understanding is evident in mathematics instruction when students demonstrate awareness of examples by using counterexamples of concepts; can recognize, interpret and apply appropriate symbols to mathematical settings; and can construct meaning to a performed procedure. Procedural knowledge is evident when students can apply appropriate procedures correctly using symbols and algorithms in an orderly manner. The third area, problem-solving, involves students' reasoning and analytic abilities in new situations (Dossey et al., 1993).
Presenting changes in theory and practice to preservice elementary education students is the focus of instruction for mathematics education faculty in institutions of higher learning. Jakubowski and Chappell's (1989) study focused on preservice elementary teachers' beliefs about mathematics and mathematics learning. The population consisted of 186 preservice teachers enrolled in a mathematics course entitled "How Children Learn Mathematics." From this group, 22 individuals were selected to be interviewed on their perceptions about the teaching and learning of mathematics. The results of the study suggested that the preservice elementary teachers believed that mathematics was procedures, rules and memorization with one correct way to approach or solve a problem. Because of course work that included demonstrations of children trying to cope and make sense of mathematics, the preservice elementary teachers indicated a change in beliefs after the 15 week study. The change of belief centered on acknowledging mathematics as a system of relationships involving patterns.

Another study completed by Schram, Wilcox, Lanier, and Even (1988) found similar results. The preservice elementary teachers were enrolled in an innovative, conceptually based program consisting of three courses. A case study was developed using two of the students. Data collection consisted of interviews, questionnaires, tape-recording, and writing assignments. Results from the study suggest that changes occurred in student thinking about mathematics and about mathematics teaching. The focus of the study revolved around what does it mean to know mathematics, how is mathematics learned, and what is the teacher's role in creating effective mathematical experiences for children. While change was observed in the preservice teachers, the researchers believe that beliefs must be "challenged" through appropriate curriculum
experiences if true conceptual understanding of mathematics is to be a supporting foundation for teaching young children.

While mathematics has been under scrutiny for many years, change in the teaching of mathematics to young children has not progressed from lecture, checking of assignments, and abundant seatwork. If preservice elementary teachers are to construct meaningful learning in mathematics then their teacher preparation programs must challenge beliefs and create programs that increase knowledge about the form and function of mathematics, show elementary children constructing patterns of knowledge, and demonstrate appropriate instructional practices that enhance conceptual understanding.

Research on Preservice Elementary Education Students' Beliefs

The review of the literature to obtain documentation for the research on preservice elementary education students' beliefs involved several steps. Computer searches of the literature were compiled by using descriptors of mathematics beliefs and preservice teachers, surveys-mathematics education, and teaching-higher education-preservice elementary teachers. These searches led to journal articles and microfilm publications of papers at conferences. Dissertation abstracts were searched using the Dissertation Abstracts International (DAI) computer database with the descriptor mathematics-beliefs and preservice teachers. Abstracts for year 1993 found seven studies with one acceptable for review and study. The second search, for years 1983 to 1993, indicated 90 entries. All were reviewed with nine selected as possible studies with two ordered for further study. A third search was conducted for years preceding 1983 but appropriate studies were not evident. Criteria for accepting studies were those studies whose focus was in alignment with the NCTM Standards, population was
preservice elementary education students, and research was conducted in the United States. Studies conducted in foreign countries or of populations of full teaching staff in elementary schools were not selected.

Major sources of information were the various handbooks that are compiled on topics. Grouws (1992) *Handbook of Research on Mathematics Teaching and Learning* has a chapter on teacher's beliefs and conceptions by Thompson. This chapter was a synthesis of current research that was a valuable assist for finding appropriate articles. Spodek (1993) *Handbook of Research on the Education of Young Children* had a chapter by Baroody that addresses the mathematical learning of young children. This chapter gave focus to the explanation of the domains in this study. A third handbook, Wittrock (1986) *Handbook of Research on Teaching* has two chapters that were used for conceptual frameworing. A chapter on research programs that studied teaching was compiled by Shulman (1986). This author was cited in many documents found in the computer review of literature. Two other authors known in the mathematics education arena, Romberg and Carpenter (1986), addressed research on teaching and learning mathematics with a perspective on future directions that are needed. Studies found through other data-base searches were supported in the various handbooks as being capstone studies with significant merit.

Using this information, research studies on the beliefs of preservice elementary education students were compiled for review. The review of literature indicated that past studies have structures with various formats. Studies have been of small populations with short treatment periods. Some of the studies have limited their scope to an area of concern such as beliefs about small group instruction and beliefs about the learning of addition and subtraction concepts. Conclusions from the studies have indicated some change of beliefs with limitations. The following is a sample of the
range of research projects that were found in the literature that address some concept of belief over time with various populations. A strength of the studies was the use of multiple methods for gathering data to support hypotheses.

Collier (1972) used Likert scales to study beliefs of preservice elementary education students at different stages of preparation in the area of beliefs about mathematics and mathematics instruction. Polar dimensions of formal-informal viewpoints on the teaching and learning of mathematics were collected. The formal dimension viewed mathematics as rigid, exact, and consisting of rules and formulas for solving mathematical tasks. The informal view was depicted as creative, investigative in task and approached problem solving with multiple strategies. Built into the design was a quotient of ambivalence to describe the beliefs of the students at the different levels of preparation. Results suggested that after two content courses' students had a neutral belief status (students do not view mathematics as formal or informal) about mathematics. With the addition of a method course small differences were noted by high achievers. A concern centered on course objectives that were not belief oriented. Another concern was the limit of the range of the instrument. However, allowing for these items Collier concluded that minimal change occurred in the beliefs of the students as they progressed through preservice education programs.

The Michigan State University Academic Learning Program provided a common study and experience program for a cohort of 25 preservice teachers. This study was conducted during the years’ 1987-1989. The intervention consisted of three content classes and a methods class with a focus of changing beliefs on how mathematics is learned and the use of small groups in an elementary classroom. The courses included three nontraditional mathematics courses that explored numbers and number theory, geometry, and probability and statistics. The methods course focused
on content courses and a field experience as a point for discussion about beliefs of mathematics education. The basic goal of the study was to develop a more conceptual understanding about the teaching and learning of mathematics for the cohort group.

Data was collected through interviews, classroom observations and a questionnaire. Four students from the cohort were tape recorded in their field assignment, interviewed, and observed. Another goal of the study was to create a new foundation of conceptual knowledge for the teaching and learning of mathematics. The findings indicated that students "doing" mathematics became better problem solvers. To achieve this, time and a risk-taking environment are necessary components. The results of the study indicated significant changes were formed from participating in the intervention. Further questions arose as to how this environment can become part of the general university classroom and continue during the first years of actual teaching (Wilcox et al., 1991).

Civil's (1990) research analyzed the understanding and beliefs about mathematics of eight preservice elementary teachers during an eight week summer course for elementary education majors that met five days a week for two hours per day. Her study did not begin with focused questions but incorporated observations and discussions about mathematics. The results of this qualitative inquiry centered on the role of the student within the discourse of mathematics instruction. The primary facets of the course were: problem solving tasks, tasks based on elementary school experiences (the teaching and learning of fractions), and tasks whose intent was to create cognitive conflict between teacher and elementary student (e.g., alternative algorithms for one of the four traditional operations).

Data was collected by: tape-recordings of peer dialogue, written homework, journals of students, tape-recorded interviews revolving around mathematical tasks,
and observations of the students working in the mathematics class. During this course, the instruction focused on the structure of teaching mathematics to elementary students. The course looked at the language used in the classroom, what is the role of "the problem", and what are acceptable indicators for answers. This was accomplished by presenting problems that caused discussion among the students. Civil recorded the participants' behaviors and interrupted their writings for insight into the beliefs held by the education students.

Upon analysis the conclusion was drawn that the subject's embedded beliefs centering on "school mathematics" interfered with their exploration of the mathematical tasks. Civil acknowledges through her discussion of the results that this was a limited time period and an unusually small group of subjects. The findings suggest that courses for preservice elementary teachers that assist in changing belief structures should incorporate tasks that cause cognitive conflict, provide discussion of mathematical questions, and make use of children's work to illustrate concepts under discussion. These findings are supported by the goals and objectives of the NCTM for training of preservice teachers.

Kight's (1991) research examined the beliefs about mathematics, about mathematics teaching, and about teaching problem solving held by preservice teachers of elementary and middle grade's mathematics. The study was conducted using the framework of constructivist inquiry with a baseline of a constructivist paradigm. Three female college students participated in the field experience study. Data was collected by a survey of beliefs, an open-ended questionnaire about beliefs, classroom observations, interviews, and written problem solving. Six themes or areas of beliefs were found by the author. The belief themes were: influences on beliefs (parents, teachers, others), beliefs about self as a doer of mathematics and as a teacher of mathematics, beliefs
about others, beliefs about the nature of mathematics, beliefs about teaching mathematics, and beliefs about teaching problem solving. These were described for each of the participants. From this a model was developed to classify preservice elementary teachers' beliefs. This model can be used to assist mathematics educators in examining preservice elementary teachers' feelings and beliefs about mathematics. With this information, appropriate instruction and experiences could be provided to preservice teachers to aid in clarification and restructuring of beliefs about teaching and learning mathematics.

Cirulis' (1991) study examined the belief structures of three prospective elementary teachers. The focus was the examination of beliefs about problem solving with their currently held beliefs about learning mathematics. The results for the first student indicated no change from the negative views held when entering coursework. The results from the second student, also with entering negative beliefs, demonstrated some effect on beliefs. The third student had experienced favorable disposition towards mathematics in previous coursework and experienced favorable beliefs from this course of study. A second course designed to call attention to negative beliefs assisted the first two students in understanding the root of their negatively held beliefs about problem-solving and mathematics. This second course emphasized the inquiry of mathematical ideas that were familiar to the students procedurally, but of which they had little or no conceptual understanding. Cirulis suggested that mathematical teaching in K-12 was often grounded in procedural rules that left students confused about their understanding of mathematical concepts. She suggests that the implications for mathematics educators are that beliefs must be addressed during coursework with time allocated for reflection about one's beliefs and the framework of those beliefs.
In summary, research on preservice elementary education students' beliefs about the teaching and learning of mathematics have been conducted with limited populations with treatment periods of short duration. While the results indicated a change in beliefs, the structure of the research focused on limited aspects of the nature of the teaching and learning of mathematics. Thompson (1992) suggests that studies that focus over longer periods of time and have courses that aim to restructure beliefs need to be convened.

This study described herein most closely reflects a cross-sectional study focusing on the beliefs of preservice elementary education students about the teaching and learning of mathematics. This design is not a pre and post design for the same group but represents one group at the beginning stage of mathematics coursework and another group exiting their mathematics coursework as if they were the same group. The entering and exiting beliefs of preservice elementary education students were surveyed through two questionnaires. The mathematics program consists of three content courses, one methods course, and a field practicum, conducted in alignment with the NCTM Standards. The course descriptions are found in Appendix H.

Research Hypotheses

Research reviewed for this study suggests that belief systems can change. Views about teaching and schooling can and do change. Therefore the challenge for mathematics educators becomes how change can be facilitated in beliefs toward mathematics and thereby effect change in elementary classrooms. From this foundation the following hypotheses are offered:
1. Preservice elementary education students' beliefs about the teaching of mathematics will become more closely aligned with the NCTM Standards after completion of the elementary mathematics coursework.

2. Preservice elementary education students' beliefs about the learning of mathematics will become more closely aligned with the NCTM Standards after completion of the elementary mathematics coursework.

3. There will be a change in preservice elementary education students' underlying beliefs about the source of their success and failure in mathematics after completion of the elementary mathematics coursework.

Included under each of these hypotheses are statements found in questionnaires that represent the domains of the nature of teaching, learning, and success or failure in mathematics that are embedded in the structure of the elementary mathematics program for preservice elementary education students. The three domains are described in the following sections. Under each domain, sub-topics are described (use of manipulatives, role of memorization). After the title of the sub-topics the Likert items that represent that sub-topic are listed (e.g., Use of manipulatives Likert Items #9-13). The statement items can be found in Appendix K, the final copy of the questionnaires.

**Nature of Teaching Domains Represented on the Likert Questionnaire**

**Use of Manipulatives (Likert Items #9-13)**

In assisting children to learn mathematical processes, bridges between concepts and realistic applications must be provided. This is the role and use of manipulatives. Manipulatives are concrete or semi-concrete materials for multi-sensory experiences by children. These models range from simple tools like buttons and macaroni, for
representing sets and classification activities, to base ten blocks and unifix cubes for whole number and decimal representation. Use of these models is part of the development of the conceptual knowledge base for students. This builds a concrete representation of the procedural knowledge that is traditionally developed through worksheet activities.

**Grouping for Instruction (Likert Items #14-18)**

Historically, instruction for children in elementary schools has been in a whole group or total classroom teaching experience. Research in cooperative group instruction indicates that children's achievement of goals is enhanced when all members of the group achieve the goal. This goal is achieved only through the involvement of all members, not members working in isolation within a group structure (Johnson & Johnson, 1987). American business leaders in the 1990's are hiring, (or seeking to hire), workers who are qualified not only in a specific area of expertise, but also workers with interpersonal relation skills and decision making strategies (Fulton, 1990). According to Fulton, "80% of people who were fired were fired not because of lack of knowledge or skill to do the task, but their inability to interface cooperatively with their peers and supervisors"(1990, p.10).

The research indicates that confident and successful problem solvers are those individuals who work together to discuss, explain, and analyze what is being learned while involved in a mathematical task. However, placing students in groups and just telling them to work together does not achieve this end. Specific strategies and role assignments are necessary to create the atmosphere for positive interaction.
Presentation of Instruction (Likert Items #19-23)

The guidelines of national organizations for teaching support a shift from teaching as a transmission of knowledge, to students constructing their own learning (Cruikshank & Sheffield, 1992). This approach is influenced by a constructivist view of teaching children. A constructivist viewpoint or belief is that student self-discovery or inventing knowledge through self-discovery is the best way to gain that knowledge. This theory suggests that all knowledge is a result of the individual's cognitive activities. Learners construct understanding through experiences that are influenced by the learners' cognitive lens (Davis, Maher, & Noddings, 1990). This is an opposite view held by traditional educators that the teacher's job is to talk to students and transmit facts, rules and information. Constructivist education allows the teacher to step out of the traditional role of "teacher" and allows everyone in the classroom to be responsible for the learning. Implementing such behaviors in the elementary classroom requires teachers to question beliefs currently held about methods of teaching elementary children.

Open-ended Approach for Instruction (Likert Items #24-28)

Instruction in the traditional classroom has been textbook bound with a daily lesson consisting of an isolated skill in a drill and practice format. Students are expected to complete the given assignment during class as individual work. New curriculum goals express a mode of instruction that is more open-ended. This instruction requires students to do multiple tasks such as constructing multiple representations of problems, students reflecting upon the problem-solving process and alternative strategies in a cooperative group setting. The children may spend the entire mathematics period working towards a solution for a single problem. Open-ended
instruction may incorporate curriculum from other content areas such as science, social studies, and language arts. Open-ended instruction encourages flexibility of thinking, risk-taking, and develops confidence in solving a multiple faceted task.

**Classroom Instruction (Likert Items #38-47)**

Teaching is not composed of a set approach to instruction. There are many different approaches that aid children in the construction of knowledge. Reliance on one approach makes for rote instruction and dull learning for children. A problem-solving environment includes opportunities for problems or tasks that encourage children to explore, debate, and solve. Instruction should vary from settings that provide experience with total class explorations to cooperative groups, pairing of students, to self instruction. Having a problem-solving centered classroom opens the doors for varied approaches to traditional textbook bound daily lessons of isolated skills. The new instructional goals require the classroom teacher be excited, involved and a risk taker for now the teacher becomes the facilitator rather than engaging in one way communication.

**Testing Instruction (Likert Items #48-53)**

The changing role of to meet the needs of the new standards may be the most influential aspect of the new directions in mathematics. New assessment procedures require the move from multiple choice paper-pencil assessments to instituting comprehensive approaches that interrelate across disciplines. Some suggested approaches include writing, portfolios of children’s work, interviews, diaries, cooperative group projects, demonstrations, and long term projects involving data collection with hypothesis (Hatfield, Edwards, & Bitter, 1993). Approaches such as
diagnostic interview techniques, anecdotal records, observations, and interviews are very different from the end-of-the-chapter test found in the traditional textbook.

**Beliefs About Good Teaching in Mathematics (Likert Items #69-73)**

The Professional Standards for Teaching Mathematics recommended by NCTM revolve around the major roles that a teacher should assume in the classroom. They include: creating a classroom environment to support the teaching and learning of mathematics, setting goals for creating problem-solving mathematical tasks for children, stimulating classroom discourse for constructivist learning, and analyzing student learning to make diagnostic instructional decisions (NCTM, 1990). This is in contrast to traditional teaching roles of lecturer, assignor of exercises and homework, and judgmental evaluator.

**Nature of Learning Domains Represented on the Likert Questionnaire**

**Problems-Strategies (Likert Items #29-34)**

A constructivist view of elementary children’s learning suggests a problem-solving climate in the classroom. A child involved in active participation of a mathematical task becomes engaged in reflective thought. Connections between past understanding and knowledge can be integrated to form new understandings. Features of a problem-solving classroom are: tasks for exploration, investigative spirits, use of manipulative models, validation by self and others of the process, and "talking" mathematics during group interactions (Van De Walle, 1990). This is very different from the traditional classroom where transmission of facts and procedures are the
primary forces of instruction. In that setting memorization is the key for success and formulas to solve problems or exercises represents the only viable way to get answers.

Role of Memorization in Instruction
(Likert Items #35-37)

Mathematics is often viewed as logical, rule bound, inflexible instead of strategy oriented in problem-solving situations. Memorization of facts, procedures, rules, and formulas has been the main instructional focus in elementary schools. The new curriculum guidelines suggest that the construction of concepts and integration of prior knowledge with new knowledge builds a stronger conceptual base for understanding than provided by isolated bits of knowledge found in procedural instruction. While some information eventually needs to be memorized, like basic addition and multiplication facts, conceptually understanding what is occurring during these processes will aid in the memorization.

Use of Technology in Instruction
(Likert Items #54-58)

What paper and pencils were to the traditional classroom, calculators and computers will become to the elementary classroom for the twenty-first century. Calculators allow children to explore and experiment, refine skills, concentrate on problem-solving instead of tedious computations, and expand their analysis of tasks beyond the scope of paper-pencil computations (NCTM, 1989). The student use of calculators and computer programs in the elementary classroom requires change in the attitudes and knowledge base of teachers. For technology to be effective, it must be modeled and incorporated into instruction by the classroom teacher.
Beliefs About Self: Attitude (Likert Items #59-68)

Bassarear's (1986) study of students' attitudes and beliefs about self in mathematics courses found students motivated by performance goals. Their focus was on getting a good grade unless confidence was low, then avoiding a low grade was the priority. Another variable being considered in the literature was the pattern of students' attributions for success and failure. Attitude regarding mathematics was defined by Haladyna, Shaughnessy, & Shaughnessy (1983) as "a general emotional disposition toward the school subject of mathematics" (p.20). Factors that influence an attitude of mathematics include student motivation, student self-confidence, importance of the subject matter to the students, and a sense of fatalism about the subject. Outside variables include the quality of the instruction of the teacher, the learning environment, gender and social class. Some variables play a more important role dependent upon the grade level of the student. Bassarear citing Meyer & Fennema's (1985) work on attribution theory suggests that success or failure at a task can be attributed to other factors such as effort, ability or luck.

Good at Math (Likert Items #74-80)

Research conducted by the National Assessment of Educational Progress suggests that high school students view mathematics as important, difficult and founded on rules and procedures. This is supported by other studies by Dossey and the Second International Mathematics Study (McLeod & Ortega, 1993). Schoenfeld (1989) reported that students believed that problem solving should be completed in a
quick, efficient manner and if unable to do so became frustrated. For many of his subjects, mathematics was only for geniuses.

Summary

In summary, the questionnaires used in this study probed preservice elementary education students' beliefs about the teaching and learning of mathematics, and their underlying source of success or failure in mathematics. The sub-topic domains are represented in questionnaire (Form I) through statements with choices of responses using a Likert scale of strongly disagree to strongly agree. Form II, incorporating an open-ended format, listed ten statements from the Likert survey. These statements allowed students to write a response to the statement, citing examples if possible. Copies of the questionnaires are found in Appendix K.
CHAPTER III

METHODOLOGY

Design

Introduction

Questionnaires were used to measure the beliefs of preservice elementary education students in an elementary education program at a mid-size, four year institution of higher learning in the Mid-West. Data was collected during Fall 1993 and Winter 1994. The population was separated into two segments: (1) students entering elementary mathematics coursework took the questionnaire during the first period of the initial course of the program, and (2) students exiting elementary mathematics coursework took the questionnaire during the last week of their methods course. The elementary mathematics coursework consists of three content courses and one methods course that are aligned with the principles of the NCTM Standards. This coursework is followed by a capstone field experience in the teaching of mathematics and science in elementary schools. Individuals responded to either a Likert scale (Form I) or an open-ended response (Form II) questionnaire.

Questionnaire Instrumentation

Form I, the Likert questionnaire, reflects the matrix polar ends containing the foundation of beliefs regarding mathematics. While not indicated on the questionnaire, statements were grouped to reflect a category of beliefs. Categories and specific statements include manipulatives (#9-13), grouping of students for instruction.
(#14-18), presentation of materials through discovery (#19-23), open-ended approaches (#24-28), problem-solving (#29-34), memorization (#35-37), classroom (#38-47), testing of instruction (#48-53), technology (#54-58), beliefs about good teaching of mathematics (#69-73), attitudes towards mathematics (#59-68), and being good at mathematics (# 74-80).

Form II, the open-ended response questionnaire contains ten statements selected from the Likert questionnaire. The open-ended statements seek further clarification of students' beliefs through a written response. Students were asked to respond to the statement with specific detail, citing examples if appropriate. The writings were selected to add clarity to student's thinking regarding the sub-topic statements. The questionnaires are found in Appendix K.

Instrumentation

Construction

Initial Thoughts for Creating the Survey

On the basis of a research question related to student success in their field assignment (practicum) and evaluating pre-field coursework, several colleagues of the mathematics education faculty began to question whether the existing mathematics education program made any difference in beliefs of students regarding "What is teaching of elementary mathematics?" The initial speculation of, "I wonder," evolved into a serious discussion with the focus "Can programs make a difference?" Further discussion led to the creation of a general statement of the perceived problem. The initial problem statement centered on "Is there a change in the beliefs of preservice elementary mathematics education students in understanding what comprises teaching and learning of mathematics for elementary children?"
In creating Form I the following procedures were followed. The first step was an informal meeting with a panel of three mathematics educators from this university. This panel of mathematics educators considered students’ responses to the question of "What is teaching of elementary mathematics?" From this meeting, the panel of mathematics educators suggested the development of a general framework to examine beliefs and attitudes of students.

Review of Literature for Existing Questionnaires

From this general theme, a research of the literature was accomplished to review existing questionnaires about preservice elementary education students’ responses to the nature of the teaching and learning of mathematics. Since no one instrument was deemed able to answer the research questions, the Schoenfeld (1988) questionnaire of students' beliefs about mathematics and their effects on performance was studied for possible statements. The Johnson (1981) questionnaire that examined attitudes towards the teaching of elementary mathematics was reviewed. This questionnaire addressed the teaching of elementary mathematics focusing on the ability to teach concepts, confidence in teaching the concepts, and enjoyment in teaching mathematics to elementary students.

Preservice teachers' perception of elementary mathematics teaching is embedded in a system of beliefs. Johnson's (1980) study that focused on preservice elementary students' perception of teaching mathematics related to their completion of student teaching was reviewed. Much of Johnson's questionnaire focused on abilities and confidence after students had finished their field experience. Jerich's (1986) study of student perceptions was used as a basis to create statements related to an exit course in the methodology of teaching elementary school mathematics. The final study reviewed...
for this initial statement base was Kraicik's (1986) work on evaluation of a science
teacher education program. This study was used to create statements related to
technology and its effect on teaching behaviors and beliefs.

Generating the Initial Item Pool of 103 Statements

The aforementioned review assisted in creating a bank of belief and attitude
statements that were revised to fit the parameters suggested by the panel of mathematics
educators. This resulting list of 103 statements was given to the panel for reaction.
This general listing contained only statements regarding beliefs, attitudes and
perceptions of teaching elementary mathematics. A Likert scale to be used for
responses was not included since the goal was to obtain some reaction to the type of
statements. Their task was to evaluate the statements against the conceptual hypothesis
of "What are the beliefs of preservice elementary education students about
mathematics?" A copy of this initial document is found in Appendix A.

After reviewing these statements, the panel of mathematics educators suggested
that the initial questions were not specific enough to generate the type of statements
needed to reflect the potential changes. Therefore, a very specific framework of polar
ends was created to reflect desired outcomes. The matrix is listed in Table 1. The left
side indicates the behavior, belief, or attitude that is believed to be representative of a
student beginning the mathematics program, and the responses on the right indicate the
desired behavior, belief, or attitude for students ending course work for elementary
mathematics.
Table 1
Matrix of Belief Domains

<table>
<thead>
<tr>
<th>ENTERING</th>
<th>EXITING</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦ paper/pencil</td>
<td>manipulatives</td>
</tr>
<tr>
<td>individual</td>
<td>small group, whole class</td>
</tr>
<tr>
<td>tell/demonstrate</td>
<td>construct knowledge</td>
</tr>
<tr>
<td>textbook/worksheet</td>
<td>open-ended activity</td>
</tr>
<tr>
<td>memorize</td>
<td>problem solve</td>
</tr>
<tr>
<td>rote</td>
<td>open-ended</td>
</tr>
<tr>
<td>one-way (right/wrong)</td>
<td>many-ways</td>
</tr>
<tr>
<td>written assessment</td>
<td>interview, questioning</td>
</tr>
</tbody>
</table>

Technology use
not appropriate for elem. grades integrated with lessons

Beliefs toward mathematical content.
Beliefs toward mathematical learning
Beliefs toward mathematical teaching.
Beliefs toward mathematical assessment.

*Glossary of terms: Appendix B

Classifying and Generating the Second Item Pool of 192 Statements

With a more focused matrix to work from, a second review of the literature was undertaken. From this review and from recommended sources from colleagues the following documents were identified as relevant. Wood's (1990) review of beliefs of students before teacher education coursework, helped in creating statements focusing
on the entering behaviors on the left side of the matrix. Research by Schmidt and Kennedy (1990) about beliefs on subject matter teaching, assisted in writing the belief statements towards content, learning, teaching, and assessment. The Second Study of International Mathematics (1985) contained several questionnaires given to students and teachers across the country. These helped in creating statements for various polar ends.

In reviewing these studies it became obvious that a valuable audience was not being tapped for information. The research study centered on initial and final mathematics coursework. Since the researcher was currently teaching two sections of the exiting class, students in these classes were asked to participate in the design of statements.

After the focus was explained, small groups of students were given a set of polar ends from the matrix. They were asked to respond to these polar ends by detailing their initial beliefs of mathematics instruction when they began their coursework. They were also asked to respond to their understanding of teaching of mathematics education currently. During class time the small groups wrote 8 to 10 statements that reflected beliefs from each end of the matrix. Before turning in the statements they were asked to share their comments with another group to see if the intents of the statements were clearly written. The original statement list, student statements and the second review of literature information were compiled into a draft survey format that contained 192 statements.

Comparison of Items to Matrix and Reducing the Item Pool to 122 Statements

This master list (Appendix C) was distributed to all full time mathematics education faculty at this university for comments regarding clarification of statements and assistance in resolving definition issues as framed by the matrix. With the return of
the draft questionnaires by faculty, a comparison of comments, ratings and editing ideas were compiled. To reduce this number of statements to a manageable number, duplicate, unclear, or same meaning statements were deleted. These were rewritten for a second draft questionnaire containing 122 statements (Appendix D).

Formatting of Statements With Likert Scale

This draft was printed in standard form using a five point Likert scale of strongly disagree, disagree, neutral, agree, and strongly agree. The questionnaire included use of two formats. One was numbers (1-5) to correspond to the scale. The second used capital letters for categories (SD,D,N,A,SA). Stems of statements that include several individual items for the same stem were italicized to show the break in format from full statements. This draft was administered to Spring 1992 exiting classes to gather information regarding the format and clarity of statements. Comments from this activity aided in the creation of the pilot questionnaire.

The majority of students, in the methods of teaching mathematics course, indicated that the letter format (SD,D,N,A,SA) was preferred to the format of numbers (1-5) for responding to statements. However, of the 42 students, 3 indicated that the numbers were more helpful. The early morning class was asked to respond to the items as if they were just beginning their mathematics courses, while they are in fact at the end of their course work. For many their first course was just a year previous and memories were vivid concerning their beliefs from their mathematics course sequence. The most important response requested from them was to circle those words or phrases that would be unfamiliar to beginning mathematics students. This activity helped to identify words such as: manipulatives, guided discovery, algorithm, open-ended, and paper-pencil, as vocabulary that was not part of a beginning preservice elementary
education students' mathematics vocabulary. While some of the items were rewritten to reflect a vocabulary that would be known to students, some statements were left in the original wording.

Reducing the Item Pool to 72 Statements

The later morning class was asked to complete the survey as students finishing their required mathematics course sequence. This was their current enrollment, but they were to imagine that this would be the last day of class. Inappropriate vocabulary and phrasings were to be circled and suggestions for revisions were welcomed. This group was able to fill in Part I to evaluate whether this sequence of requested information flowed in an orderly manner.

The students were given indicators that separated the different polar ends of the matrix. They were to indicate the most appropriate statements within each sub-section (manipulatives, assessment, technology, etc.). A tally was compiled from each student group on a master copy along with comments and proposed changes. These tallies were compared with the faculty tallies to help reduce the selection of statements. A grid of statements with total tallies by each student group and faculty was created for selection purposes.

Both classes were asked to indicate how long it took to complete the questionnaire. Responses indicated one to two hours as the range of time. The instrument development activity was designated as a course project in order to provide motivation for students to work carefully through the questionnaire.

Ten questionnaires from each section were selected to code as if this was the actual event. This information assisted in selecting the final statements that are in the questionnaire. During this editing process, several statements were moved to different
matrix units since their focus would be more appropriate in that section. Space was provided on the questionnaire for students to write additional comments if they so chose. This completed the next phase of the creation of the final questionnaire of 72 statements that was used for piloting (Appendix E).

Creating Cover Letter and Instruction Sheet

A cover letter (Appendix F) was written to explain to students the purpose of the questionnaire and how the information would be used. The letter indicated that participation was voluntary and participation or non-participation would not be reflected in the course grade. Since there were several sections of each class, a general instruction letter for questionnaire facilitators was designed to maintain as much as possible, exact procedures in each instance. Further details of these items are found in the procedure section of this chapter.

Alternate Form (Form II)

While reviewing the initial results from the pilot questionnaire, the panel of mathematics educators questioned the true thinking of student responses to some statements. The panel of mathematics educators selected items from the original questionnaire and rewrote them in an open-ended format to get a clearer and deeper description of student thought. These items were typed with general directions on how to respond to the statements. Included in the material was a description of how to return the instrument and receive a token of appreciation for their time and effort. A sample of this document is included in Appendix G.
Pilot Study

The questionnaire, resulting from the above process, was piloted by entering and exiting mathematics classes during school year 1992-1993, September through April. Students (N=540) responded to the questionnaire during their first class session in their entering mathematics coursework and exiting students during the last week of their mathematics program. The purpose of the pilot was to check for clarity of wording of statements, ease of use, and generate data for reliability procedures. At this time there are no four year institutions with such an intense program as the project site for piloting outside the university for comparison purposes.

Upon return of the pilot questionnaires, the questionnaires were reviewed for clarity as indicated by response or non-response by the pilot group. The rewritten form became the Likert questionnaire (Form I) that was administered to entering coursework students in the first week of Fall 1993 and Winter 1994. The final week of classes for the Fall 1993 and Winter 1994 were used for students in the exiting mathematics education sequence of coursework.

Two examples of the Form II, the open-ended instrument, were piloted during Spring 1993 in exiting mathematics coursework classes. One example used an open-ended response format with one statement from each of the domains that allowed students to complete the thought of the statement. The second example took a statement from each of the domains and students were asked to write their thoughts about that statement.

Upon completion of the instrument, the students placed their responses in the envelope provided. There was a one week window to return the envelope. When the instruments were returned to class, the students received tokens of appreciation for their time and effort. The tokens of appreciation were sealed in envelopes for a "blind" pick.
by the student. These items were manipulatives that will be useful in future teaching situations. A college student was in charge of collecting the envelopes and returning them to the instructor. The instructor placed these in the researcher's mailbox for future analysis.

The results of the pilot of the two alternate forms indicated that more detailed responses were written by students responding to statements than in the second form in which students completed the statement. The responding to statement instrument was used as Form II, the open-ended questionnaire for the actual study. Statistical data was not obtained from Form II. The writings of the students were used to assist in the description of the analysis of the Likert questionnaire (Form I).

Reliability and Validity of Pilot Study:
Likert Questionnaire

Reliability is the generic term given to the problem of consistency of measurement (Brown, 1983). When only one form of a test is available for quantitative analysis the consistency of performance over the various items comprising the test can be investigated. Measures of internal consistency indicate the degrees to which the items found in the test are intercorrelated. The function is to decide if all items measure the same characteristic. Thus the "fit" of the internal structure of the instrument to the whole instrument is the primary outcome.

The Cronbach's coefficient alpha was used to give a measure of reliability among the items for each section of the matrix. The SPSS reliability program command was used to compute the above. Coefficient alpha can be interpreted as "the expected correlation between a test and another test of the same length drawn from the same domain or as the average expected correlation between all \( k \)-item tests constructed from this domain" (Brown, 1983, p. 89).
Table 2
Cronbach's Coefficient Alpha Test for Reliability on Domains-Likert

<table>
<thead>
<tr>
<th>Domain</th>
<th>alpha (Pilot)</th>
<th>alpha (Study)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N=534)</td>
<td>(n=267)</td>
</tr>
<tr>
<td>Total Likert (#9-80)</td>
<td>.91</td>
<td>.91</td>
</tr>
<tr>
<td>Teaching Domains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>manipulative use (#9-13)</td>
<td>.87 (41 items)</td>
<td>.88 (41 items)</td>
</tr>
<tr>
<td>instruction (#14-18)</td>
<td>.62</td>
<td>.66</td>
</tr>
<tr>
<td>discover (#19-23)</td>
<td>.70</td>
<td>.61</td>
</tr>
<tr>
<td>open-ended (#24-28)</td>
<td>.69</td>
<td>.71</td>
</tr>
<tr>
<td>classroom (#38-47)</td>
<td>.82</td>
<td>.83</td>
</tr>
<tr>
<td>testing (#48-53)</td>
<td>.72</td>
<td>.70</td>
</tr>
<tr>
<td>good teaching(#69-73)</td>
<td>.45</td>
<td>.24</td>
</tr>
<tr>
<td>Learning Domains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>problems(#29-34)</td>
<td>.77 (14 items)</td>
<td>.74 (14 items)</td>
</tr>
<tr>
<td>memorization (#35-37)</td>
<td>.70</td>
<td>.61</td>
</tr>
<tr>
<td>technology (#54-58)</td>
<td>.62</td>
<td>.57</td>
</tr>
<tr>
<td>Self Domains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>attitude (#59-68)</td>
<td>.61 (17 items)</td>
<td>.56 (17 items)</td>
</tr>
<tr>
<td>good at math (#74-80)</td>
<td>.67</td>
<td>.64</td>
</tr>
</tbody>
</table>

The definition of validity can be defined as the "degree to which the sample of test items represents the content that the test is designed to measure" (Borg & Gall, 1989, p. 250). Content validity for survey research is often established by selective judgment by a "panel of judges," such as mathematics educators. The mathematics educators hold credentials of tenure and associate level professor at a Level I Doctoral Research Institution. The previous mentioned literature review assisted in the verification that statements on the questionnaires are part of preservice elementary education students' beliefs.
A "panel of judges" as well as same population type students (n=50) was consulted for creation and review of statements since many instruments do not assess or consult the audience whose belief the instrument will attempt to measure (Ibrahim, 1990). Upon completion of a review of the pool of possible statements for Form I, the Likert questionnaire, student and faculty comments and concerns were compiled to eliminate inappropriate statements.

Population

The population for this study was preservice elementary education students enrolled in mathematics content and methods courses at a mid-size, four year institution of higher learning in the Mid-west. At this institution, all elementary education students must complete four mathematics classes for 14 credits and a practicum of 2 credits with additional classes in science content that results in a group elementary science and mathematics minor. This translates into a science endorsement for grades K-8 on the student's undergraduate official university transcripts.

The entering course in the mathematics sequence is, Number Concepts for Elementary/Middle School Teachers, which is usually taken by students in their freshman or sophomore year. The second course in the program is, Geometry for Elementary/Middle School Teachers, which is usually taken during freshman and sophomore years. A passing grade of C or better is required to progress to the next required class. The final content course, Probability and Statistics for Elementary/Middle School Teachers, is usually taken at the junior or senior level. A passing grade of C or better is required for admittance to the remaining class. The fourth course in this sequence is, Methods of Teaching Elementary School
Mathematics, which is also required from this institution. Descriptions of course contents are found in Appendix H.

For this study, all students entering mathematics coursework were given the opportunity to complete the questionnaires on their first day of class. The entering class is a requirement for all education students including special programs of study (music, special education, art, physical education, and speech pathology). Those students who indicated that their goal was to teach in any one "special program area" were eliminated from data analysis since they would not be taking the other three mathematics courses. Subjects indicating that they were repeating the initial course of number concepts for elementary school teachers were eliminated from the study because their answers would be biased from previously taking the course. School year 1993-1994, fall and winter terms were used for entering student data collection. This entering population consisted of 445 students with 110 freshmen, 161 sophomores, 162 juniors and 12 seniors.

All students exiting their mathematics coursework were given the opportunity to complete the questionnaires during their last week of classes. Some students may select to take the science and mathematics minor even though their goal is to specialize in a particular area (art, music, physical education, special education, or speech pathology). To maintain the control used for entering students, the same selection criteria for exiting students was used to eliminate such students for data analysis. School year 1993-1994, fall and winter terms was used for exiting student data collection. This exiting population consisted of 264 students with 11 sophomores, 80 juniors, and 173 seniors.

While both males and females are enrolled in mathematics education content courses, the population was 90% female. A small percentage, less than 5%,
represented minority populations. While the majority of the students are traditional college age students (ages’ 18-22) there was a sub-set population of non-traditional students. A non-traditional student was a student returning to complete a course of study after several years of absence due to family or work constraints, individuals initiating a teaching career after pursuing another career, or currently certified teachers returning for additional endorsements. This latter category of graduate/recertification students was eliminated from the study because the full compliment of four mathematics courses was not required for their program. The beginning two classes are given at other sites around the state and allowed to transfer into this institution for credit purposes. Additionally, only students completing all four courses at this institution were considered for data analysis. Using students who only experienced courses from this institution assisted in controlling the variable of curriculum content contamination.

Procedures

This section describes the procedures used for dissemination of the questionnaires. This study used numerous individuals to distribute the questionnaires to students. In order to maintain consistency standardized procedures were developed. Questionnaires and a cover letter were compiled for each section of entering or exiting coursework during the appropriate time of the semesters. A large envelope was included for completed questionnaires. A procedural letter (Appendix I) was placed on top of the materials addressed to the specific instructor and an indication of when to present the questionnaire to students. The letter indicated that approximately 20 minutes of class time was needed for completion by students. The procedures indicated that the cover letter (Appendix F) was to be distributed to all students and read by the
instructor. In the situation of the researcher's classes, another member of the faculty administered the questionnaires. The rationale was to maintain anonymity of those who might not wish to complete the questionnaire but would feel impelled to in the researcher's presence. The letter indicated to the instructor that there are alternate forms of the questionnaire and explained this to the students. The questionnaires were pre-packaged with alternating forms. The instructor only needed to pass them out to the students. Upon completion of the questionnaires, the instructor was instructed to place the questionnaires in the large envelope and return them to the department secretary who placed them in the researcher's mailbox. This procedure was used for Fall and Winter semesters of entering and exiting mathematics classes during school year 1993-1994.

Throughout the planning and execution of the study, the rights of the students were a high priority. Students were advised of the focus of the study and intended use of the results. Care was taken to maintain student anonymity during the data collection process. The benefit of the study was primarily informative for the profession and for the mathematics education goals of the university. The Human Subjects Institutional Review Board granted permission to continue in the manner written (Appendix J). Risks for the students were minimal but could include: coercion by instructors to complete the questionnaire, inadvertent disclosure of individual information and harm from either of these two possibilities. Course instructors distributing the instruments were instructed to follow specific procedures so risks were eliminated.

Additional care was taken by the researcher in interpreting markings by a student on Form I, the Likert questionnaire. If the researcher was unable to clearly interpret which Likert scale was chosen or if multiple scales were circled, the response for that statement was not coded. For Form II, the open-ended questionnaire, the
researcher continued carefully in making extrapolations about the intent of the written response and the analysis of that information.

Inferential Analysis

On the basis of the research hypotheses stated earlier, the following operational hypotheses were developed.

Operationalized Hypotheses

1. Exiting preservice elementary education students' beliefs about the teaching of mathematics will have a greater mean score than students entering mathematics coursework; $\alpha=0.05$.

2. Exiting preservice elementary education students' beliefs about the learning of mathematics will have a greater mean score than students entering mathematics coursework; $\alpha=0.05$.

3. Exiting preservice elementary education students' beliefs about their success or failure in mathematics will have a greater mean score than students entering mathematics coursework; $\alpha=0.05$.

Null Hypotheses

1. There will be no difference in the mean scores between preservice elementary education students entering and exiting beliefs about the teaching of mathematics.

2. There will be no difference in the mean scores between preservice elementary education students entering and exiting beliefs about the learning of mathematics.
3. There will be no difference in the mean scores between preservice elementary education students entering and exiting beliefs about their success or failure in mathematics.

To test the hypotheses, t-test group for independent means was used to test the difference of the means of the entering and exiting beliefs' of preservice elementary education students. Group scores were generated for each of the items in the domains under the three hypotheses.

Demographic information of total available population and usable population is displayed in Table 3 (found in Chapter V). The number of students enrolled in the entering and exiting mathematics courses for each semester was recorded. Further refinement looked at grade status (freshmen, sophomore, junior, senior) for entering and for exiting mathematics coursework and is displayed in Table 4 in Chapter V.

Transforming the Data for Analysis

Upon completion of the data collection, the letter responses on Form I, the Likert questionnaire, were recorded into numbers for statistical procedures (strongly disagree = 1, disagree = 2, neutral = 3, agree = 4 and strongly agree = 5). For those items that "disagree" was the positive response, scores were recoded using SPSS procedures before statistical procedures were programmed. The SPSS recode command was used to change a coded 1 to 5, a 2 to 4, a 4 to 2 and 5 to 1. Content analysis was used for clarification of the analysis of Likert data. For Form II, the open-ended questionnaire, a matrix format was created to record student responses. Each of the ten statements had a heading of whether the student answered the statement in an affirmative or negative response. Additionally, categories of types of responses were collected for comparison of trends of responses.
Use of Results

Results from the study were given to mathematics education faculty. From this analysis a review of course content may be initiated to match goals addressed in the matrix design. If differences are found, support for the faculty belief that the sequence of four mathematics courses reflects the direction of the NCTM Standards will be upheld. If differences are small, looking at the individual means may assist in checking which statements are generating differences. This will assist in decisions regarding restructure of course materials to connect or to align with the goals of the NCTM for preparation of preservice elementary education teachers.

Summary

This chapter describes the methods used in this study. The purpose of the study was to examine the entering and exiting beliefs of preservice elementary education students about the teaching and learning of mathematics and their beliefs about their success and failure in mathematics. To accomplish this goal, questionnaires were constructed to gain data about specific sub-topics under each domain such as: use of manipulatives in instruction, appropriate teaching patterns and attitudes towards mathematics. Participants were preservice elementary education students entering and exiting the elementary mathematics program coursework at a Mid-west university. This program was designed to reflect the NCTM Standards. Upon collection of data, analysis continued using statistical methods as well as descriptive writings. Chapter IV contains the analysis of the data.
CHAPTER IV

RESULTS

Introduction

The purpose of this study was to examine the beliefs of preservice elementary education students about the teaching and learning of mathematics and their beliefs about the underlying source of their success or failure in mathematics. The beliefs were structured around the goals of the NCTM Standards as taught through three contents and one methods mathematics courses. In addition, the researcher was interested in any patterns or trends of beliefs about mathematics that might emerge from the data. In order to examine these beliefs, two questionnaires were given to two groups of students when they were entering and exiting their mathematics coursework.

The questionnaires used were developed during a survey research class and are detailed in the previous chapter. The purpose of the five point value Likert questionnaire (Form I), was to obtain some objective measure of student beliefs based on the three main hypotheses. To gain better descriptions of the students' beliefs, the open-ended questionnaire (Form II), was designed to add depth to the analysis of the statistical results. This chapter presents the results of the study. Copies of the questionnaires are found in Appendix K.

Usable Responses

Likert (Form I) and Open-ended (Form II) questionnaires were distributed in an alternating format to students in the entering and exiting mathematics coursework.
classes. Table 3 indicates the total number of available students; there were 445 entering students and 264 exiting students. The usable sample consisted of 294 entering students and 225 exiting students; some subjects were eliminated from the study for the following reasons. The category "not general education" refers to students who indicated on the questionnaire that their goal was to be an elementary teacher with responsibilities in other areas such as: special education, music, physical education, or art. This group of students is only required to take the initial mathematics course in their program. These students indicating such a goal were eliminated. Other reasons for elimination were students had repeated the initial course, no cover sheet available, returned for recertification that does not require the full compliment of coursework, and enrolled in other institutions for beginning coursework which was accepted by this university for enrollment in the education program.

The class status count and percent of the entering and exiting sample for the Likert and open-ended questionnaire are represented in Table 4. For the entering students, 70% are sophomores and juniors.

Plan for Reporting Data

In this section, the results from the Likert (Form I) and open-ended (Form II) questionnaires are presented for students entering and exiting their mathematics coursework. First, the mean scores, standard deviations, differences between means, and 2-tailed probability of the total survey are described along with the entering and exiting beliefs of the three domains as stated in the hypotheses. The domains are: the nature of teaching mathematics, the nature of learning mathematics, and the nature of their underlying success or failure in mathematics (Table 5). Second, the sub-topics’ results for each of the three domains are presented from the Likert questionnaire (Tables
### Table 3

Available Sample and Usable Sample After Exclusions

<table>
<thead>
<tr>
<th></th>
<th>Entering Sample</th>
<th></th>
<th>Exiting Sample</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall</td>
<td>Winter</td>
<td>Fall</td>
<td>Winter</td>
</tr>
<tr>
<td>Total Responses</td>
<td>232</td>
<td>213</td>
<td>126</td>
<td>138</td>
</tr>
<tr>
<td>Exclusion:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not General Education</td>
<td>59</td>
<td>62</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Repeating Coursework</td>
<td>13</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Cover Sheet</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Recertification</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coursework Outside</td>
<td>8</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usable Responses</td>
<td>160</td>
<td>134</td>
<td>109</td>
<td>116</td>
</tr>
<tr>
<td>Totals</td>
<td>294</td>
<td></td>
<td>225</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4

Usable Sample Class Status

<table>
<thead>
<tr>
<th></th>
<th>Entering</th>
<th></th>
<th>Exiting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Likert</td>
<td>%</td>
<td>Open-ended</td>
<td>#</td>
</tr>
<tr>
<td>Freshman</td>
<td>39</td>
<td>25</td>
<td>42</td>
<td>30</td>
</tr>
<tr>
<td>Sophomore</td>
<td>62</td>
<td>41</td>
<td>40</td>
<td>28</td>
</tr>
<tr>
<td>Junior</td>
<td>46</td>
<td>30</td>
<td>53</td>
<td>38</td>
</tr>
<tr>
<td>Senior</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td>153</td>
<td>100</td>
<td>141</td>
<td>100</td>
</tr>
</tbody>
</table>

*Percent may not equal 100% due to rounding of results.
6, 7, and 8). Third, the individual item results from the Likert questionnaire are presented (Tables 9, 10, and 11). The percent of responses from the open-ended questionnaire are found in Table 12. Actual responses from entering and exiting students from the open-ended questionnaire are found in Appendix L.

In reporting the analysis for each t-test group of independent means the separate variance estimate was used in place of the pooled variance. The separate variance was used as a more conservative measure. If two population distributions can be assumed to have the same variance and standard deviation, then the pooled variance of the t-test is more likely to demonstrate significant results. However, if the variances of the two populations are not known to have equal variance then the separate variance is a more conservative measure of the two populations for demonstrating significance (Crocher & Algina, 1986).

Likert Questionnaire

Means and standard deviations from the results of the t-test of independent means of students entering and exiting mathematics coursework are shown in Table 5. Results for the total survey and for each of the three domains represent the mean score of change in beliefs from entering mathematics coursework to exiting mathematics coursework. For items in two of the three categories, teaching and learning of mathematics, findings indicated a consistent change in beliefs with a mean difference range of 0.16 - 0.66 for each category (Tables 6, 7). For the third domain, the nature of self, the item range was 0.04 - 0.26 (Table 8).

The results of the nature of teaching domain sub-topics (Table 6) continue a change in beliefs with a mean difference range of 0.16 - 0.60 between entering and exiting students.
Table 5
Responses of Entering and Exiting Students - Likert Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Entering (n=153)**</th>
<th>Exiting (n=114)</th>
<th>Separate variance estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Difference</td>
</tr>
<tr>
<td>Total Survey</td>
<td>3.50 (.24)</td>
<td>3.85 (.23)</td>
<td>0.35</td>
</tr>
<tr>
<td>Nature of Teaching</td>
<td>3.61 (.29)</td>
<td>3.95 (.28)</td>
<td>0.34</td>
</tr>
<tr>
<td>Nature of Learning</td>
<td>3.01 (.34)</td>
<td>3.57 (.30)</td>
<td>0.56</td>
</tr>
<tr>
<td>Nature of Self</td>
<td>3.65 (.30)</td>
<td>3.82 (.26)</td>
<td>0.17</td>
</tr>
</tbody>
</table>

**The range of entering students was 150 to 153 and for exiting students 112 to 114.

* p< .05.

The results of the difference in means for the items in the nature of learning domain sub-topics (Table 7) indicate a consistent change in beliefs with a mean difference ranging from 0.47 - 0.66 for each category.

The results of the difference in means for the nature of self domain have a mean difference range of 0.04 - 0.26 (Table 8). Since this is a minimal difference between the means of entering and exiting students one must exercise caution in attaching practical significance to the results.

Individual Item Responses - Likert Questionnaire

Tables 9-11 show entering and exiting means and standard deviations for the individual items found in the three domains. Each of the three domains individual items are displayed in separate tables.
### Table 6

**Nature of Teaching Domain-Likert Student Results**

<table>
<thead>
<tr>
<th>Likert Items</th>
<th>Entering (n=153)**</th>
<th>Exiting (n=114)</th>
<th>Separate variance estimate</th>
<th>2-tail prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>Manipulatives (#9-13)</td>
<td>3.63 (.51)</td>
<td>4.23 (.43)</td>
<td>0.60</td>
<td>.00*</td>
</tr>
<tr>
<td>Instruction (#14-18)</td>
<td>3.61 (.56)</td>
<td>3.98 (.50)</td>
<td>.37</td>
<td>.00*</td>
</tr>
<tr>
<td>Discovery (#19-23)</td>
<td>3.93 (.52)</td>
<td>4.25 (.50)</td>
<td>0.32</td>
<td>.00*</td>
</tr>
<tr>
<td>Open ended (#24-28)</td>
<td>3.92 (.50)</td>
<td>4.16 (.53)</td>
<td>0.24</td>
<td>.00*</td>
</tr>
<tr>
<td>Classroom (#38-47)</td>
<td>3.69 (.37)</td>
<td>4.05 (.32)</td>
<td>0.36</td>
<td>.00*</td>
</tr>
<tr>
<td>Testing (#48-53)</td>
<td>2.88 (.35)</td>
<td>3.22 (.40)</td>
<td>0.34</td>
<td>.00*</td>
</tr>
<tr>
<td>Good teaching (#69-73)</td>
<td>3.67 (.38)</td>
<td>3.83 (.38)</td>
<td>0.16</td>
<td>.00*</td>
</tr>
</tbody>
</table>

**The range for entering students was 150 to 153 and for exiting students 112 to 114.**

*p < .05.

**Open-Ended Questionnaire**

The open-ended questionnaire (Form II) consisted of ten statements taken from the Likert questionnaire (Form I) without the five point scale. Students were asked to respond favorably or negatively to the statements and cite specific examples if possible. The percent of response for the entering and exiting students are displayed in Table 12. Information from these responses will be detailed in the following chapter under the sub-topics interpretations for each of the three domains; the nature of teaching.
Table 7
Nature of Learning Domain-Likert Student Results

<table>
<thead>
<tr>
<th>Likert Items</th>
<th>Entering Mean (SD)</th>
<th>Exiting Mean (SD)</th>
<th>Difference</th>
<th>2-tail prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems (#29-34)</td>
<td>2.93 (.46)</td>
<td>3.40 (.43)</td>
<td>0.47</td>
<td>.00*</td>
</tr>
<tr>
<td>Memorization (#35-37)</td>
<td>2.50 (.51)</td>
<td>3.08 (.54)</td>
<td>0.58</td>
<td>.00*</td>
</tr>
<tr>
<td>Technology (#54-58)</td>
<td>3.40 (.45)</td>
<td>4.06 (.47)</td>
<td>0.66</td>
<td>.00*</td>
</tr>
</tbody>
</table>

**The range for entering students was 150 to 153 and for exiting students 112 to 114.

* p<.05.

Table 8
Nature of Self Domain-Likert Student Results

<table>
<thead>
<tr>
<th>Likert Items</th>
<th>Entering Mean (SD)</th>
<th>Exiting Mean (SD)</th>
<th>Difference</th>
<th>2-tail prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude (#59-68)</td>
<td>3.56 (.43)</td>
<td>3.82 (.37)</td>
<td>0.26</td>
<td>.00*</td>
</tr>
<tr>
<td>Good at math (#74-80)</td>
<td>3.77 (.30)</td>
<td>3.81 (.32)</td>
<td>0.04</td>
<td>.40</td>
</tr>
</tbody>
</table>

**The range for entering students in 150 to 153 and for exiting students 112 to 114.

* p<.05.
Table 9
Likert Student Results-Domain: Teaching of Mathematics

<table>
<thead>
<tr>
<th>Domain: Teaching of Mathematics</th>
<th>Enter Mean (SD)</th>
<th>Exit Mean (SD)</th>
<th>Diff. Tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td># Statement from Questionnaire</td>
<td>Enter Exit</td>
<td>Transform</td>
<td>Transform</td>
</tr>
<tr>
<td>Manipulatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Children who answer correctly</td>
<td>3.11 (1.02)</td>
<td>3.93 (.84)</td>
<td>0.82 .00*</td>
</tr>
<tr>
<td>all problems on a worksheet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fully understand the concept.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Manipulatives are useful</td>
<td>4.14 (.86)</td>
<td>4.50 (.78)</td>
<td>0.36 00*</td>
</tr>
<tr>
<td>tools in understanding all</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>types of mathematics in all</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grades.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Because of the cost of most</td>
<td>3.82 (.76)</td>
<td>4.40 (.71)</td>
<td>0.58 00*</td>
</tr>
<tr>
<td>manipulatives, it is better to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>learn paper pencil approaches.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 The use of rules to produce</td>
<td>3.12 (.85)</td>
<td>3.83 (.86)</td>
<td>0.71 00*</td>
</tr>
<tr>
<td>answers is best taught using</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>paper-pencil instruction.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Upper elementary children</td>
<td>3.94 (.71)</td>
<td>4.52 (.55)</td>
<td>0.58 00*</td>
</tr>
<tr>
<td>find no connection between</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>manipulatives and concepts.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruction</td>
<td>Enter Exit</td>
<td>Transform</td>
<td>Transform</td>
</tr>
<tr>
<td>14 Because small group activities</td>
<td>4.20 (.70)</td>
<td>4.48 (.63)</td>
<td>0.28 00*</td>
</tr>
<tr>
<td>create confusion and noise not</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>much learning takes place.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 A classroom with a high noise</td>
<td>2.98 (1.21)</td>
<td>3.90 (.93)</td>
<td>0.92 00*</td>
</tr>
<tr>
<td>level is not a good math</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>learning environment.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 In small groups only a few</td>
<td>3.82 (.77)</td>
<td>3.97 (.75)</td>
<td>0.15 00*</td>
</tr>
<tr>
<td>students are really learning the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>concept.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Statement from Questionnaire</td>
<td>Enter Mean (SD) (n=153)</td>
<td>Exit Mean (SD) (n=114)</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>17</td>
<td>Individual work is the best way to practice rules.</td>
<td>3.57 (.88)</td>
<td>3.90 (.80)</td>
</tr>
<tr>
<td>18</td>
<td>Whole class instruction is more efficient since all children need to learn all concepts to the same depth.</td>
<td>3.51 (.95)</td>
<td>3.62 (.85)</td>
</tr>
<tr>
<td></td>
<td><strong>Discover</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>The teacher’s role is to demonstrate to students how to do problems.</td>
<td>2.81 (1.04)</td>
<td>3.41 (.94)</td>
</tr>
<tr>
<td>20</td>
<td>Facts told to a student are much more likely to be remembered than facts the student discovers.</td>
<td>4.26 (.73)</td>
<td>4.52 (.60)</td>
</tr>
<tr>
<td>21</td>
<td>Students understand concepts better when teachers encourage them to discover concepts on their own.</td>
<td>4.07 (.84)</td>
<td>4.47 (.64)</td>
</tr>
<tr>
<td>22</td>
<td>Guided discovery and questioning helps children learn thinking processes and gain self-confidence.</td>
<td>4.30 (.69)</td>
<td>4.44 (.63)</td>
</tr>
<tr>
<td>23</td>
<td>Guided discovery and questioning activities will lead to further discovery by students on their.</td>
<td>4.17 (.68)</td>
<td>4.41 (.59)</td>
</tr>
<tr>
<td></td>
<td><strong>Open-Ended</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Given the choice, I’d prefer to teach with open-ended activities and without textbook/worksheets.</td>
<td>3.33 (.91)</td>
<td>3.80 (.88)</td>
</tr>
<tr>
<td>#</td>
<td>Statement from Questionnaire</td>
<td>Enter Mean (SD)</td>
<td>Exit Mean (SD)</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>25</td>
<td>Open-ended activities make learning fun and interesting.</td>
<td>4.08 (.65)</td>
<td>4.22 (.61)</td>
</tr>
<tr>
<td>26</td>
<td>Open-ended activities adds variety to teaching.</td>
<td>4.22 (.51)</td>
<td>4.35 (.53)</td>
</tr>
<tr>
<td>27</td>
<td>Open-ended activities helps students remember procedures.</td>
<td>3.93 (.67)</td>
<td>4.18 (.63)</td>
</tr>
<tr>
<td>28</td>
<td>Open-ended activities helps students transfer knowledge to new areas.</td>
<td>4.04 (.52)</td>
<td>4.23 (.58)</td>
</tr>
<tr>
<td></td>
<td><strong>Classroom</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>When you get the wrong answer to a math problem it is absolutely wrong, there is no room for argument.</td>
<td>3.86 (.86)</td>
<td>4.18 (.80)</td>
</tr>
<tr>
<td>39</td>
<td>Children following exact procedures always perform better than in open-ended problem solving situations.</td>
<td>3.62 (.74)</td>
<td>3.86 (.69)</td>
</tr>
<tr>
<td>40</td>
<td>The use of manipulatives and classroom discussion are necessary for teaching by rules/procedures.</td>
<td>3.58 (.71)</td>
<td>3.82 (.82)</td>
</tr>
<tr>
<td>41</td>
<td>Open-ended teaching and the use of manipulatives are only appropriate for primary grades.</td>
<td>3.73 (.70)</td>
<td>4.26 (.70)</td>
</tr>
<tr>
<td>42</td>
<td>In math classes “rules of thumb” should be taught as the way to learn math.</td>
<td>3.03 (.77)</td>
<td>3.61 (.79)</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Domain: Teaching of Mathematics</th>
<th>Enter Mean (SD) (n=153)</th>
<th>Exit Mean (SD) (n=114)</th>
<th>Diff.</th>
<th>2-Tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td># Statement from Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43 Sometimes it is best for the teacher to act as an observer and allow the learning to happen.</td>
<td>3.97 (.82)</td>
<td>4.31 (.61)</td>
<td>0.34</td>
<td>.00*</td>
</tr>
<tr>
<td>44 Students need paper-pencil computation skills to do most math problems.</td>
<td>2.58 (.77)</td>
<td>3.33 (.92)</td>
<td>0.75</td>
<td>.00*</td>
</tr>
<tr>
<td>45 Many different models and materials should be used in the classroom.</td>
<td>4.33 (.59)</td>
<td>4.61 (.49)</td>
<td>0.28</td>
<td>.00*</td>
</tr>
<tr>
<td>46 Trial and error can often be used to solve a math problem.</td>
<td>4.12 (.60)</td>
<td>4.30 (.64)</td>
<td>0.18</td>
<td>.02*</td>
</tr>
<tr>
<td>47 There are many different ways to solve most mathematics problems.</td>
<td>4.05 (.80)</td>
<td>4.25 (.61)</td>
<td>0.20</td>
<td>.02*</td>
</tr>
<tr>
<td><strong>Testing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 To test student performance in mathematics, the teacher should develop paper-pencil tests to content taught.</td>
<td>2.64 (.69)</td>
<td>3.21 (.88)</td>
<td>0.57</td>
<td>.00*</td>
</tr>
<tr>
<td>49 Written assessments are no longer needed in classrooms because of the variety of alternative assessments available to the teacher.</td>
<td>2.50 (.72)</td>
<td>2.50 (.84)</td>
<td>0.00</td>
<td>.97</td>
</tr>
<tr>
<td>50 The purpose of testing is only for the teacher to get information on student performance.</td>
<td>3.14 (1.07)</td>
<td>3.45 (.98)</td>
<td>0.31</td>
<td>.02*</td>
</tr>
<tr>
<td>51 Varied forms of assessment are not needed, one or two will sufficient.</td>
<td>3.78 (.71)</td>
<td>4.10 (.65)</td>
<td>0.32</td>
<td>.00*</td>
</tr>
</tbody>
</table>

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### Table 9--Continued

<table>
<thead>
<tr>
<th>Domain:</th>
<th>Enter Mean (SD) &lt;i&gt;(n=153)&lt;/i&gt;</th>
<th>Exit Mean (SD) &lt;i&gt;(n=114)&lt;/i&gt;</th>
<th>Diff.</th>
<th>2-Tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Good Teaching</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52 The more homework = more practice = more understanding.</td>
<td>2.92 (1.11)</td>
<td>3.68 (1.00)</td>
<td>0.76</td>
<td>.00*</td>
</tr>
<tr>
<td>53 The best way to assess student work is on an individual basis.</td>
<td>2.29 (.79)</td>
<td>2.42 (.93)</td>
<td>0.13</td>
<td>.21</td>
</tr>
</tbody>
</table>

**The range for entering students is 150 to 153 and for exiting students 112 to 114.**

*p<.05.*
Table 10
Likert Student Results-Domain: Learning of Mathematics

<table>
<thead>
<tr>
<th>#</th>
<th>Statement from Questionnaire</th>
<th>Enter Mean (SD)</th>
<th>Exit Mean (SD)</th>
<th>Diff.</th>
<th>2-Tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>In math class you have to accept the fact that many facts must be memorized.</td>
<td>2.31 (.81)</td>
<td>2.83 (.97)</td>
<td>0.52</td>
<td>.00*</td>
</tr>
<tr>
<td>30</td>
<td>Students perform better on tests when they memorize the procedures.</td>
<td>3.00 (1.03)</td>
<td>3.70 (.80)</td>
<td>0.70</td>
<td>.00*</td>
</tr>
<tr>
<td>31</td>
<td>Problem-solving strategies cannot be tested.</td>
<td>3.87 (.70)</td>
<td>4.14 (.61)</td>
<td>0.27</td>
<td>.00*</td>
</tr>
<tr>
<td>32</td>
<td>Mathematics is mostly facts and procedures that have to be memorized.</td>
<td>3.20 (.88)</td>
<td>3.95 (.69)</td>
<td>0.75</td>
<td>.00*</td>
</tr>
<tr>
<td>33</td>
<td>Problem-solving strategies are easy to learn.</td>
<td>2.65 (.86)</td>
<td>2.96 (.94)</td>
<td>0.31</td>
<td>.00*</td>
</tr>
<tr>
<td>34</td>
<td>Problem-solving strategies are easy to teach.</td>
<td>2.52 (.73)</td>
<td>2.80 (.88)</td>
<td>0.28</td>
<td>.01*</td>
</tr>
<tr>
<td></td>
<td><strong>Memorize</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Memorizing is important in learning mathematics.</td>
<td>2.45 (.75)</td>
<td>3.19 (.88)</td>
<td>0.74</td>
<td>.00*</td>
</tr>
<tr>
<td>36</td>
<td>The best way to do well is to memorize formulas.</td>
<td>3.09 (.89)</td>
<td>3.94 (.74)</td>
<td>0.85</td>
<td>.00*</td>
</tr>
<tr>
<td>37</td>
<td>Some basic mathematical content must be memorized.</td>
<td>2.01 (.48)</td>
<td>2.11 (.68)</td>
<td>0.10</td>
<td>.15</td>
</tr>
</tbody>
</table>
Table 10—Continued

<table>
<thead>
<tr>
<th>Domain: Learning of Mathematics</th>
<th>Enter Mean (SD) (n=153)</th>
<th>Exit Mean (SD) (n=114)</th>
<th>Diff.</th>
<th>2-Tail Prob.</th>
</tr>
</thead>
</table>

**Technology**

54 The use of technology (calculators, computers) enables students to avoid learning to compute with paper-and-pencil.

2.99 (1.01) 3.62 (1.02) 0.63 .00*

55 Technology can aid in the development of mathematical concepts.

3.94 (.70) 4.38 (.51) 0.44 .00*

56 Calculators have little relevance to elementary student’s daily lives.

3.06 (1.07) 4.34 (.66) 1.28 .00*

57 The use of an overhead is a more effective way of teaching than using a chalkboard.

2.95 (.78) 3.69 (.78) 0.74 .00*

58 Computer math programs used in the classroom can reinforce concepts and provide practice time.

4.07 (.51) 4.27 (.63) 0.20 .01*

**The range for entering students was 150 to 153 and for exiting students 112 to 114.

*p< .05.

mathematics, the nature of learning mathematics, and the nature of their underlying source of success or failure in mathematics.

The total number of students responding to the individual statements on the open-ended questionnaire ranged from 127 to 141 for entering students and 95 to 109 for exiting students. The column marked "other" represents comments such as "I don't
Table 11
Likert Student Results-Domain:
Success and Failure of Self

<table>
<thead>
<tr>
<th>Domain: Learning of Mathematics</th>
<th>Enter Mean (SD) (n=153)</th>
<th>Exit Mean (SD) (n=114)</th>
<th>Diff.</th>
<th>2-Tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td># Statement from Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Attitude</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59 I can get along well in everyday life without using mathematics.</td>
<td>4.11 (.86)</td>
<td>4.51 (.72)</td>
<td>0.40</td>
<td>.00*</td>
</tr>
<tr>
<td>60 I usually understand what we are talking about in math class.</td>
<td>3.52 (.85)</td>
<td>4.16 (.61)</td>
<td>0.64</td>
<td>.00*</td>
</tr>
<tr>
<td>61 I work a long time in order to understand a new idea in mathematics.</td>
<td>2.71 (.95)</td>
<td>3.08 (1.03)</td>
<td>0.37</td>
<td>.00*</td>
</tr>
<tr>
<td>62 A knowledge of mathematics is not necessary in most occupations.</td>
<td>4.19 (.81)</td>
<td>4.48 (.79)</td>
<td>0.29</td>
<td>.00*</td>
</tr>
<tr>
<td><strong>When I get a good grade in math:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63 -it is because I work hard.</td>
<td>1.73 (.68)</td>
<td>1.94 (.73)</td>
<td>0.21</td>
<td>.02*</td>
</tr>
<tr>
<td>64 -it is because I'm confident in my abilities.</td>
<td>3.75 (.89)</td>
<td>3.94 (.79)</td>
<td>0.19</td>
<td>.07</td>
</tr>
<tr>
<td>65 -it is just a matter of luck.</td>
<td>3.73 (.99)</td>
<td>4.05 (.87)</td>
<td>0.32</td>
<td>.01*</td>
</tr>
<tr>
<td>66 -I never know how it happens.</td>
<td>4.12 (.92)</td>
<td>4.33 (.70)</td>
<td>0.21</td>
<td>.03*</td>
</tr>
<tr>
<td><strong>When I get a poor grade in math:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>67 -it is because I didn't study hard enough.</td>
<td>3.69 (1.03)</td>
<td>3.69 (1.02)</td>
<td>0.00</td>
<td>.98</td>
</tr>
<tr>
<td>68 -it is because of careless mistakes.</td>
<td>4.08 (.81)</td>
<td>4.05 (.79)</td>
<td>0.03</td>
<td>.80</td>
</tr>
</tbody>
</table>
Table 11—Continued

<table>
<thead>
<tr>
<th>Domain: Learning of Mathematics</th>
<th>Enter Mean (SD) (n=153)</th>
<th>Exit Mean (SD) (n=114)</th>
<th>Diff.</th>
<th>2-Tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Good at Math</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>To be good at mathematics,</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I need to:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>74  -work hard at it.</td>
<td>4.21 (.81)</td>
<td>3.92 (.81)</td>
<td>0.29</td>
<td>.01*</td>
</tr>
<tr>
<td>75  -remember formulas,</td>
<td>1.97 (.66)</td>
<td>2.54 (.88)</td>
<td>0.57</td>
<td>.00*</td>
</tr>
<tr>
<td>principles and procedures.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>76  -think in a logical step-by-</td>
<td>4.16 (.65)</td>
<td>4.01 (.70)</td>
<td>0.15</td>
<td>.08</td>
</tr>
<tr>
<td>step manner.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77  -have basic understandings</td>
<td>4.36 (.48)</td>
<td>4.31 (.50)</td>
<td>0.05</td>
<td>.44</td>
</tr>
<tr>
<td>of concepts and strategies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>78  -be able to think flexibly.</td>
<td>4.29 (.66)</td>
<td>4.33 (.59)</td>
<td>0.04</td>
<td>.57</td>
</tr>
<tr>
<td>79  -have confidence I can do it.</td>
<td>4.47 (.55)</td>
<td>4.50 (.50)</td>
<td>0.03</td>
<td>.61</td>
</tr>
<tr>
<td>80  -have a “mathematical mind”</td>
<td>2.97 (1.17)</td>
<td>3.03 (1.08)</td>
<td>0.06</td>
<td>.67</td>
</tr>
</tbody>
</table>

**The range for entering students was 150 to 153 and for exiting students 112 to 114.**

* p<.05.

"I know", "maybe", or "sometimes." Actual student responses are found in Appendix L for fall and winter semesters for entering and exiting students.
Table 12
Percent of Student Responses-Open-Ended Format Questionnaire

<table>
<thead>
<tr>
<th>Questionnaire Statements</th>
<th>#</th>
<th>Yes</th>
<th>No</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. To be good at mathematics I need to have a Mathematical mind.&quot;</td>
<td>139</td>
<td>25</td>
<td>71</td>
<td>3</td>
</tr>
<tr>
<td>Q2. To be a good teacher of elementary mathematics you need to encourage students to think and question.</td>
<td>141</td>
<td>96</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Q3. There are many different ways to solve most mathematics problems.</td>
<td>141</td>
<td>84</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Q4. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.</td>
<td>130</td>
<td>65</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Q5. The purpose of testing is only for the teacher to get information on student performance.</td>
<td>131</td>
<td>31</td>
<td>69</td>
<td>0</td>
</tr>
<tr>
<td>Q6. The more homework = more practice = more understanding.</td>
<td>135</td>
<td>45</td>
<td>31</td>
<td>24</td>
</tr>
<tr>
<td>Q7. Mathematics is mostly facts and procedures that have to be memorized.</td>
<td>128</td>
<td>48</td>
<td>39</td>
<td>13</td>
</tr>
<tr>
<td>Q8. Children who answer correctly all problems on a worksheet fully understand the concept that was taught.</td>
<td>134</td>
<td>17</td>
<td>73</td>
<td>10</td>
</tr>
<tr>
<td>Q9. The use of calculators enables students to avoid learning to compute with paper and pencil.</td>
<td>124</td>
<td>48</td>
<td>48</td>
<td>3</td>
</tr>
</tbody>
</table>

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Table 12—Continued

<table>
<thead>
<tr>
<th>Questionnaire Statements</th>
<th>Yes</th>
<th>No</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entering</strong></td>
<td>#</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Q10. In small groups only a few students are really learning the concept.</td>
<td>127</td>
<td>17</td>
<td>58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questionnaire Statements</th>
<th>Yes</th>
<th>No</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exiting</strong></td>
<td>#</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Q1. To be good at mathematics I need to have a Mathematical mind.&quot;</td>
<td>105</td>
<td>22</td>
<td>78</td>
</tr>
<tr>
<td>Q2. To be a good teacher of elementary mathematics you need to encourage students to think and question.</td>
<td>111</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Q3. There are many different ways to solve most mathematics problems.</td>
<td>109</td>
<td>96</td>
<td>2</td>
</tr>
<tr>
<td>Q4. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.</td>
<td>109</td>
<td>96</td>
<td>4</td>
</tr>
<tr>
<td>Q5. The purpose of testing is only for the teacher to get information on student performance.</td>
<td>103</td>
<td>22</td>
<td>77</td>
</tr>
<tr>
<td>Q6. The more homework = more practice = more understanding.</td>
<td>107</td>
<td>10</td>
<td>83</td>
</tr>
<tr>
<td>Q7. Mathematics is mostly facts and procedures that have to be memorized.</td>
<td>104</td>
<td>6</td>
<td>93</td>
</tr>
</tbody>
</table>
Table 12—Continued

<table>
<thead>
<tr>
<th>Questionnaire Statements</th>
<th>Exiting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
</tr>
<tr>
<td>Q8. Children who answer correctly all problems on a worksheet fully understand the concept that was taught.</td>
<td>104</td>
</tr>
<tr>
<td>Q9. The use of calculators enables students to avoid learning to compute with paper and pencil.</td>
<td>111</td>
</tr>
<tr>
<td>Q10. In small groups only a few students are really learning the concept.</td>
<td>95</td>
</tr>
</tbody>
</table>

Findings Related to Hypothesis

Hypothesis I - The Nature of Teaching Mathematics

Using the alpha level of 0.05, the findings result in rejecting the null hypothesis that there is no difference between entering and exiting beliefs of preservice elementary education students about the teaching of mathematics.

Hypothesis II - The Learning of Mathematics

Using the alpha level of 0.05, the findings result in rejecting the null hypothesis that there is no difference between entering and exiting beliefs of preservice elementary education students about the learning of mathematics.
Hypothesis III - The Nature of Success and Failure of Self in Mathematics

Using the alpha level of 0.05, the findings result in rejecting the null hypothesis that there is no difference between entering and exiting beliefs of preservice elementary education students about their underlying source of success or failure in mathematics.

Missing Data

Missing data is a concern for any researcher in a study. The Likert questionnaire (Form I) data responses were exceptionally complete. There were three entering and two exiting subjects who did not answer the last seven items on the final page. Reasons for this might suggest a lack of time to complete the questionnaire or not noticing the arrow indicating another page. Other data that was missing was sporadic suggesting that either the students could not make a choice from the scale or just skipped an item. Fifteen entering and 14 exiting questionnaires were found that indicated missing one or two responses to a statement.

On the open-ended questionnaire, responses varied from a simple favorable or negative indication too lengthy written statements reflecting a subject's viewpoint for the item asked. Questions #9 and #10 had the fewest responses. This might indicate a lack of time to complete the questionnaire. The remainder of the missing responses did not form any discernible pattern.

Summary

This chapter has presented data of the study based on two questionnaires, the five point value Likert (Form I) and the open--ended format (Form II) which sought to examine the beliefs of preservice elementary teachers regarding mathematics. The researcher grouped data around the following domains: the nature of teaching
mathematics, the nature of learning mathematics, and nature of the underlying source of their success or failure in mathematics.

The descriptive and statistical information for the three domains was presented in this chapter. In the final chapter the researcher will attempt to analyze the data across the domains and develop some foundations regarding the beliefs of preservice elementary education students.
CHAPTER V

DISCUSSION AND CONCLUSIONS

Introduction

The purpose of this study was to examine the beliefs of preservice elementary education students about the teaching and learning of mathematics and beliefs underlying their success or failure in mathematics. As noted by previous research studies, preservice elementary teachers' beliefs may determine their classroom behavior when instructing elementary children (Wilcox et al., 1991). Also, understanding preservice elementary education students' beliefs may assist in the development of appropriate mathematics coursework to reflect the beliefs needed for the classroom of the twenty-first century (Underhill, 1988a).

To assess these beliefs two questionnaires with different formats were administered to 10 classes of entering students and 12 classes of exiting students during fall and winter terms' 1993-1994. One questionnaire was a five point value Likert (Form I) and the other a ten question open-ended format (Form II). Questionnaires were given to entering preservice elementary education students during their first week of classes in their mathematics coursework and to exiting preservice elementary education students during their final week of mathematics coursework. The mathematics program consists of three content classes and one methods class in the teaching of mathematics.
In this chapter, conclusions are drawn from the data captured by the Likert and open-ended questionnaires. Discussion will also focus on limitations of the study and recommendations for further research.

**Statistical and Practical Significance Determination**

Although the value of this study centers on providing foundational information regarding the beliefs of preservice elementary education students about the teaching and learning of mathematics, consideration was given to the practical value of the findings. Is there a change in this area and is it sufficiently large for educators to consider it important? This researcher has used 0.30 as a criterion for overall and for each subcategory as appropriate difference of the means for the entering and exiting students which has relevance to practitioners. To set a conservative measure criterion for accepting this difference the following reasons were used: (a) lack of other data for comparison, (b) it was a natural cut-off point in the distribution of the data, (c) this criterion provided a balance for practical teaching application, and (d) implementing such changes into a curriculum that reflect the NCTM Standards would not be an excessively costly process.

**Interpretation**

An overall interpretation of this study is that the difference in the preservice elementary education student means indicate a change in their belief structure regarding the teaching and learning of mathematics. For the third domain, the underlying source of their success or failure in mathematics, little change is evident. This is consistent with research that suggests that changing attitudes is an extremely difficult process (McLeod & Ortega, 1993). The following is an interpretation for each of the domains,
the nature of teaching mathematics, the nature of learning mathematics, and the nature of their underlying source of success or failure in mathematics.

**Interpretation of Nature of Teaching Domain**

The Likert questionnaire consisted of 72 statements grouped under various sub-categories for the three domains. Forty-one of these items are addressed under the domain the nature of teaching. From these statements the means and standard deviations were compiled for statistical interpretation. To add descriptive interpretation to these items' statements from the Likert were selected for an open-ended format questionnaire. For interpreting this section the Likert items and supportive open-ended statements are listed preceding each sub-topic.

The difference in the means for entering and exiting students for the domain, the teaching of mathematics, represents a change in beliefs that aligns with the criterion established for the difference to have an implication for the field of mathematics educators. This domain focused on aspects of teaching mathematics such as, the use of manipulatives, methodologies to use in instruction of mathematics, appropriate classroom configurations for instruction, and qualities of good teaching. Many of these topics are aspects of general behaviors for teaching in any content arena and are taught in other classes in the University in the preservice elementary education program. While there is a difference in the means, the difference falls just within the criterion cut-off point. Reasons for this limited difference may center on the entering population that was approximately 70% sophomores and juniors. This population would have the opportunity to take several of the general education and other content courses that also establish guidelines for effective teaching and therefore beliefs regarding the teaching of mathematics may be generalized from that coursework.
The foundational information framework of what preservice elementary education students believe about the teaching of mathematics is described in the following sections. The Likert type information and the written responses from the open-ended questionnaire are explained in detail to create a picture of what are the beliefs of entering and exiting preservice elementary students.

**Sub-Categorv: Manipulatives (Likert Items #9-13 and Open-Ended Item #8)**

Manipulatives are the concrete or semi-concrete materials that assist children in learning mathematical processes. They bridge the gap between conceptual and real world applications. The items on the Likert questionnaire looked at the usefulness of manipulatives for all grades, cost of manipulatives prohibiting use, and finding connections between manipulatives and concepts. This was contrasted with using rules and formulas in a paper and pencil format with the worksheet as a barometer for success in understanding the concept.

The entering and exiting students differ on their responses to manipulatives. This difference was the greatest for any of the sub categories within the domain of teaching of mathematics. This difference would be expected to be higher in the second group since the mathematics coursework of four classes used manipulatives as a tool for instruction. Manipulative examples are base ten blocks, unifix cubes, geoboards, attribute blocks, pattern blocks, fraction bars, and decimal mats. Typically entering students have no prior experience with manipulatives. One entering student wrote in the comment section of the open-ended survey "I haven't got a clue what manipulatives/physical models are."

With the use of manipulatives less attention is given to the use of worksheets for instruction. The open-ended item #8 addressed worksheets as an indicator that a
child answering all items correctly understood the concept that was taught. Students entering coursework responded negatively (73%) on the open-ended questionnaire to the statement "answering all problems correctly on a worksheet children would therefore fully understand the concept that was taught." There was recognition that getting the answer correct does not translate into understanding of a concept. Exiting students responded negatively (85%) for this statement. Seventeen percent of those respondents wrote that children might be missing the whole concept so teachers must make sure why children responded in the way they did as their major concern. There was recognition that rules or procedures may be known without attaching meaning to the action. Forty-seven percent suggested that children might just have memorized a formula that works for those particular problems and just got lucky.

Entering students responding favorably (27%) that students would fully understand the concept but several testings might be needed to discover if the concept carried over to other activities. Exiting students responded favorably (2%) to this statement. Children often learn the rules, procedures or "recipe" to work out an algorithm without attaching conceptual understanding to the process or algorithm.

A portion of the entering open-ended respondents suggested a reason that students did answer problems correctly on a worksheet that surprised the researcher. Thirty-one percent of entering students and seven percent of exiting student suggested that children cheated to get correct answers. "I don’t really know where they got the answer from, some cheat (copy papers)” was indicated as the reason for getting the correct answers. Reasons for this belief are presented as assumptions that preservice elementary students may be responding to their personal behavior as elementary students or their perception of little children as being "copiers" of actions.
The results for sub-topic instruction indicated that the two groups, entering and exiting students, differ on their mean response. It would be expected that the second group, exiting students, would be higher based on instructional practices in coursework. Two of the mathematics content courses are structured in small group laboratory settings. The methods class also uses small group assignments and projects. During this class, attention to what is happening in the classroom when small groups are interacting is highlighted. Students are shown that noise is a factor in small group activities but that does not indicate that learning is not taking place. If small group activities are structured for multiple tasks then there is a high probability that all students in the group are learning by teaching and assisting each other to complete the task.

Comments from the open-ended questionnaire item #10 offer clarity to the issue of small group instruction. The statement to respond to was "In small groups only a few students are really learning the concept." The entering students responding that this was true or possibly true was 42% of the total entering population. Of this entering student group, 47% suggested that one must have the right kind of group for success. A concern with small groups surfaced with this comment:

Too many people like to remain anonymous in a group situation and don't contribute anything. If people could be matched according to ability in groups, this would be more effective. I don't agree that the more intelligent or harder worker person inspires others. I have never seen this happen.

Only two exiting students supported this position indicating that usually there is only one person who does all the work in small group activities.

Those responding negatively to this statement were 58% of the entering population. A major portion of the negative respondents (64%) wrote statements
similar to the following: "I feel that in small groups more minds bring better ideas and greater success. Many thinking strategies are brought together to create an idea and thus solve problems." Twelve percent of entering students indicated that "small groups are able to see how classmates solve and comprehend problems. Students are usually more willing to ask questions and usually don't feel as though they are the only one who does not understand a problem." Exiting students indicated a negative response (87%) to this item. Forty-eight percent of these students indicated that "small groups are good especially when they're mixed up instead of categorized by level of understanding because it enables the advanced student to reteach it to the ones who have a harder time understanding." Keeping the group focused and on task was seen as a concern during cooperative instruction by 17% of the exiting group that responded negatively.

**Sub-Topic: Discovery (Likert Items #19-23)**

The statements in this section addressed the interaction between student and teacher. This section had at its base a foundation in constructivist philosophy that children create their knowledge based on their own experiences. The mean scores between the entering and exiting students differ in their response to sub-topic discovery and fall just within the cut-off criterion that was pre-established. This is consistent with pre-study expectations because of activities and discussion in the laboratory content classes and methods class. Students are expected to construct patterns for finding formulas in the geometry class and discover properties of statistics and probability through simulation activities such as Monte Carlo. This issue is addressed in methods class during discussion of how a teacher presents new instruction to elementary students.
Sub-Topic: Open-Ended (Likert Items #24-28)

Results for this sub-topic indicate a smaller difference between the mean scores of the entering and exiting groups and falls below the established criterion cut-off point. Items in this section addressed open-ended activities as means for making learning fun and interesting, adding variety to teaching, and assisting students in transferring knowledge to new arenas. This sub-topic seemed to be less amiable to changes in coursework as described for this study. In discussions with faculty of the Department of Education, they indicated that open-ended activities are used in classes of science and reading content. There is the possibility that other classes have influenced this section of statements since the entering population was a majority of sophomores and juniors.

Sub-Topic: Classroom (Likert Items #38-47 and Open-Ended Items #3, #4)

The entering and exiting groups differ in their mean response to classroom issues. This was expected to be higher in the exiting group since the majority of the statements in this section are focused on classroom behaviors of instruction in a mathematical setting. These items addressed using manipulatives as a tool for teaching rules and procedures contrasted with using paper-pencil computational skills as a necessary component for most mathematical problems. In the past, mathematics class was viewed as "rules" as the way to learn mathematics and open-ended activities with manipulatives were just used at the primary grades.

The responses from the open-ended survey for question #3 addressed the issue of whether there are many different ways to solve most mathematics problems. A positive response (84%) was indicated by the entering students. Indicators for this high response focused back on elementary experiences with teachers, friends, and being a parent. One entering respondent wrote:
When I was young I thought my teacher's way was the only way, then when I needed help at home, my parents only knew one way, but it wasn't the same as at school. I've learned the most about mathematics when more than one approach is used and I'm seeing that with my elementary age son as he naturally comes up with more than one way.

Another noticed that a friend could do many problems in his head while he had to write everything down. Exiting students responded favorable (96%) to this statement. A majority of these students (39%) indicated that "math is unique in that to get one single answer many ways of solving for that answer may be used." Another wrote "I didn't know this until now, I had no idea that almost every problem can be done differently." Also, in support for this mathematics coursework to change beliefs, one student wrote "my background told me there was one way, now I've learned and am aware of many others." This brought up comments that teachers must be willing to address the various ways that children might solve a problem and not look for just "their" way. There are easy ways, models to follow, many routes to a destination, and various strategies to find answers to problems.

Those entering students responding negatively to this statement were emphatic in their statements. Responses ranged from "I have always been taught that there is a right and a wrong answer" to "there are different ways of teaching but not different ways to solve problems." Sixteen percent of entering students responded negatively to the statement. Exiting students responding negatively (2%) to the statement with written comments suggesting that the "most expedient method is the one that the teacher goes by" or "at best there is only one or two ways to solve most math problems, few have many ways."

Question #4 on the open-ended survey addressed the concern that sometimes it is best for the teacher to act as an observer and allows learning to happen. Entering students responding negatively or uncertain about their response were 35%. Of this
group, 48% of the responses wrote "if the teacher explained all the relevant points and then just sees if the students understand then OK, otherwise no." Some thought that this was appropriate for high school but not for elementary. This seems to be in conflict with the constructivist philosophy and research on cooperative learning that students can construct knowledge through interaction with each other and without much teacher direction (Johnson & Johnson, 1987). Exiting students responded negatively or uncertain about a response (9%) to this item. One wrote that "this was not true in math, as the teacher you have to make sure that students are not making foolish mistakes." Another felt that teachers should not "just observe" often because students would become frustrated with learning.

Entering students responded favorably (65%) to this statement. Of this group, 36%, indicated that allowing children to continue on their own allowed the teacher to sit back and observe what processes their class was using and what changes might be needed for further instruction of a concept. Another wrote

"Anyone can memorize what you want them to know and parrot the facts and processes back to you but real understanding will happen if the teacher stands back and acts as a guide and lets the children make their own concepts."

A student suggested that mathematics is like the "lab" in science class.

Exiting students responded favorably (96%) to the statement. The written comments suggested a conceptual understanding of the constructivist philosophy. Statements by 34% of this group of exiting students were similar to the following "... helps to build confidence when they (children) figure it out correctly by experimentation by self or in groups, knowledge becomes theirs." Others within this group (18%) suggested that the teacher's role has changed to that of facilitators and the teacher's role is to facilitate questions from children. Eight percent wrote that "it helps to learn by discovery." Summing up this area two students wrote
If as a teacher all you do is throw out information and the students just act as computers absorbing it, they will never understand the uniqueness of mathematics. They will perceive it as rules and procedures rather than an interesting subject.

Sub-Topic: Testing (Likert Items #48-53 and Open-Ended Items #5, #6)

The entering and exiting students mean scores differed on the sub-topic testing. Their mean difference falls within the set criterion for practical significance. This difference would be expected to be greater in the exiting group because of the emphasis on demonstrating to preservice elementary education students alternative forms of assessment. Students are required to complete projects, performance tasks, journals and put together a portfolio for cumulative points towards their final grade during their mathematics coursework.

Question #5 on the open-ended questionnaire focus was "testings' major purpose is for the teacher to get information on student performance." Sixty-nine percent of entering students responded negatively to this statement. Sixty percent of those responding negatively saw testing as a source of information for the student regarding their progress within the subject. Eight percent saw testing as a benefit for teachers so they may see where they need to further instruction. Exiting students responded negatively (77%) to this statement. They indicated similar comments as the entering students. Of the exiting group responding negatively, many (54%) wrote the purpose of testing is to see how much the student understands, knows concepts, and makes applications in other situations as well as telling the teacher how effective is the instruction.

Entering students responded favorably (31%) to this statement. Forty percent of the favorable entering group indicated that "tests show teachers what students learned and how much effort students put in to learn it." One wrote the "purpose of
testing is to grade the student, that is all the educational system is about.” Exiting students responded favorably (22%) to this statement. Comments centered on testing gives an indication of the concepts that you are teaching to students.

Question #6 on the open-ended questionnaire focused on a relationship between more homework and more practice resulting in more understanding. Entering students responded negatively (31%) to this relationship. Nine percent of this negative response group wrote responses similar to “Quality time not quantity time equals more understanding.” Others wrote that “homework is not the key to more understanding, hands-on and manipulatives help with more understanding.” There seemed to be a general tone that homework by itself does not result in understanding. Good teaching with quality problems assisted in the understanding of concepts. Exiting students responded negatively (83%) to this relationship. Twenty-six percent indicated understanding does not follow by merely getting practice through homework. The issue of incorrect procedures being practiced will not facilitate understanding or learning. One wrote “more hands-on learning=the more practice=the more understanding. Involve them and they will learn more.” Another suggests that “all the 'grill and drill' in the world won’t help a child understand a concept. A child needs to 'concretely' learn the concepts with manipulatives.

Entering students responded favorable or maybe (69%) to this relationship. Twelve percent of this group of students reported that more homework is not necessarily the connection to more understanding but that more practice is essential to more understanding. One wrote ”homework is ESPECIALLY important in math, a teacher should assign a reasonable amount of homework (1 hour) and encourage students to do more if they need it.” Exiting students responded favorably (10%) to
this relationship. Their responses indicated that the emphasis is on good practice and appropriate homework should supplement learning.

**Sub-Topic: Good Teaching (Likert Items #69-73 and Open-Ended Item #2)**

There is little difference in the means between the two groups on the sub-topic good teaching. Of all the sub-topics under the domain of the teaching of mathematics this sub-topic contains issues that are generic to many courses in a preservice elementary education students' program of study. Encouraging students to think and question is a message that is prominent in courses in science, social studies, and reading. Students and faculty in the Department of Education have indicated that discussion in education classes' centers on methods to teach to assist children to think and question rather than just accepting what is told by the teacher. The faculty that was interviewed also teach from a constructivist foundation that would blend with the items on the questionnaires.

Question #2 on the open-ended questionnaire addressed this issue of encouraging students to think and question as an indicator of a good teacher of mathematics. The entering students responded favorably (96%) to this item. Of this group, 47% indicated that a good teacher of mathematics must question and require thinking of students. Many saw that this is the purpose of elementary education and elementary teachers. Several suggested that questioning and thinking strategies are the tools to challenge children in their mathematics studies. A few students wrote "... makes the children go deeper into their thinking and helps them understand better than just listening to a lecture. Active learners are the best learners."

Exiting students responded favorably (100%) to this item. A common thread for many within this group (38%) was "the need to know how and why problems can
be achieved and this you do by asking questions.” A few wrote “without the desire to
know 'why' there isn't much point in doing mathematics, it then becomes routine,
blank-minded procedures.” Another wrote “this concept was new to me, I became
frustrated when the geometry class was centered around independent problem-solving
since elementary school concepts were taught and drilled.”

Entering students responded negatively (3%) to this item. One response that
positions itself on the extreme of what belief the study would like to demonstrate is
"depends on the question, for formula work you just memorize those, don't think.”
Hopefully during the coursework that requires the construction of formulas will have
an impact on this thinking. Exiting students responding negatively (0%) to this item.

Interpretation of Nature of Learning Mathematics
Domain

The three sub-topics from the nature of learning of mathematics ask questions
that are closely aligned to a mathematics curriculum. The three sub-topics exceeded the
practical significant criterion selected for this study. Since each of the statements in the
questionnaire directly relates to how a student might learn mathematics rather than the
Teaching of the content that may account for the strength of the difference.

Within the sub-domain problem, strategies for problem-solving are addressed
as well as mathematics being composed of rules and procedures. Entering students are
more apt to see mathematics as memorization and difficult to learn. The sub-topic
technology has the greatest difference of means within this domain. This can be
attributed to mathematics coursework instruction in the use of the calculator as a
problem solving tool for children in elementary schools.
Sub-Topic: Problems (Likert Items #29-34 and Open-Ended Item #7)

The entering and exiting students differ in their mean scores for the subtopic, Problems. The mean of the exiting students was expected to be higher because this sub-topic focus addressed "What is mathematics?" Likert question #32 directly assessed whether preservice elementary students believe mathematics is facts and procedures that have to be memorized. Hopefully coursework has demonstrated that many content pieces of mathematics can be constructed through investigations and that multiple problem-solving strategies are available for solving complex mathematical problems.

Question #7 on the open-ended questionnaire addressed the concept that mathematics is mostly facts and procedures that have to be memorized. The entering students responded negatively (39%) on the open-ended questionnaire. This group of students reflected that "mathematics should be approached in real life situations so that students don't remember a 'dumb' formula, they should remember the method to solve the problem." Twenty-two percent of the group that responded negatively suggested that understanding, not memorization, should be the focus of mathematics instruction. Mathematics was viewed as problem-solving and knowing how to work through a problem. Once these skills were learned then new skills can be built from these.

Exiting students responded negatively (93%) to this item. Forty-five percent of this group indicated that "mathematics should be about discovery and problem solving, developing ideas not facts and procedures." Others suggested that "this is the old way of thinking, people need to learn the way mathematics is used in everyday life." Problem solving should be the focus with an understanding that mathematics is a process through models. An interesting response was "mathematics is the manipulation of value; facts and procedures are part of mathematics, but they aren't the cool part that
a lot of people find interesting and fun.” There was recognition by exiting students that there are a variety of strategies that can be applied to assist in solving problems without memorizing each isolated facet of mathematics.

Entering students responded favorably or uncertain on how to respond (61%) to this question. Comments included ”mathematics is concepts that must be learned and become repetitious”; ”mathematics is concepts and the formulas have to be memorized”; ”understanding simple problems is taught but algebra seems to be facts and procedures”; and ”in a school setting, this is true, but outside school situations arise in which mathematics is needed and students must be able to incorporate all that they’ve learned to solve the problem.” A couple of students wrote ”sometimes there are a lot of terms and definitions to learn, but it always goes back to the basic operations of addition, subtraction, multiplication and division.”

Exiting students responded favorably (6%) to this item. A response that is indicative of this belief was ”mathematics should be mostly facts and procedures that the student has invented, then they are learned and committed to memory or are available for easy recall.”

**Sub-Topic: Memorization (Likert Items #35-37)**

The entering and exiting students mean difference exceeded the established criterion for sub-topic memorization. The exiting students mean score was expected to be higher because of the experiences in the mathematics coursework. In this coursework, memorization was demonstrated to be one method of learning. However, memorization by itself does not equate with understanding. The geometry class, instead of requiring students to memorize formulas, has developed a laboratory approach that requires students to construct formulas through investigations of patterns.
In the methods class, understanding what the operations mean rather than just memorizing addition, subtraction, multiplication and division basic facts is a major relationship of knowing procedural versus conceptual knowledge about mathematics.

Sub-Topic: Technology (Likert Items #54-58 and Open-Ended Item #9)

The entering and exiting students mean difference for sub-topic technology exceeded the established criterion with the greatest difference for any sub-topic in the study. The exiting students mean score was expected to be higher because of the experiences in the mathematics coursework. Students were encouraged to use calculators during problem-solving situations throughout the mathematics coursework. Students use computer software to explore relationships in geometry and graphing calculators for exploring statistical data. During methods classes, students received instruction on appropriate methods to instruct elementary children in the use of the calculator to find patterns for number facts and as an assist during multiple-step problem-solving situations.

Question #9 on the open-ended questionnaire addressed the issue of the calculator hindering elementary students from learning to compute through paper-and-pencil methods. Entering students responded negatively (48%) to this statement. Eighteen percent of this group of students responded that "the use of calculators just simply speeds up the learning process making it more logical and efficient." Forty-five percent indicated that paper and pencil formats should be taught first so calculators would not hinder student's computational learning. For those who would suggest that the calculator is doing all the work, students responded that "if you don't know the procedure to punch in on the calculator you can't solve the problem."
Exiting students responded negatively (87%) to this statement. The majority of these respondents (49%) indicated that the calculator "enhanced paper and pencil activities as it aids in critical thinking." Another stated "get serious . . . if anything calculators reinforce those skills learned through the algorithm." Others saw the calculator as a tool to "show patterns and as an assist in solving longer problems." Some have grasped the conceptual knowledge of the use of the calculator by writing "students still need to know what numbers and in what order they need to enter the numbers in to the calculator to get a correct answer."

Entering students responded positively (51%) to this statement. Many comments focused on that calculators can be helpful in some cases but should only be used when the teacher permits them. A surprising response (23%) was "basically for elementary and middle school children calculators aren't too helpful" and "elementary students should not be using calculators unless it's a lesson on learning how to use a calculator." Their concerns seemed to focus on if calculators are used too early in the process of learning then students might not know paper and pencil procedures. One suggested that the use of the calculator "does not allow the student to think through some of the most basic math concepts." There seemed to be an underlying belief that using a calculator requires no thinking on the part of the student when in fact one must totally understand functions and processes of the calculator to use it effectively.

Exiting students responded favorably (7%) to this statement. This group suggested that this statement is "sadly true." They based this on adults who have forgotten how to compute with paper and pencil and depend on the calculator to do simple computational tasks. Again the missing piece was, to do the calculations and know you have correct answers, requires thinking and estimation skills.
Interpretation of Nature of Self Domain

Research studies have indicated that changing attitudes is difficult even under good conditions since attitudes have to be brought to the surface of one's cognitive thoughts and then discussed in detail (Bassarear, 1986). This domain sought to clarify underlying beliefs of a student regarding their success and failure in mathematics classes. To be "good" at mathematics, beliefs focused on components of mathematics as remembering formulas and procedures, thinking in a logical manner, understanding basic concepts and strategies, thinking flexibly, and having confidence that one can succeed. Getting a good grade in mathematics was seen as the result of hard work, abilities, luck, or happenstance. Getting a poor grade was reflective of little studying and careless errors.

The difference in the mean scores for entering and exiting students for the third domain, the nature of the underlying source of success or failure in mathematics fell considerably below the established practical criterion established for the study even though statistical significance was established.

Sub-Topic: Attitude (Likert Items #59-68)

The entering and exiting mean scores were very close for the sub-topic attitude. One would have hoped for a higher score by the exiting population based upon experiences and success in their mathematics coursework. The items in this section addressed getting a good grade in mathematics based on students' behaviors such as working hard at it and being confident in one's abilities. This is contrasted with success being "just a matter of luck" or the student has "no idea" how a good grade was received. Another section looked at getting a poor grade in mathematics because a student did not study appropriately or made careless mistakes.
Sub-Topic: Good at Math (Likert Items #74-80 and Open-Ended Item #1)

There was an extremely slight difference in the means of the entering and exiting students on the sub-topic of being good at mathematics. These items focused on attributes of mathematics and one's behaviors. These included working hard at mathematics, remembering formulas and procedures, thinking in a logical manner, having understanding of concepts and strategies, thinking flexibly, having confidence in one's ability and having a "mathematical mind" set towards mathematics. A higher score in the exiting student group was expected but written comments, individual conversations, and former research all indicate that this is a very difficult arena for change. Mathematical beliefs about one's success or failure are grounded in behavior from elementary to high school with many students focused on difficulties with algebra and geometry at the high school level as a capstone of their abilities to "do mathematics."

Question #1 on the open-ended questionnaire addresses the thought that in order to be "good" at mathematics one needs to have a "mathematical mind." The entering students responded favorably (29%) to this statement. They interpreted a mathematical mind as a mind that deals with numbers in an easy manner. Mathematics was viewed as a relationship between numbers (11%) and one is either "good" or "bad" at mathematics. For some, "it just doesn't click." Also just having a mathematical mind is not enough, one must also have "talent, desire, patience, refined skills and a willingness to work hard at it" (14%). This attitude seems to be summarized best by the following student's response:

My best friend and I were co-valedictorians in high school. She had a mathematical mind and breezed through mathematics I was good in English. We were naturals in opposite subjects. Mathematics is not easy to weasel through. Either you know it or you don't. If you can't catch on in the beginning you're lost forever.
The exiting students responded favorably (22%) to this statement. They perceived a need to thinking numbers, concepts, strategies, and a mind that was in a mode for abstract thinking of ideas. Several equated having to have "a mathematical mind" as a necessary component for teaching mathematics.

The entering students responded negatively (71%) to this statement. From this group, they interpreted a mathematical mind as a need to grasp concepts (38%), having patience and persistence (5%), needing common sense and willingness to learn (12%) and taking time and effort to get an answer (14%). The foundation for success was one's attitude towards the subject as one wrote "I just need to open up my mind more for mathematics and try different ideas and possibilities." Others saw the need for guidance in mathematics either by parents or teachers as a necessary component for success. This underlying framework was best summarized by the following student response: 1) "I was raised with this statement in K-12, changed my mind in college when I discovered mathematics is something that anyone can LEARN," and 2) "To be good in mathematics one has to be devoted and practice. Mathematics is not a spectator sport."

Exiting students responded negatively (78%) to this statement. Many from this group (38%) stated that "people can achieve in mathematics with the proper guidance and preparation using hands-on problem solving approaches that make mathematics an achievable subject." One wrote "I feel that it is due to the way I was taught, ditto after ditto, not a thinking process." Several saw that "success lies in a person's ability to visualize the problem and relate it to something that they know" or to put it another way "one must have a comfort zone with mathematics." This section was summarized best by this response from one student: "... old myth about needing mathematical mind to
be successful in mathematics, not true. It's a belief tied to mathematical anxiety.
Incorporating other subjects into a mathematics curriculum will dispel this belief."

**Implications**

**Population Concerns**

Caution must be maintained in making generalization from the data. Differences in this study may result from population differences (each group of entering and exiting students represented a different population of students) and may not be representative of one group at different stages of course work. The difference may not be the result of mathematics coursework but to other coursework within the college experience. An elongated study following entering students through coursework and sorting for other classroom experiences would assist to focus on this issue.

The researcher did not attempt to control outside conditions that might influence responses outside the mathematics coursework. According to students in the exiting mathematics coursework and faculty from the Department of Education at this university several courses contain instruction in the same sub-topics. Since a majority of the entering students are non-freshmen (70%) there is a greater chance that other sources that encompass good teaching strategies in the coursework influenced the change of beliefs. It should be noted, however, that students do not enter the professional sequence until their second year. The areas most common to good teaching are cooperative learning, assessment techniques, constructivist foundations for instruction, and teacher behaviors during instruction.

Using scores of only entering freshman and exiting seniors could have been used to maximize differences between groups. This would present the extreme naive entering students against the sophisticated exiting students concerning the beliefs about
the teaching and learning of mathematics. This was not possible at this University since classes would not occur in this pattern for any given year. If such a study was supported, several succeeding years would be needed to obtain a usable population.

Another area of concern is the percent of non-freshman in the study. In the entering usable sample 70% of the students were sophomores and juniors with only 27% freshmen representation. The mix of greater number of sophomores and juniors in the entering classes may continue for the following reasons. One reason for this high percent is getting enrolled in the coursework at appropriate times. There are usually six sessions of classes offered each semester, fall and winter, and one class during spring and summer. This is often not enough spaces for the number of students requiring the entering class. Therefore freshmen are often locked out of registration until a later time. A second reason is the admissions requirement from the College of Education for a grade point average of 2.50. Some students perceive that the mathematics content and methods courses are difficult and take other content subjects and education courses to maintain a high grade point and get their admittance into the Department of Education before taking the mathematics strand.

Recommendations for Further Research

From the results of this study, several other studies could be suggested. Using the open-ended response format for the remaining statements on the Likert would create a richer bank of foundation beliefs of entering and exiting students. Another possibility is identifying students in their freshman year and following them through their mathematics and educational coursework through various methods such as interviews, questionnaires, and journals to discover beginning beliefs and how and when were these beliefs changed or reinforced. However, effects of pretests could become a
compounding variable in any study using a repeated measure design. Kight's (1991) model for placing preservice elementary education students into a belief framework could be an assistance in completing such a study.

Since the research literature suggests that beliefs are in constant flux, following students through their mathematics and science practicum might trace their development of attitudes and beliefs as they begin to work with children in elementary classrooms. Here beliefs come in contact with actual teaching situations. Through journal writings and interviews, preservice elementary education students would see how their coursework played out in actual teaching placements. Continuing this study into preservice elementary education students' internship placements would add to the framework of student beliefs regarding mathematics teaching and learning.

A longitudinal study following undergraduate students through their first five years of teaching could compare the exiting beliefs with their beliefs after several years of teaching experience. The question would focus on whether those entering and exiting beliefs have now shifted to a third set of beliefs or were entering or exiting beliefs reinforced or weakened by actual classroom experiences.

Another area for exploration would look back at preservice elementary education students early experiences in mathematics and try to determine the source of their beliefs. Were their beliefs a product of schools, parental interventions, peer advising or textbook orientation? A researcher might also study the interaction of beliefs regarding the nature of mathematics and the other domain's considered in this study.

Conclusions

This dissertation has focused on the entering and exiting beliefs of preservice
elementary education students at a mid-west university. Students were surveyed using a five-point Likert questionnaire and an open-ended questionnaire. It was found for the nature of teaching mathematics and the nature of learning mathematics that students' beliefs become more closely aligned with the new directions in mathematics education. It is also conjectured that these changes may be primarily attributable to a mathematics and science program designed to prepare these students for the elementary classroom. For the nature of the underlying source of their success or failure in mathematics there is no indication that attitudes regarding mathematics have been changed through the university education coursework.

For the first domain, the teaching of mathematics, the findings of the study are consistent with other researchers' findings. To teach mathematics, exiting preservice elementary education students recognize that it is essential to provide children with engaging tasks and opportunities to construct their mathematical thinking. This belief requires that teaching is an interactive activity between teacher and child to reveal the patterns of mathematics through explorations. The construction of mathematics knowledge occurs through children working in small groups to create mathematical connections and not from practicing procedures that often develop into mindless routines. The instruction becomes one of process-focused approach rather than a content-focused approach (Thompson, 1984; Underhill, 1988a). In this sense, mathematics is a study of ideas and mental processes rather than a study of facts with the main idea of developing reasoning and thinking skills.

To create this atmosphere of construction of knowledge the exiting students indicated that the teacher becomes the facilitator rather than the lecturer. In this role the teacher asks questions to challenge children to develop insights into mathematical patterns and representations. This questioning allows the children to develop
innovative and unique solution paths of discovery rather than procedural step-by-step recipes often taught in the past. Making connections to realistic situations for children assists in creating a heightened awareness of the role of mathematics within their daily life. The teacher becomes the creator of building bridges for children within the classroom (Simon & Schifter, 1991).

For the second domain, the learning of mathematics, the findings of the study are supported by other research in the field of learning mathematics. The role of memorization, as understood by entering students as a primary function of learning mathematics, is not echoed by exiting students. This is supported by others who found preservice elementary education students view that mathematics is a "fixed" body of knowledge of rules and regulations that must be memorized (Wilcox et al., 1991). Memorization has become a less emphasized aspect of learning mathematics with construction of knowledge and conceptual understanding of relationships becoming the focus of learning.

The greatest change in beliefs was found in the area of the use of technology in teaching and learning mathematics. Technology has become a cornerstone of our daily lives as we move into the informational highway of the twenty-first century. The change of beliefs from entering and exiting students in the use and application of calculators has been strongly affected by classroom coursework. This is very encouraging for instructors in higher education who recognize the gap between what is taught in university coursework and what is occurring in elementary classrooms. Hopefully as these students enter the elementary classroom as full time educators they can diminish the gap between theory and practice.

For the third domain, the nature of success or failure of self in mathematics, the findings of the study are consistent with other researchers that suggests changing
attitudes of individuals is a difficult task. McLeod and Ortega (1993) suggests that attitudes with emotional reactions once experienced by an individual are transferred to other situations. The comments from preservice elementary education students support this concept. Students believe that having a mathematical mind is probably a necessary component of being able to perform well in mathematics. There still exists a belief that being successful in mathematics is a result of luck or possessing special insights into "numbers" that aids in one's understanding of the content. In conversations with students, the comments focused on that even though they had learned many strategies for problem solving they still believed that one had to have an inclination towards mathematics for success. While this seems contradictory, students seem to be accepting of the contradiction of their belief and knowledge learned in the coursework. Schoenfeld's (1989a) questionnaire on student beliefs found similar findings in this arena with students who perceive themselves as weak in mathematical ability and project that their success is a matter of luck and their failures as a lack of ability. This is just the opposite for students who perceive themselves as successful in mathematics. They perceive the success as a function of their abilities, hard work, and knowing procedures for solving mathematical problems.

In order to change beliefs of preservice elementary education students continued investigations into the belief structures of this audience must continue. Within the coursework that is required of this population, it must challenge their beliefs in safe environments so that desired teaching behaviors for the study of mathematics can be optimized (Wilcox et al., 1991).

This study has attempted to conceptually paint a picture of the beliefs of entering and exiting students in elementary mathematics teaching curricula. It was found that for some sub-topics' beliefs have changed in the direction that is supported by NCTM
in its professional standards for teaching of mathematics and the awareness of the nature of mathematics. Much more work is necessary to truly understand beliefs of preservice elementary education students, the source of these beliefs and effective methods for aligning these beliefs with professional recommendations.

It is hoped that the information garnered from this study extends the foundation information in the research that assists in understanding the beliefs of entering and exiting preservice elementary education students. This information should also be an assist to practicing teachers to understand what their interns bring to the classroom. For educators at institutions of higher learning, this information might assist in evaluating their preservice elementary education students' beliefs about mathematics and provide some insights into curricular improvements to more effectively implement criteria of the NCTM Standards for effective mathematics instruction.
Appendix A
Initial Item Pool of 103 Statements
Indicate what course you are currently enrolled when taking this survey: 150 151 265 352

What is your academic year?

Did you take 150 at WMU?
Did you take 151 at WMU?

Belief Questionnaire

When I get a good grade in math:
1. It's because I work hard
2. It's because the teacher likes me
3. It's just a matter of luck
4. It's because I'm always good at math
5. I never know how it happens

When I get a bad grade in math:
1. It's because I don't study hard enough
2. It's because the teacher doesn't like me.
3. It's just bad luck.
4. It's because I'm just not good at math
5. It's because of careless mistakes.

Student Perceptions:
1. Some people are good at math and some just aren't.
2. Good math teachers show the exact ways to answer the question you'll be tested on.
3. In math it's either right or it's wrong.
4. Good math teachers show students lots of different ways to look at the same question.

Memorization Questions:
The math that I learn in schools is mostly facts and procedures that have to be memorized.

When the teacher asks a question in math class the students who understand only need a few seconds to answer correctly.

The best way to do well in math is to memorize all the formulas.

You have to memorize the way to do mathematics.
Understanding and Creativity in Mathematics

The math that I learn in class is thought provoking.

In mathematics you can be creative and discover concepts by yourself.

When I do procedural/abstract mathematics I get a better understanding of mathematical thinking.

When I do conceptual/concrete mathematics I get a better understanding of mathematical thinking.

When I do procedural/abstract mathematics I can discover things about mathematics I haven't been taught.

When I do conceptual/concrete mathematics I can discover things about mathematics I haven't been taught.

The reasons I try to learn mathematics is to help me think more clearly in general.

Memorizing is important in learning mathematics.

The mathematics I'm studying is useful.

If you understand the material how long should it take to solve a typical homework problem.

What is a reasonable amount of time to work on a problem before you know it's impossible?

Everything important about mathematics is already known by mathematicians.

Math problems can be done correctly in only one way.

To solve math problems you have to be taught the right procedure, or you can't do anything.

The best way to do well in math is to memorize all the formulas.

When you get the wrong answer to a math problem it's absolutely wrong-there's no room for argument.

Compared to other students in math I'm about:

Compared to how hard other students work at math I'm:

How important do you think it is to do well in math?

You are confident in your ability to read and understand elementary school mathematics textbooks and curriculum guides.

You are confident in your ability to select mathematics teaching materials.
You are confident in your ability to adequately select, design, and use mathematics evaluation materials.

You are confident that elementary school mathematics can be learned by most children.

You find it easy to work with peers on mathematics related teaching concerns.

You do not dread the thought of teaching mathematics at ANY level of the elementary school.

You are confident that all elementary school mathematics ideas can be understood by you.

You have a reasonable working knowledge of where to go for mathematics ideas and resources.

You are convinced that it is of utmost importance to make math concepts and symbols "meaningful" before practice and drill begins.

You are convinced that children should have meaning experiences" before and while learning abstract ideas.

You do not believe that teachers should use any one means (such as one test) to determine learner readiness.

You do not believe concrete, semiconcrete, or abstract experiences produce the same kind of learning.

You are confident in your attempt to be a successful teacher of elementary school mathematics.

You are confident that you can be "retrained" or "up-dated" with little effort in the teaching of elementary school mathematics.

You are open to "new" and "better" ways to be a more successful mathematics teacher.

Your experience in this Western Michigan University mathematics course will be beneficial to your teaching career.

Your experience in this Western Michigan University mathematics course has a significant positive effect on how you plan to teach mathematics.

I have developed an attitude of inquiry in mathematics.

I have developed an awareness of the importance of mathematics in everyday life.

I can perform computations with speed and accuracy.

I have developed an awareness of the importance of technology in mathematics teaching.
I have developed a systematic approach to problem solving
I have learned about the relevance of mathematics to careers
I have become interested in mathematics
I know mathematc facts and principles.

*Attitudes:*

I am looking forward to teaching elementary school mathematics.

My ability to perform mathematical computations is adequate for teaching elementary school mathematics.

I have feelings of inadequacy in teaching elementary school mathematics.

I feel comfortable about my ability to teach elementary school mathematics to an entire class.

I feel that I can adequately teach the concepts of a fraction.

I feel highly anxious in thinking about teaching elementary school mathematics.

Teaching mathematics to children will be fun and exciting.

My understanding of mathematical concepts is adequate for teaching elementary school mathematics.

I feel comfortable about my ability in teaching a child on a one-to-one basis only.

I feel that I can adequately teach the concepts of whole numbers.

I feel comfortable about my ability to teach elementary school mathematics in small groups.

I feel inadequate to teach operations with fractions.

I feel very confident about my ability to teach elementary school mathematics.

Teaching elementary school mathematics will be boring for me.

I feel that I can make mathematics interesting for the children I teach.

The thought of teaching elementary school mathematics frightens me.

When at all possible, I will avoid teaching mathematics to my students.

Elementary school mathematics will be easy for me to teach.
I feel the teaching of elementary school mathematics will be dull and repetitive for me.

I feel that I can adequately teach whole number operations.

Mathematics will be the most difficult elementary school subject for me to teach.

To what extent did you understand the goals of the course?

To what extent did you understand the objectives of the course?

In terms of clarity, were the objectives of the course related to the topics the instructor presented in class?

The topic of "conceptual understanding" was clearly presented during the classroom sessions of the course.

To what extent did you find the instructional materials of the class sessions helpful?

To what extent did you find the instructor's orientations of the class procedures presented in class sessions helpful?

To what extent did the instructor boost your enthusiasm about teaching?

To what extent did the instructor define the topics presented in class?

To what extent did the methods class provide an appropriate setting to develop and refine many teaching strategies?

The course instructor covered topics that were directly related to issues of teaching in today's schools?

Should the amount of college hours credit be increased for the course?

Should the amount of college hours credit be decreased for the course?

The content covered in the different sections of the course should be more consistent with each other?

How effective was the instructor in presenting materials in this course?

Did the instructor encourage development of new viewpoints in this course?

Did the instructor encourage development of new appreciation for the teaching of mathematics for elementary students?

The instructor promoted an atmosphere conducive to work and learning.
Questions just for 352:

The topic of "depth in lesson planning" was clearly presented during the classroom sessions of the course?

To what extent was your methods class helpful in preparing for your field practicum.

Did the methods course improve your understanding of concepts and principles in teaching?
## Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>paper-pencil</td>
<td>represents a method of presenting mathematical concepts in the traditional manner of teacher lecturing or telling students how to do a problem</td>
</tr>
<tr>
<td>manipulatives</td>
<td>physical models that assist in representing mathematical concepts for students (base ten blocks, unifix cubes, pattern blocks, geoboards, rulers)</td>
</tr>
<tr>
<td>small group</td>
<td>small group (cooperative group) of students working together towards a common goal</td>
</tr>
<tr>
<td>guided discovery</td>
<td>opposite of lecture, questioning strategies are used to elicit approaches to solve the given problem or math situation</td>
</tr>
<tr>
<td>open-ended activity</td>
<td>a problem-solving activity which allows several possible solutions, a fixed procedure is not mandated for children to use to solve the mathematical situation</td>
</tr>
<tr>
<td>rote</td>
<td>traditional approach of memorizing procedures and facts for mathematical operations</td>
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<tr>
<td>many-way</td>
<td>term used to indicate that there is more than one way appropriate for solving mathematical problems or situational context versus a one-way procedural formal format</td>
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</table>
Appendix C

Second List of Item Pool of 192 Statements
Please check the appropriate box for the following information.

1. Which course are you currently enrolled? Check one:
   - Math 150 Explorations in Numbers
   - Math 352 Methods for Teaching Mathematics

2. If you are currently in Math 352 answer the following, if in Math 150 go to question 3.
   Did you take Math 150-Exploration in Numbers at WMU?  yes  no
   How many times did you take Math 150?  one time  two times
   Did you take Math 151-Geometry and Measurement at WMU?  yes  no
   How many times did you take Math 151?  one time  two times
   Did you take Math 265-Statistics and Probability at WMU?  yes  no
   How many times did you take Math 265?  one time  two times

3. What is your academic status?
   - Freshman  - Sophomore  - Junior  - Senior  - Other

Below is a list of mathematical objectives for........

**pencil**

Paper-pencil teaching increases children's comprehension of mathematical concepts.

Timed testing is a good measurement in evaluating understanding of mathematical concepts.

Children that have correctly answered all problems on a worksheet have fully understood the concept being taught.

Worksheets are a vital part of understanding mathematics.

The best way of teaching basic facts is through memorization.

Manipulatives are a vital ingredient in understanding all types of mathematics in all grades.

Conceptual learning cannot be easily evaluated through paper-pencil testing.

Manipulatives are toys for most children.
Manipulatives take too much instructional time to be of any benefit to students.

Paper pencil responses indicate that the child understands the meaning of a concept.

Because of the cost of most manipulatives, it is better to learn paper pencil approaches since school's won't have manipulatives for me to use.

The use of algorithms to produce answers is best taught using paper-pencil instruction.

The use of manipulatives should be limited to primary grades.

Older children find no connection between manipulatives and concepts.

The use of manipulatives and paper-pencil activities promotes holistic learning.

*individual*  *small group*  *whole class*

Evaluation through small group activities is an unfair assessment.

Whole class instruction aids in keeping the class in order, therefore it a better approach than small group instruction.

Small group activities create confusion and noise and not much learning.

Whole class instruction should be focused on procedure only.

In small groups only a few students are really learning the concept.

Individual work is the best way to practice concepts.

The whole class approach is more efficient since all children need to learn all concepts to the same depth.

Small group work allows the slow student to pull through by the work of the high achievers in the group.

Excelled students get frustrated and tired by waiting on the slower learner to grasp a concept.

*tell/demonstrate*  *guided discovery(?ing)*

The teacher's role is to tell or show students how to do problems.
Students asking questions should be told the answer and have answers demonstrated rather than being given another question leading them towards the answer.

Facts told to a student by a teacher are much more apt to be remembered than those facts the student discovers.

Students should work problems on their own before problems are discussed and demonstrated in class.

Students should never be told all the facts or have all the methods demonstrated.

Guiding students through problems takes too much instructional time.

Peer groups of children have difficulty in working together to discover solutions to posed problems.

Demonstrating a concept without manipulatives is good teaching.

Students understand concepts better when teachers encourage them to discover answers on their own.

There are some situations in which a teacher must tell or demonstrate a lesson to students.

Guided discovery and questioning helps children learn thinking processes and gain self-confidence.

Guided discovery and questioning activities will lead to further discovery by students on their own.

**textbook/worksheet**  
open-ended activity

A student learns best by using a textbook or worksheet.

Worksheets from the textbook should be given as homework assignments since "the more practice the better."

Manipulatives allow a child to use their own problem solving skills.

Problem-solving is best when taught by problems in the textbook.

Worksheets can be valuable for assessing conceptual knowledge.

Worksheets are the only way to assess procedural knowledge.

Limiting teaching to textbooks and worksheets limits development of conceptual knowledge.

Open-ended activities (hands on activities that model concepts) are best for demonstrating and clarifying concepts.

Open-ended problem solving just frustrates students.
Open-ended activities cannot be done in a classroom setting because it promotes behavioral problems.

Open-ended activities should only be used as a supplement, if used at all.

Given the choice, I'd rather teach with open-ended activities and no textbook/worksheets than vice versa.

Open-ended activities make learning fun and interesting.
Open-ended activities adds variety to teaching and learning.
Open-ended activities helps for remembering procedures.
Open-ended activities help transfer knowledge to new areas.
Textbook learning stays with the child forever.

memorize problem solve
In math you have to just accept the fact that lots of things in math must be memorized; there aren't explanations for them.

Memorizing is more effective than problem-solving.

Problem solving is child-centered where as memorizing is fact centered.

Memorization teaches logical reasoning and logical thinking.
Memorization stays with you only for testing.
Problem solving strategies stay with you to help in new problems.
Problem solving is good for younger children but after initial experience, memorization is best.

Memorization is best for learning basic facts because there are no problem-solving strategies to help learn them.

Students test better when they memorize.

Problem solving skills cannot be tested.

Mathematics should be mostly facts and procedures that have to be memorized.

When the teacher asks a question in math class the students who understand only need a few seconds to answer correctly.
You have to memorize the way to do mathematics.

You have to problem solve to do mathematics.

Problem solving strategies are easy to learn.

Problem solving strategies are easy to teach.

Memorizing is important in learning mathematics.

The best way to do well in math is to memorize formulas.

Memorizing does not allow an understanding of concepts.

Memorizing allows a student to apply previous learning to new situations.

Some basic mathematical content must be memorized.

When working with problem solving strategies it is easier to understand how to find solutions.

Memorizing leads a student to believe that there is only one right method for solving some problems.

*rote*  

When you get the wrong answer to a math problem it is absolutely wrong, there is no room for argument.

Children following the exact procedures as indicated by the teacher perform better in problem solving open-ended situations.

Students and teacher working together is an effective method for working through problem-solving situations.

When developing mathematical procedures, the use of the teacher's manual is the better mathematic procedure.

Rote teaching is the most recommended method of approach for teaching mathematics.

Open-ended teaching involves strict rules and procedures.

The use of manipulatives and classroom discussion is a primary concept of rote teaching.

The only way to get a mathematics concept through to students is to write it on the chalkboard.

Open-ended teaching and the use of manipulatives is only appropriate for primary grades.
Open-ended teaching is recommended when teaching mathematics rather than rote teaching.

Rote teaching is used so that order is maintained in the classroom.

**one-way (right/wrong)  many-way**

In math classes rules of thumb should be taught as the way to learn math.

Teachers standing in front of the classroom and using the blackboard is better instruction than having a group discussion.

The understanding of conceptual, transitional, and procedural learning is not as important as getting the right answer.

Some time it is best for the teacher to act as an observer and allow the learning to happen.

The teacher should use the chalkboard most of the time when writing or diagraming an idea.

The teacher should try to remain in front on the class, so children's attention is focused in one direction.

Calculators should not be used in the classroom, because students need to develop paper-pencil computation.

Avoid small group work because it causes chaos and sloppy work.

Models for math should be used after the children learn the procedures.

The "concepts" of math should take up the majority of teaching time.

Many different models and materials should be used in the classroom.

Calculators should be an integral part of the math classroom.

Testing should include conceptual knowledge.

Group work is often noisy and disruptive which impairs the learning process.

To solve math problems you have to be taught the right procedure.

Math problems can be solved correctly in only one way.

There are many different ways to solve a single problem.

Trial and error can often be used to solve a mathematical problem.

In mathematics, problems can be solved without using rules.
There is little place for originality in solving mathematics problems.
There are many different ways to solve most mathematics problems.
A mathematics problem can always be solved in different ways.

**written assessment**

To assess student performance in mathematics, the teacher should:

- develop written paper-pencil tests for content taught.
- require rote recall of mathematical concepts.
- use open-ended questions.
- test each objective taught in the curriculum.
- accept written explanations of how a student solved the problem even if the final answer is incorrect.
- check with student’s on what was their thinking on a test that had many errors within a single skill or concept.
- have weekly timed tests on basic facts.
- accept math projects as well as paper-pencil work as an indicator of the understanding of a child’s knowledge of a problem situation.

The best way to test knowledge of students is to give them a written assessment of mathematical material covered.

In grading math work of students, there is an absolute correct answer to the problem.

The only way to assess student understanding of the problem is to check their knowledge of the rules for solving a particular problem.

The best way to assess student work is on an individual basis.

Children feel good about themselves when they achieve on an individual competitive level.

A classroom with a high noise level is not a good math learning environment.

Procedural evaluation is the only way to assess student’s knowledge of math.

**Technology use**

The use of technology (calculators, computers) is . . .
a way to not have to learn how to compute.

making mathematics more mechanical and boring.

something everyone should learn.

important for developing mathematical concepts.

too difficult for kindergarten children to understand and use.

a fun activity but it has little relevance to elementary student's daily lives.

time-consuming to teach.

not as important as knowing basic skills and concepts of whole numbers.

a key to expanding problem solving to higher levels of difficulty.

to help students understand the uses of computers and computer software.

a fun way to solve word problems.

Computer math programs are just an optional time-filler.

The use of audio/visual equipment in the math class are not effective.

Manipulatives are not as important as worksheets on math concepts.

The use of an overhead is a more effective way of teaching than using a chalkboard.

Computer math programs used in the classroom can reinforce concepts and provide practice time.

**Beliefs toward mathematics content**
To be good at mathematics, you need to:

work hard at it.

remember formulas, principles and procedures.

think in a logical step-by-step manner.

have basic understandings of concepts and strategies.

be able to think flexibly.

have confidence you can do it.

have a kind of "mathematical mind".
be interested in mathematics.
give full effort to learn advanced math.

Beliefs toward mathematics learning
As an elementary mathematics teachers, a teacher needs to . . .
improve general teaching skills like how to motivate students.
take a course on teaching math.
get some (or more) experience teaching math.
observe other teachers and get their comments.
take a math course.

When I get a good grade in math:
It is because I work hard.
It is because the teacher likes me.
It is because I'm always good at math.
It's just a matter of luck.
I never know how it happens.

When I get a poor grade in math:
It is because I didn't study hard enough.
It is because the teacher doesn't like me.
It is just bad luck.
It is because I'm just not good at math.
It is because of careless mistakes.

I can get along well in everyday life without using mathematics.
I usually understand what we are talking about in math class.
I work a long time in order to understand a new idea in mathematics.
A knowledge of mathematics in not necessary in most occupations.
Beliefs toward mathematics teaching

To be good teachers of elementary mathematics, you need to . . .

be confident in your ability to select mathematics teaching materials.
be confident in your ability to read and understand math textbooks and curriculum guides.
avoid grouping students by ability or level of performance.
make independent decisions about what to teach.
focus instruction on "minimum competency" for slow learners.
transmit the values of the mainstream American culture.
encourage students to think and question.
teach the subject matter as your primary focus.

In teaching mathematics, the teacher should decide on a specific method of teaching and stick with it.

It is more important for students to understand "how to" get the answer instead of understanding "why" they did it.

Using models and hands-on activities are much better than just jumping right into pencil-paper computations for understanding conceptual ideas.

Beliefs toward mathematics assessment.

In order to assess students mathematics abilities, an elementary math teacher needs to . . .

adequately select, design, and use mathematics evaluation materials.
believe that elementary school mathematics can be learned by most children.

Assessment should only be done by individual testing.

Diagnostic assessment of students abilities can be assessed by means of math games.

Written assessments are no longer needed in classrooms because of the variety of non-writing assessments available to the teacher.

Peer assessment is an effective method of evaluating students.

The purpose of assessment is only for the teacher to obtain information on student performance.
Varied forms of assessment are not needed, one or two are sufficient.

The more homework = more practice = more understanding.
Appendix D
Second Draft Questionnaire of 122 Statements
PLEASE DO NOT WRITE YOUR NAME OR ANY IDENTIFYING INFORMATION ANYWHERE ON THIS SURVEY.

Please check the appropriate box for the following information.

1. Which course are you currently enrolled? Check one:
   _ Math 150 Number Concepts Elementary Middle School Teaching
   _ Math 352 Teaching Elementary School Mathematics

2. If you are currently in Math 352 answer the following, if in Math 150 go to question 3.
   Did you take Math 150-Number Concepts Elem/Mid at WMU? _yes_ no
   How many times did you take Math 150? _one time_ _two or more times_
   Did you take Math 151-Geometry Elem/Mid. Sch. Teaching at WMU? _yes_ no
   How many times did you take Math 151? _one time_ _two or more times_
   Did you take Math 265-Probability & Statistics Elem/Mid Sch. Tch at WMU? _yes_ no
   How many times did you take Math 265? _one time_ _two or more times_

3. What is your academic status?
   _Freshman_ _Sophomore_ _Junior_ _Senior_ _Other_

Please complete each statement by circling the number which most closely represents your response.

Agree  Strongly Agree  Strongly
Strongly  Neutral  Disagree

   1  2  3  4  5

5. Children who answer correctly all problems on a worksheet fully understand the concept that was taught. 
   1  2  3  4  5

6. Drill-and-practice sheets are a vital part of understanding mathematics.  
   1  2  3  4  5

7. Manipulatives are useful tools in understanding all types of mathematics in all grades.  
   1  2  3  4  5

8. Conceptual learning cannot be easily evaluated through paper-pencil testing.  
   1  2  3  4  5

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9. Because of the cost of most manipulatives, it is better to learn paper pencil approaches since school's won't have manipulatives to use.

10. The use of algorithms to produce answers is best taught using paper-pencil instruction.

11. The use of manipulatives should be limited to primary grades.

12. Upper elementary children find no connection between manipulatives and concepts.


14. Evaluation through small group activities is an unfair assessment.

15. Whole class instruction aids in keeping the class in order.

16. Small group activities create confusion and noise and not much learning.

17. In small groups only a few students are really learning the concept.

18. Individual work is the best way to practice procedures.

19. Whole class instruction is more efficient since all children need to learn all concepts to the same depth.

20. The teacher's role is to tell or show students how to do problems.

21. Students asking questions should be told the answer and have answers demonstrated rather than another question leading them towards the answer.

22. Facts told to a student are much more likely to be remembered than facts the student discovers.

23. Students should work problems on their own before problems are discussed and demonstrated in class.

24. Students understand concepts better when teachers encourage them to discover concepts on their own.

25. There are some situations in which a teacher must tell or demonstrate a lesson to students.
<table>
<thead>
<tr>
<th></th>
<th>Guided discovery and questioning helps children learn thinking processes and gain self-confidence.</th>
<th>Agree</th>
<th>Strongly Agree</th>
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<th>Strongly Disagree</th>
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<table>
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<th>Guided discovery and questioning activities will lead to further discovery by students on their own.</th>
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<th>Manipulatives allow children to use their own problem-solving skills.</th>
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<th></th>
<th>Given the choice, I'd rather teach with open-ended activities and no textbook/worksheets than vice versa.</th>
<th>Agree</th>
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<th>Open-ended activities make learning fun and interesting.</th>
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<th>Open-ended activities adds variety to teaching.</th>
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<th>Open-ended activities helps students transfer knowledge to new areas.</th>
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<th>When you get the wrong answer to a math problem it is absolutely wrong, there is no room for argument.</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Neutral</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
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<tr>
<td>45</td>
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<tr>
<td>47.</td>
<td>Children following exact procedures perform better in open-ended problem solving situations.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>48.</td>
<td>The use of manipulatives and classroom discussion are necessary for rote teaching.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>49.</td>
<td>Open-ended teaching and the use of manipulatives are only appropriate for primary grades.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>50.</td>
<td>In math classes rules of thumb should be taught as the way to learn math.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>51.</td>
<td>A teacher standing in front of a classroom and using the blackboard is better instruction than having a group discussion.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>52.</td>
<td>Sometimes it is best for the teacher to act as an observer and allow the learning to happen.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>53.</td>
<td>The teacher should try to remain in front of the class, so student attention is focused in one direction.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>54.</td>
<td>Calculators should not be used in the classroom.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>55.</td>
<td>Students need to develop paper-pencil computation skills.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>56.</td>
<td>Manipulatives or physical models for math should be used after the children learn the procedures.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>57.</td>
<td>Teaching for conceptual learning should take up the majority of instructional time.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>58.</td>
<td>Many different models and materials should be used in the classroom.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>59.</td>
<td>Calculators should be an integral part of the classroom.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>60.</td>
<td>There are many different ways to solve a single problem.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>61.</td>
<td>Trial and error can often be used to solve a math problem.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>62.</td>
<td>In mathematics, problems can be solved without using rules.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>63.</td>
<td>There are many different ways to solve most mathematics problems.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
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To assess student performance in mathematics, the teacher should:

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<tr>
<td>64</td>
<td>develop paper-pencil tests for content taught.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>65</td>
<td>require rote recall of mathematical concepts.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>66</td>
<td>use open-ended questions.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>67</td>
<td>test each objective taught in the curriculum.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>68</td>
<td>accept written explanations of how a student solved the problem even if the final answer is incorrect.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>69</td>
<td>check with student's on what was their thinking on a test that had many errors within a single skill or concept.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>70</td>
<td>have weekly timed tests on basic facts.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>71</td>
<td>accept math projects as well as paper-pencil work as an indicator of the mathematical understanding of a child.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
</tbody>
</table>

72. The best way to assess student work is on an individual basis. SD D N A SA

73. Children feel good about themselves when they achieve on an individual competitive level. SD D N A SA

74. A classroom with a high noise level is not a good math learning environment. SD D N A SA

The use of technology (calculators, computers) is:

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<tr>
<td>75</td>
<td>enables students to avoid learning to compute with paper-and-pencil.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>76</td>
<td>makes mathematics more mechanical and boring.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>77</td>
<td>something everyone should learn.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>78</td>
<td>can aid in the development of mathematical concepts.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>79</td>
<td>has little relevance to elementary student's daily lives.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>80</td>
<td>time-consuming to teach.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
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</tr>
<tr>
<td>81.</td>
<td>not as important as knowing basic skills and concepts of whole numbers.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
</tr>
<tr>
<td>82.</td>
<td>key to expanding problem solving to higher levels of difficulty.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
</tr>
<tr>
<td>83.</td>
<td>The use of an overhead is a more effective way of teaching than using a chalkboard.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
</tr>
<tr>
<td>84.</td>
<td>Computer math programs used in the classroom can reinforce concepts and provide practice time.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
</tr>
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</table>

To be good at mathematics, you need to:

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<tbody>
<tr>
<td>85.</td>
<td>work hard at it.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>86.</td>
<td>remember formulas, principles and procedures.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>87.</td>
<td>think in a logical step-by-step manner.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>88.</td>
<td>have basic understandings of concepts and strategies.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>89.</td>
<td>be able to think flexibly.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>90.</td>
<td>have confidence you can do it.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>91.</td>
<td>have a kind of &quot;mathematical mind&quot;.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>92.</td>
<td>be interested in mathematics.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>93.</td>
<td>give full effort.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
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</table>

When I get a good grade in math:

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<tbody>
<tr>
<td>94.</td>
<td>It is because I work hard.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>95.</td>
<td>It is because the teacher likes me.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>96.</td>
<td>It is because I'm always good at math.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>97.</td>
<td>It is just a matter of luck.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>98.</td>
<td>I never know how it happens.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
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When I get a poor grade in math:

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<tr>
<td>99.</td>
<td>It is because I didn't study hard enough.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>100.</td>
<td>It is because the teacher doesn't like me.</td>
<td>Agree</td>
<td>Strongly Agree</td>
<td>Neutral</td>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>
101. It is just bad luck.  
102. It is because I'm not good at math.  
103. It is because of careless mistakes.  
104. I can get along well in everyday life without using mathematics  
105. I usually understand what we are talking about in math class.  
106. I work a long time in order to understand a new idea in mathematics.  
107. A knowledge of mathematics is not necessary in most occupations.  

To be a good teacher of elementary mathematics, you need to:

108. be confident in your ability to select mathematics teaching materials.  
109. be confident in your ability to read and understand math textbooks and teacher editions.  
110. avoid grouping students by ability or level of performance.  
111. make independent decisions about what to teach.  
112. focus instruction on "minimum competency" for slow learners.  
113.  
114. encourage students to think and question.  
115. teach the subject matter as the primary focus.  
116. Assessment should be done by individual testing.  
117. Diagnostic assessment of students abilities can be accomplished by means of math games.  
118. Written assessments are no longer needed in classrooms because of the variety of alternative assessments available to the teacher.
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<tbody>
<tr>
<td>119.</td>
<td>Peer assessment is an effective method of evaluating students.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>120.</td>
<td>The purpose of assessment is only for the teacher to get information on student performance.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>121.</td>
<td>Varied forms of assessment are not needed, one or two are sufficient.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>122.</td>
<td>The more homework = more practice = more understanding.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
</tr>
</tbody>
</table>
Appendix E

Final Questionnaires
PLEASE DO NOT WRITE YOUR NAME OR ANY IDENTIFYING INFORMATION ANYWHERE ON THIS SURVEY.

PART I. Please check the appropriate box.

1. Which course are you currently enrolled? Check one:
   _ Math 150 Number Concepts Elementary Middle School Teaching
   _ Math 352 Teaching Elementary School Mathematics.

If you are currently in Math 352 answer the following, if in Math 150 go to question #8.

2. Did you take Math 150-Number Concepts Elem/Mid at WMU?
   _ yes
   _ no

3. How many times did you take Math 150?
   _ one time
   _ two or more times

4. Did you take Math 151-Geometry Elem/Mid. Sch. Teaching at WMU?
   _ yes
   _ no

5. How many times did you take Math 151?
   _ one time
   _ two or more times

6. Did you take Math 265-Probability & Statistics Elem/Mid Sch. Tch at WMU?
   _ yes
   _ no

7. How many times did you take Math 265?
   _ one time
   _ two or more times

8. What is your academic status?
   _ Freshman
   _ Sophomore
   _ Junior
   _ Senior
   _ Other ___________________ ______
PART II. Please circle your response.

SD = Strongly Disagree
D = Disagree
N = Neutral
A = Agree
SA = Strongly Agree

9. Children who answer correctly all problems on a worksheet fully understand the concept that was taught. SD D N A SA

10. Manipulatives/physical models are useful tools in understanding all types of mathematics in all grades. SD D N A SA

11. Because of the cost of most manipulatives/physical models, it is better to learn paper pencil approaches. SD D N A SA

12. The use of rules/formulas to produce answers is best taught using paper-pencil instruction. SD D N A SA

13. Upper elementary children find no connection between manipulatives and concepts. SD D N A SA

14. Because small group activities create confusion and noise not much learning takes place. SD D N A SA

15. A classroom with a high noise level is not a good math learning environment. SD D N A SA

16. In small groups only a few students are really learning the concept. SD D N A SA

17. Individual work is the best way to practice rules. SD D N A SA

18. Whole class instruction is more efficient since all children need to learn all concepts to the same depth. SD D N A SA

19. The teacher's role is to demonstrate to students how to do problems. SD D N A SA

20. Facts told to a student are much more likely to be remembered than facts the student discovers. SD D N A SA

21. Students understand concepts better when teachers encourage them to discover concepts on their own. SD D N A SA

22. Guided discovery and questioning helps children learn thinking processes and gain self-confidence. SD D N A SA

23. Guided discovery and questioning activities will lead to further discovery by students on their own. SD D N A SA

24. Given the choice, I'd prefer to teach with open-ended activities and without textbook/worksheets. SD D N A SA
25. Open-ended activities make learning fun and interesting.  SD  D  N  A  SA
26. Open-ended activities adds variety to teaching.  SD  D  N  A  SA
27. Open-ended activities helps students remember procedures.  SD  D  N  A  SA
28. Open-ended activities helps students transfer knowledge to new areas.  SD  D  N  A  SA
29. In math you have to accept the fact that many facts must be memorized.  SD  D  N  A  SA
30. Students perform better on tests when they memorize the procedures.  SD  D  N  A  SA
31. Problem-solving strategies cannot be tested.  SD  D  N  A  SA
32. Mathematics is mostly facts and procedures that have to be memorized.  SD  D  N  A  SA
33. Problem-solving strategies are easy to learn.  SD  D  N  A  SA
34. Problem-solving strategies are easy to teach.  SD  D  N  A  SA
35. Memorizing is important in learning mathematics.  SD  D  N  A  SA
36. The best way to do well is to memorize formulas.  SD  D  N  A  SA
37. Some basic mathematical content must be memorized.  SD  D  N  A  SA
38. When you get the wrong answer to a math problem it is absolutely wrong, there is no room for argument.  SD  D  N  A  SA
39. Children following exact procedures always perform better than in open-ended problem solving situations.  SD  D  N  A  SA
40. The use of manipulatives and classroom discussion are necessary for teaching by rules/procedures.  SD  D  N  A  SA
41. Open-ended teaching and the use of manipulatives are only appropriate for primary grades.  SD  D  N  A  SA
42. In math classes "rules of thumb" should be taught as the way to learn math.  SD  D  N  A  SA
43. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.  SD  D  N  A  SA
44. Students need paper-pencil computation skills to do most math problems.  SD  D  N  A  SA
45. Many different models and materials should be used in the classroom. **SD**

46. Trial and error can often be used to solve a math problem. **D**

47. There are many different ways to solve most mathematics problems. **N**

48. To test student performance in mathematics, the teacher should develop paper-pencil tests for content taught. **A**

49. Written assessments are no longer needed in classrooms because of the variety of alternative assessments available to the teacher. **SA**

50. The purpose of testing is only for the teacher to get information on student performance. **SD**

51. Varied forms of assessment are not needed, one or two are sufficient. **D**

52. The more homework = more practice = more understanding. **N**

53. The best way to assess student work is on an individual basis. **A**

54. The use of technology (calculators, computers) enables students to avoid learning to compute with paper-and-pencil. **SD**

55. Technology can aid in the development of mathematical concepts. **D**

56. Calculators have little relevance to elementary student's daily lives. **N**

57. The use of an overhead is a more effective way of teaching than using a chalkboard. **A**

58. Computer math programs used in the classroom can reinforce concepts and provide practice time. **SD**

59. I can get along well in everyday life without using mathematics **D**

60. I usually understand what we are talking about in math class. **N**

61. I work a long time in order to understand a new idea in mathematics. **A**
62. A knowledge of mathematics is not necessary in most occupations.  

When I get a good grade in math:  
63. it is because I work hard.  
64. it is because I'm confident in my abilities.  
65. it is just a matter of luck.  
66. I never know how it happens.  

When I get a poor grade in math:  
67. it is because I didn't study hard enough.  
68. it is because of careless mistakes.  

To be a good teacher of elementary mathematics, you need to:  
69. be confident in your ability to select mathematics teaching materials.  
70. be confident in your ability to read and understand math textbooks and teacher editions.  
71. avoid grouping students by ability or level of performance.  
72. make independent decisions about what to teach.  
73. encourage students to think and question.
To be good at mathematics, I need to:

74. work hard at it. SD D N A SA
75. remember formulas, principles and procedures. SD D N A SA
76. think in a logical step-by-step manner. SD D N A SA
77. have basic understandings of concepts and strategies. SD D N A SA
78. be able to think flexibly. SD D N A SA
79. have confidence I can do it. SD D N A SA
80. have a "mathematical mind". SD D N A SA

Comments:
Appendix F

Cover Letter
Cover Letter

This is a study being conducted in order to learn about student perception and attitudes regarding the teaching of mathematics. The results of this study will be used to make changes in the curriculum of the math education program at Western Michigan University. Participation is voluntary and you are free to discontinue participation at any time. Participation in the research or lack of participation will have no impact on the relationship between you and your instructor or your grade in this course.

If you decide to participate, approximately 20 minutes of your time will be required. The faculty have agreed to allow class time for you to complete this information. The measure will require you to rank on a scale of 1 to 5 aspects relating to your attitude and perceptions of teaching of elementary mathematics.

In order to maintain anonymous response please do not put your name anywhere on the survey.

If requested, a brief summary of the findings will be sent to you after the study has been completed. If you have any questions or concerns relating to the research, you may contact me at 4419 Everett Tower, 387-4536. Thank you for your assistance in providing information for this study.

Elsa L. Geskus, Instructor
Math and Statistics Department
Appendix G

Follow-Up Questionnaire
Follow-up

Your voluntary cooperation in writing responses to the statements below is greatly appreciated. The information requested will be used by the Department of Mathematics and Statistics to review the overall effectiveness of the mathematics program for elementary teachers. Please do not write your name or put any distinguishing marks on the paper to identify yourself. When you are finished please place your response in the envelope provided. Seal the envelope. At your next class session, give the envelope to the designated student. You may then select an envelope from the "grab bag" as a token of our appreciation for your time and efforts.

Please respond to the following statements with your own thoughts. Be as specific as possible and give examples if appropriate. Use as much space as needed (backside or additional paper).

1. To be good at mathematics, I need to have a "mathematical mind".

2. To be a good teacher of elementary mathematics, you need to encourage students to think and question.

3. There are many different ways to solve most mathematics problems.

4. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.
5. Mathematics is mostly facts and procedures that have to be memorized.

6. Open-ended activities help students remember procedures.

7. Guided discovery and questioning activities will lead to further discovery by students on their own.

8. Children who answer correctly all problems on a worksheet fully understand the concept that was taught.
Follow-up

Your voluntary cooperation in writing responses to the statements below is greatly appreciated. The information requested will be used by the Department of Mathematics and Statistics to review the overall effectiveness of the mathematics program for elementary teachers. Please do not write your name or put any distinguishing marks on the paper to identify yourself. When you are finished please place your response in the envelope provided. Seal the envelope. At your next class session, give the envelope to the designated student. You may then select an envelope from the "grab bag" as a token of our appreciation for your time and efforts.

Please complete the following statements with your own thoughts. Be as specific as possible and give examples if appropriate. Use as much space as needed (backside or additional paper).

1. Calculator/computer use in elementary mathematics classes should be . . .

2. To assess student performance in mathematics, the teacher should . . .

3. If a student receives good grades in mathematics, it is because . . .

4. The best way for elementary students to learn mathematics is . . .
5. A successful student in mathematics is one who...

6. A good teacher of elementary mathematics should...

7. To be good at mathematics, I need to...

8. Problem solving in the elementary classroom is...

9. To solve most mathematical problems...
Appendix H
Course Outlines
Number Concepts for Elementary/Middle School Teachers

- An Introduction to Mathematical Problem Solving
  Solving non-routine mathematical problems, steps in the problem-solving process, and applications of problem-solving strategies. (This strand is continued throughout the remainder of the course.)

- Numeration Systems
  Examination and construction of various types of numeration systems with emphasis on the properties of grouping and place value and the use of materials to model these properties.

- Operations and Properties of Whole Numbers
  Conceptual development of the four basic operations with emphasis on the use of concrete materials to model the operations and upon the use of thinking strategies for working with basic facts.

- Whole Number Computation
  Strategies for performing exact mental arithmetic and computational estimations, calculator use, developmental algorithms and low-stress algorithms. Emphasis is on the use of concrete and pictorial models, developing number sense, and mathematical reasoning.

- Number Theory
  Development of the concepts of prime and composite numbers using manipulatives, prime factorization techniques, developmental and standard algorithms for computing least common multiples and greatest common factors.

- Rational Numbers
  Essential fraction ideas, use of concrete and pictorial models for fractions and decimals to solve problem situations involving equivalence, ordering, and operations (no standard algorithms permitted), developing the ratio concept, unit rates, proportional reasoning, reasoning with percents, integer concepts, developing mental arithmetic and computational estimation strategies for rational numbers, and calculator applications. Emphasis on number sense, the use of multiple representations, and reasoning.
Geometry for Elementary/Middle School Teachers

- An Introduction to Geometry
  Overview of geometry in the environment and the van Hiele levels of geometric reasoning

- Analysis of Figures in the Plane
  Attributes of common geometric shapes including properties of sides and angles, line and rotational
  symmetries, cartesian coordinates, use of the Mira® and geoboard, angle measure, analysis of regular
  polygons, tessellations of the plane, geometric problem solving in a Logo environment, and the matrix
  representation of graphs.

- Analysis of Figures in Space
  Describing 3-dimensional figures, analysis of regular polyhedra, and developing spatial visualization.

- Measurement
  Concept of measure and the use of standard and non-standard units, developing concepts and formulas related
  to measures of length, area, volume, and surface area; and additional problem solving with Logo.

- Transformations in the Plane
  Rigid motions, congruence, more on symmetry of plane figures, tessellations and construction and analysis
  of Escher-type drawings.
Probability & Statistics for Elementary/Middle School Teachers

- **Collection, Organization, Summarization, and Interpretation of Data**
  Construction and interpretation of tabulated data including contingency tables, applications of a computerized database, construction and interpretation of stem-and-leaf plots, frequency tables, and histograms.

- **Other Graphical Displays of Data**
  Construction and interpretation of real graphs, picture graphs, bar graphs, circle graphs, and line graphs; applications of a computer-based statistical package.

- **Measure of Central Tendency**
  Concepts of mean and median; applications of the statistical features of programmable/graphing calculators.

- **Measures of Dispersion**
  Construction and interpretation of box-and-whisker plots; concept of standard deviation including applications to z-scores and normal distributions; continued use of programmable calculators.

- **An Introduction to Probability**
  Concepts of likelihood of events, randomness, probability experiments, experimental vs. theoretical probability, and geometric probability with applications and problem solving accomplished without the use of standard probability formulas; continued use of programmable calculators.

- **Simulation Techniques**
  Use of manipulatives, programmable calculators, and random number tables to simulate probabilistic events; applications of Monte Carlo procedures.

- **Analytic Methods for Probability**
  Use of probability trees, area models, and partial trees to solve multistage probability problems based upon an analysis of fair and unfair games and other real-world settings.
Methods for Elementary/Middle School Teachers

- Understanding of Problem Solving Strategies
  Role of appropriate strategies in nonroutine, open-ended, multiple step and cooperative problem solving situations.

- Assessment and Planning for Instruction
  Journal writing, performance tasks, portfolios, lesson plans, unit plans, cooperative grouping.

- Place Value, Mental Mathematics and Estimation Strategies
  Place holders; front-end estimation, rounding, reasonable answer; mental thinking activities.

- Pre-Number and Whole Number Strategies
  Attribute blocks, pattern blocks, tangrams for classification, sorting, matching and patterning; basic fact strategies using unifix cubes; base-ten blocks for operations.

- Fractions, Decimals, Ratios, Percents, Probability and Statistics
  Concepts of likelihood of events; fraction bars, paper folding, geoboard; decimal mats.

- Measurement, Geometry, Time and Money Concepts
  Use of manipulatives with English and metric systems of measurement; geometric concepts; time; money

- Technology-Calculators and Computers
  Use of calculator in instruction; review of commercial software.
Appendix I

Procedural Instructions for Questionnaire Administration
To: Mathematics Education 352 Professors
From: Dr. R.A. Meyer, Chairperson,
Elsa Geskus, Instructor
Re: Instructions for implementing the surveys (two forms)
Date: April 1994

Enclosed please find a cover letter and two forms of a survey for distribution for your Math 352 class during the last week of classes. Thank you for assisting in the research study by reading the COVER LETTER and allowing 20 minutes of class time for your students to complete one of the forms.

Please note that Part I has 3 questions that all students will select appropriate responses. The Likert survey begins with Question 9, (there are no missing questions from Part I question 3). The alternate survey has statements that require written responses.

In order for the research to be presented in a uniform manner to all the participants, please follow the procedure outlined below.

1. As you distribute the forms, alternating the forms, (already done for you in your stack of surveys) introduce the study by stating:

   I am distributing a cover letter, and a survey for a study which is being conducted by Elsa Geskus, Instructor in the math education area group. Your participation in this study is voluntary and will not affect your grade in this class. There are two forms of the survey, I will alternate the forms. While the forms are addressing similar responses, we did not want to take up a lot of your class time by you doing both. Therefore, half of each class will take one form and half the alternate form. After you have finished the survey, I will place them in an envelope (show envelope) and seal it. I have been instructed to read the cover letter to you.

2. Read cover letter to the class.

3. After reading the cover letter, announce:

   I will allow 20 minutes for those willing to participate in the study to complete the survey.

4. After 20 minutes collect the forms.

5. Please count and record the number of students present in class today.

   ___________ students were present.

6. Please place the collected forms and this sheet in the envelope, seal it and return it to the math department office. Please place in the mail box of Elsa Geskus or on the counter in the office.

If you have any questions, you may contact me at 387-4536. Your assistance and cooperation are very much appreciated. Thanks. To sweeten the process, enjoy the candy bar for your efforts.

Sincerely,

Elsa Geskus
Instructor,
Math Education Area Group
Appendix J

Human Subjects Institutional Review Board Approval
Date: June 3, 1993
To: Elsa Geskus
From: M. Michele Burnette, Chair
Re: HSIRB Project Number 93-06-01

This letter will serve as confirmation that your research project entitled "Preservice elementary teacher's beliefs about mathematics and mathematics instruction" has been approved under the exempt category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: June 3, 1994

xc: Warfield, EDLD
Appendix K
Research Study: Likert and Open-Ended Questionnaires
PLEASE DO NOT WRITE YOUR NAME OR ANY IDENTIFYING INFORMATION ANYWHERE ON THIS SURVEY.

MATH 150
Number Concepts Elementary Middle School Teaching

PART I

1. Please select one of the following choices that best describes your future goal for employment.

_____ My goal is to become a special education grade school teacher (working with emotionally, mentally or physically impaired students)

_____ My goal is to become an art, music or physical education specialist.

_____ My goal is to become an elementary/middle school classroom teacher

2. What is your academic status?

___ Freshman
___ Sophomore
___ Junior
___ Senior
___ Other: ________________________________

3. Is this your first time taking Math 150, at WMU or are you repeating Math 150?

___ First time
___ Repeating
PART I

1. Please select one of the following choices that best describes your future goal for employment.

_____ My goal is to become a special education grade school teacher (working with emotionally, mentally or physically impaired students)

_____ My goal is to become an art, music, physical education or speech specialist.

_____ My goal is to become an elementary/middle school classroom teacher

2. What is your academic status?

___ Sophomore
___ Junior
___ Senior
___ Other: ______________________________

3. Did you satisfactorily complete ALL of the following courses at WMU with a grade of C or better?
   a. Math 150 Number Concepts Elem/Middle School Teaching
   b. Math 151 Geometry Elementary/Middle School Teaching

   ___ yes  ___ no
PART II. Please circle your response.

Note: Survey questions begin with #9.

SD = Strongly Disagree
D = Disagree
N = Neutral
A = Agree
SA = Strongly Agree

9. Children who answer correctly all problems on a worksheet fully understand the concept that was taught. SD D N A SA

10. Manipulatives/physical models are useful tools in understanding all types of mathematics in all grades. SD D N A SA

11. Because of the cost of most manipulatives/physical models, it is better to learn paper pencil approaches. SD D N A SA

12. The use of rules/formulas to produce answers is best taught using paper-pencil instruction. SD D N A SA

13. Upper elementary children find no connection between manipulatives and concepts. SD D N A SA

14. Because small group activities create confusion and noise not much learning takes place. SD D N A SA

15. A classroom with a high noise level is not a good math learning environment. SD D N A SA

16. In small groups only a few students are really learning the concept. SD D N A SA

17. Individual work is the best way to practice rules. SD D N A SA

18. Whole class instruction is more efficient since all children need to learn all concepts to the same depth. SD D N A SA

19. The teacher’s role is to demonstrate to students how to do problems. SD D N A SA

20. Facts told to a student are much more likely to be remembered than facts the student discovers. SD D N A SA

21. Students understand concepts better when teachers encourage them to discover concepts on their own. SD D N A SA

22. Guided discovery and questioning helps children learn thinking processes and gain self-confidence. SD D N A SA

23. Guided discovery and questioning activities will lead to further discovery by students on their own. SD D N A SA

24. Given the choice, I’d prefer to teach with open-ended activities and without textbook/worksheets. SD D N A SA
25. Open-ended activities make learning fun and interesting.  SD D N A SA
26. Open-ended activities adds variety to teaching.  SD D N A SA
27. Open-ended activities helps students remember procedures.  SD D N A SA
28. Open-ended activities helps students transfer knowledge to new areas.  SD D N A SA
29. In math you have to accept the fact that many facts must be memorized.  SD D N A SA
30. Students perform better on tests when they memorize the procedures.  SD D N A SA
31. Problem-solving strategies cannot be tested.  SD D N A SA
32. Mathematics is mostly facts and procedures that have to be memorized.  SD D N A SA
33. Problem-solving strategies are easy to learn.  SD D N A SA
34. Problem-solving strategies are easy to teach.  SD D N A SA
35. Memorizing is important in learning mathematics.  SD D N A SA
36. The best way to do well is to memorize formulas.  SD D N A SA
37. Some basic mathematical content must be memorized.  SD D N A SA
38. When you get the wrong answer to a math problem it is absolutely wrong, there is no room for argument.  SD D N A SA
39. Children following exact procedures always perform better than in open-ended problem solving situations.  SD D N A SA
40. The use of manipulatives and classroom discussion are necessary for teaching by rules/procedures.  SD D N A SA
41. Open-ended teaching and the use of manipulatives are only appropriate for primary grades.  SD D N A SA
42. In math classes "rules of thumb" should be taught as the way to learn math.  SD D N A SA
43. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.  SD D N A SA
44. Students need paper-pencil computation skills to do most math problems.  SD D N A SA

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45. Many different models and materials should be used in the classroom. SD D N A SA
46. Trial and error can often be used to solve a math problem. SD D N A SA
47. There are many different ways to solve most mathematics problems. SD D N A SA
48. To test student performance in mathematics, the teacher should develop paper-pencil tests for content taught. SD D N A SA
49. Written assessments are no longer needed in classrooms because of the variety of alternative assessments available to the teacher. SD D N A SA
50. The purpose of testing is only for the teacher to get information on student performance. SD D N A SA
51. Varied forms of assessment are not needed, one or two are sufficient. SD D N A SA
52. The more homework = more practice = more understanding. SD D N A SA
53. The best way to assess student work is on an individual basis. SD D N A SA
54. The use of technology (calculators, computers) enables students to avoid learning to compute with paper-and-pencil. SD D N A SA
55. Technology can aid in the development of mathematical concepts. SD D N A SA
56. Calculators have little relevance to elementary student's daily lives. SD D N A SA
57. The use of an overhead is a more effective way of teaching than using a chalkboard. SD D N A SA
58. Computer math programs used in the classroom can reinforce concepts and provide practice time. SD D N A SA
59. I can get along well in everyday life without using mathematics. SD D N A SA
60. I usually understand what we are talking about in math class. SD D N A SA
61. I work a long time in order to understand a new idea in mathematics. SD D N A SA
62. A knowledge of mathematics is not necessary in most occupations.  

**When I get a good grade in math:**

63. it is because I work hard.  
64. it is because I'm confident in my abilities.  
65. it is just a matter of luck.  
66. I never know how it happens.  

**When I get a poor grade in math:**

67. it is because I didn't study hard enough.  
68. it is because of careless mistakes.  

**To be a good teacher of elementary mathematics, you need to:**

69. be confident in your ability to select mathematics teaching materials.  
70. be confident in your ability to read and understand math textbooks and teacher editions.  
71. avoid grouping students by ability or level of performance.  
72. make independent decisions about what to teach.  
73. encourage students to think and question.
To be good at mathematics, I need to:

74. work hard at it. SD D N A SA
75. remember formulas, principles and procedures. SD D N A SA
76. think in a logical step-by-step manner. SD D N A SA
77. have basic understandings of concepts and strategies. SD D N A SA
78. be able to think flexibly. SD D N A SA
79. have confidence I can do it. SD D N A SA
80. have a "mathematical mind". SD D N A SA

Comments:
Math 352 Methods of Teaching Mathematics Survey

Please respond to the following statements with your own thoughts. Be as specific as possible and give examples if appropriate. Use as much space as needed (backside or additional paper).

1. To be good at mathematics, I need to have a "mathematical mind".

2. To be a good teacher of elementary mathematics, you need to encourage students to think and question.

3. There are many different ways to solve most mathematics problems.
4. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.

5. The purpose of testing is only for the teacher to get information on student performance.

6. The more homework = more practice = more understanding.

7. Mathematics is mostly facts and procedures that have to be memorized.
8. Children who answer correctly all problems on a worksheet full understanding the concept that was taught.

9. The use of calculators enables students to avoid learning to compute with paper-and-pencil.

10. In small groups only a few students are really learning the concept.
Appendix L

Student Responses: Open-Ended Questionnaire
Q#1 To be good at mathematics, I need to have a Mathematical mind.

<table>
<thead>
<tr>
<th>Fall entering students</th>
<th>exiting students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>no 58</strong></td>
<td><strong>no 38</strong></td>
</tr>
<tr>
<td>- need to grasp concepts 14</td>
<td>- I believe a person can achieve in math with the proper guidance and preparation, using hands-on problem solving approach makes math an achievable subject. 19</td>
</tr>
<tr>
<td>- I need to open my mind to new concepts and accept them. This is the barrier for majority of people, need to brainstorm, understanding 3</td>
<td>- where there's a will, there's a way, need enthusiasm, desire, not just knowledge 13</td>
</tr>
<tr>
<td>- you must have a teacher or parent to help mold your mind toward math 3</td>
<td>- need to be a good problem solver not MM 4</td>
</tr>
<tr>
<td>- Math logic can be taught and &quot;caught&quot; our brains are logical and to look for patterns in math leading to the MM 2</td>
<td>- Anyone can have a MM, I use to hate math, thought I was not mathematical, but good instructors have taught me strategies that make me think and understand mathematics. 3</td>
</tr>
<tr>
<td>- has more to do with the teacher's in past and present classes</td>
<td>- need common sense, need creative methods to help lessen student, fear of failure</td>
</tr>
<tr>
<td>- I was raised with this statement in K-12, changed my mind in college when discovered math is something that anyone can LEARN</td>
<td>- success lies in a person's ability to visualize the problem and relate it to something that they know, a MM is one that is familiar and comfortable with abstract math concepts 2</td>
</tr>
<tr>
<td>- often math problems don't make sense, can't rely on formulas and laws</td>
<td>- I need to have a creative mind, don't need a calculus whiz to teach elem. school, math</td>
</tr>
<tr>
<td>- it has to interest you, have fun with it</td>
<td>- I was low in math but in High School I realized math wasn't all that difficult. Takes a lot of patience, will power and determination. For superior math, I think that's great but to be able to teach to children you must meet their level. All the fancy definitions aren't needed for someone who struggled in math, need to reach for ideas.</td>
</tr>
<tr>
<td>- need common sense &amp; willingness to learn 4</td>
<td>- need to conceptualize concepts through use of manipulatives make decision, be open to possible solutions, and support your ideas 2</td>
</tr>
<tr>
<td>- need to be taught methods to solve problems, following steps does not require a &quot;specific type of mind&quot;</td>
<td>- involves linking conceptual knowledge w/ procedural, done through meaningful experiences that develop relational understanding, then one is good at math</td>
</tr>
<tr>
<td>- need mind which processes math makes logic out of mumble to others</td>
<td>- old myth about needing MM to be successful in math not true. It's a belief tied to math anxiety, incorporating other subjects into math curriculum, will dispel this belief.</td>
</tr>
<tr>
<td>- not imp. to memorize, understand why &amp; how</td>
<td>- I don't, need creative ways to see things</td>
</tr>
<tr>
<td>- everyone can learn, need to be shown how 11</td>
<td>- need analytical thinking, right attitude 4</td>
</tr>
<tr>
<td>- patience &amp; persistence-say I love math 4</td>
<td>- hard work is what it takes 4</td>
</tr>
<tr>
<td>- I don't, need creative ways to see things</td>
<td>- manipulatives are resources-don't require mm 3</td>
</tr>
<tr>
<td>- need common sense &amp; willingness to learn 4</td>
<td>- just need to pay attention 3</td>
</tr>
<tr>
<td>- need to be taught methods to solve problems, following steps does not require a &quot;specific type of mind&quot;</td>
<td>- should have the concepts, know how to teach them, MM isn't possible for everyone 2</td>
</tr>
<tr>
<td>- need an analytical thinking, right attitude 4</td>
<td>- most people don't think numbers, approaches for the majority will be more successful</td>
</tr>
<tr>
<td>- hard work is what it takes 4</td>
<td>- depends on how willing a teacher is to go over problems and help student, being patient</td>
</tr>
<tr>
<td>- manipulatives are resources-don't require mm 3</td>
<td>- need open mind, time to decide on answer. 2</td>
</tr>
<tr>
<td>- just need to pay attention 3</td>
<td>- all you do is plug numbers into formula and solve</td>
</tr>
<tr>
<td>- need an analytical thinking, right attitude 4</td>
<td>- it must be exciting to you</td>
</tr>
</tbody>
</table>

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you do not need, but switch to and think and do logically.
- this is a mind that deals with numbers.
- math equals lots of concepts, your mind has to figure them out.
- in order to apply formulas to specific applications why they are needed, need to learn basics.
- you can really excel and even discover things that would one day be taught.
- along with talent, desire, practice, refining your skills, hard work.
- something either good at or bad at, took Algebra 110 twice not a lack of trying or tutors, just didn't click.
- math is just numerical facts.
- 4 years of High School, 2 semesters, at WMU, I still don't get it or like it.
- need to teach student, with MM.
- you have to understand what is going on.

- need analytical mind to memorize facts and to recall in split second timing.
- need a quick mind, I'm frustrated by students who call out answers quickly and I can't.
- need to know math in order to teach it.
- you'd have to follow straight from the book without a MM.
- I feel that it is due to the way I was taught, ditto after ditto, not a thinking process.
- without MM, some people can't grasp some concepts, maybe w/ hard work they can overcome math difficulties.
- helps to have.
- need to think numbers, concepts, strategies, mind has to be in a mode for math, abstract thinking of ideas.
Q#2. To be a good teacher of elementary mathematics, you need to encourage students to think and question.

<table>
<thead>
<tr>
<th>Fall entering students</th>
<th>exiting students</th>
</tr>
</thead>
<tbody>
<tr>
<td>no 2</td>
<td>no</td>
</tr>
<tr>
<td>-you need to show them how 2</td>
<td></td>
</tr>
<tr>
<td>yes 74</td>
<td>yes 55</td>
</tr>
<tr>
<td>-need to be challenged 9</td>
<td>-need to know how and why prob. can be achieved, do by asking questions 21</td>
</tr>
<tr>
<td>-the time of a page of identical procedure problems is passing, being replaced by cumulative math textbooks where the student must think and question both procedure and facts given</td>
<td>-need active learning 9</td>
</tr>
<tr>
<td>-children must believe in self 2</td>
<td>-students need to work in groups to solve and discover concepts 9</td>
</tr>
<tr>
<td>-usually answer staring right at them</td>
<td>-can’t just throw rules at students 5</td>
</tr>
<tr>
<td>-need to question and think 33</td>
<td>-without the desire to know &quot;Why&quot; there isn't much point in doing math, it then becomes routine, blank-minded procedures 3</td>
</tr>
<tr>
<td>-asking questions big part of understanding and math is all thinking 5</td>
<td>-questioning shows critical thinking can be vehicle for alternative means of assessment</td>
</tr>
<tr>
<td>-need to watch for math anxiety 2</td>
<td>-students just need to be encouraged, need time to think and to be taught to think 5</td>
</tr>
<tr>
<td>-need to understand reasons &amp; basic concepts 6</td>
<td>-never accept what the teacher says at face value, figure it out for yourself</td>
</tr>
<tr>
<td>-need to know it’s okay to be wrong 2</td>
<td>-this concept was new to me at WMU, in elem. school concepts were taught and drilled, I became frustrated when 151 was centered around independent problem-solving. Need this exposure early in our elem. schools</td>
</tr>
<tr>
<td>-need lots of examples 3</td>
<td>-a challenge of thought promotes independent thinkers and hard workers</td>
</tr>
<tr>
<td>-can’t get behind, builds on itself 2</td>
<td></td>
</tr>
<tr>
<td>-if I was encouraged I might like math</td>
<td></td>
</tr>
<tr>
<td>-lecture is only of your five senses 2</td>
<td></td>
</tr>
<tr>
<td>-that's the only way to learn it 2</td>
<td></td>
</tr>
<tr>
<td>-this is the purpose of elementary education and elementary teacher’s 5</td>
<td></td>
</tr>
<tr>
<td>-need to show real-life applications 5</td>
<td></td>
</tr>
<tr>
<td>-you need to let them use their brain 3</td>
<td></td>
</tr>
</tbody>
</table>
Q#3. There are many different ways to solve most mathematics problems.

Fall entering students
not sure 2
-haven't had the training to ans. this question
-most of the time use one specific formula

no 9
-really only a few ways 4
-teachers press "their way" & that's it
-need to find one that works best for you
-certain ways only 1 + 1 = 2 that's it
-different ways of Teaching not solving problem
-in my classes there is only one way to solve each problem
-there are specific steps to organizing information and solving the problem

yes 66
-need to find one most comfortable with 13
-everyone processes information differently, we're not robots
-all based upon pattern and finding an unknown, the unknown is what frightens a lot of people, this is why people hesitate when it comes to the subject of math
-when I was young I thought my teacher's way was the only way, then when I needed help at home—my parents only know one way, but it wasn't the same as at school. I've learned the most about math when more than one approach is used and I'm seeing that with my elementary, age son he naturally comes up with more than one way.
-don't insist on your way, listen to students 4
-many different, I just pick the wrong one
-but few ways mostly variations of others
-think logically be creative in problem solving.
-for lower education, not true for algebra
-usually several but one that instructors feel is the best approach
-short and long ways, Prof. long way first
-more complex problems, more solutions
-don't always have to go by the book 2
-some solutions easier than others 7
-need MM to come up with idea that nobody else figured out already
-new ways to solve, always more options 6
-learning the techniques is the difficult part
-I'll learn ways by taking courses at WMU
-there are many different ways to solve 3
-I have to write everything down, friend does everything in his head.
-as teachers need many, not all students. think alike 3
-I've used this myself doesn't always work
-students show work and explain their answer 2

 exiting students

no 2
-most expedient methods is the one that your teacher goes by
-at best only one or two way to solve most math problems, few have many ways

yes 52
-math is unique in that to get one single answer many ways of solving for that answer may be used 17
-many algorithms get to the same answer 7
-many models and games to assist 6
-however, I eventually learn just one way
-I didn't know this until now, I had no idea that almost every problem can be done differently 2
-some learn best with visual, other with paper and pen, others mentally 2
-but it also helps to know the quickest way
-more important to be able to explain how you got the answer
-as teachers must be prepared to teach different ways but also must be willing to accept students valid methods 3
-different ways should be taught to students because everyone learns differently 5
-we've been taught "the" way, but that doesn't mean there aren't other ways
-but I prefer simpler solutions
-my background told me there was one way, now I've learned and aware of many others

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Q#4. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.

**Fall entering students**

no 10 * sometimes 19

- I think, teachers needs to help the process along 5
  *sometimes, if teacher explain all the relevant points and then just see if the student understand then OK otherwise no. 13
- in elem. school, the child needs to learn, perhaps in High School. the teacher can observe, but not in elem.
  - shouldn't happen to much, give a little time and then ask questions to see if understand
  - only if student is capable on their own 2
  - some student are too shy to participate, especially when they don't understand concept
  - in life experience, this may be true but not with classroom subjects
  - teacher is there to lead and instruct, not watch. 2

yes 45

- It enables the teacher to sit back and see the process on how their class is operating and see what changes need to be made. 19
- experimentation and discovery are very motivating and the feel of no pressure is relaxing and it is easier to think freely
- this encourages others to work together and provides social interaction 2

**Exiting students**

no 3 * maybe 2

- there has to be direction initiated by the teacher and then student might go on their own 2
  * maybe in learning centers but teachers must be able to answer questions if students have problems
  * not to often, leads to frustration in students. and students try to teach other students about what they don't know
  - not so true in math, you have to make sure in math that they are not making foolish mistakes

yes 49

- good for students to learn some things on their own and not always being fed by the teacher 9
  - helps to learn by discovery 8
- Teacher's role is changing to that of facilitator, need to facilitate questions from student's. 5
  - helps to build confidence when they figure it out correctly by experimentation by self or in groups, knowledge becomes "theirs". 14
  - if as a teacher all you do is throw out information and the student just act as computers absorbing they will never understand the uniqueness of mathematics. They will perceive it as rules and procedures rather than an interesting subject. 2
  - need to observe more for grading, too many rote lessons and tests are given, grades on such are sometimes poor representations
  - as teacher's we can't do our student's learning, they need to succeed and fail all on their own, need our guidance and support 4
  - cooperative learning groups encourage and increase peer teaching and is easier for student teacher fear if questioned 2
  - many teachers are teacher directed and believe worksheets help a child learn, having students create problems and be creative in problem solving is more effective 2
  - especially when using manipulatives. students have a natural desire to play with objects you will get much information from just observing
  - Teachers learn a lot about their students progress, how they learn and even about their own teaching methods by making observations 2

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Q#5. The purpose of testing is only for the teacher to get information on student performance.

Full entering students
no 43
- testing is for student to see how much progress is being made by the student 28
- also helps the challenge student
- shows where the teacher may need to explain more for easier understanding 10
- helps each student review types of problems that were taught weeks before, to test self 4
- testing should be eliminated, students panic during testing, do more quizzes
- students learn several things by exams, exams reinforce knowledge, students monitor their progress in the class, areas that require additional attention are highlighted by exams

yes 27
- basically true, tests show teacher what students learned and how much effort students put in to learn it 16
- I would like to think that there would be more to it. I guess if there were more to it, it would be a chance for the student to evaluate themselves and where they're at mathematically
- pinpoints problems of students 2
- need to have some idea of where students stand in academics
- purpose of testing is to grade the student that is all the educational system is about.

no 38
- also gives the student's an idea on their performance, and tells teacher whether teaching is successful 12
- homework, observations portfolios, projects, papers also indicators 2
- used as an assessment tool to see where student needs more help not just to get information 4
- assist in evaluation for parents, Administration, students, teachers 2
- to see how much the student understands, knows concepts, and application other situations 14
- more for the student than anything, student can realize areas of weakness and strength, teacher realize ways that they need to change their lessons and teaching to better suit students needs 5

yes 11
- it is to see how well the students are grasping the concepts you are teaching 6
- pretty much

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Q#6. The more homework = more practice = more understanding.

<table>
<thead>
<tr>
<th>Fall entering students</th>
<th>exiting students</th>
</tr>
</thead>
<tbody>
<tr>
<td>no 23</td>
<td>no 45</td>
</tr>
<tr>
<td>-good teaching methods=understanding 9</td>
<td>-there are other means through which student can gain understanding 4</td>
</tr>
<tr>
<td>-work must be meaningful not busywork which might make students rebel 2</td>
<td>-Don't understand merely by getting practice through homework. What happens if they are incorrect right from the start? 8</td>
</tr>
<tr>
<td>-understanding comes from explanation and problem solving methods, not from repetition, homework often turns a child off to the subject matter, hardly the objective of teaching</td>
<td>-simply repeating mathematical process over &amp; over does not improve understanding 12</td>
</tr>
<tr>
<td>-Quality time not quantity time=more understanding</td>
<td>-the more homework=more=practice=more boredom and less interest! 9</td>
</tr>
<tr>
<td>-once a concept is fully understood, busy work is not going to increase any understanding</td>
<td>-if you are giving them rote exercises that are all the same you aren't challenging them to problem solve</td>
</tr>
<tr>
<td>-a lot of homework and practice can't help if one never understood the process to begin with</td>
<td>-Students would be better doing quality work on 5 problems, rather than quantitative work on 100, this would bore them. 2</td>
</tr>
<tr>
<td>-practice makes permanent</td>
<td>-more hands on learning=the more practice=the more understanding. Involve them and they will learn more.</td>
</tr>
<tr>
<td>-homework is not the key to more understanding, hands-on and manipulatives help with more understanding 2</td>
<td>-I never was very good at doing repetitive homework and if I did get it done I was too angry to learn anything. Thinking questions are better suited than homework.</td>
</tr>
<tr>
<td>yes 32 *maybe 16</td>
<td>-All the &quot;grill and drill&quot; in the world won't help a child understand a concept. A child needs to &quot;concretely&quot; learn the concepts with manipulatives.</td>
</tr>
<tr>
<td>-the more you do something the easier it becomes and the better you are at it. 10</td>
<td>-if you don't teach the meaning behind the process you're stuck with procedural knowledge, but not understanding. You could do practice of procedures 'til you turn the color of this paper (blue) and never understand what you're really doing.</td>
</tr>
<tr>
<td>-but too much may make a student burn out 2</td>
<td>yes 5 *maybe 2</td>
</tr>
<tr>
<td>-yes=yes=yes</td>
<td>*understanding results from learning, therefore homework should supplement learning</td>
</tr>
<tr>
<td>-if a student understands then they shouldn't have to do it over and over. If they don't understand they should continue until they do.</td>
<td>*practice should be in groups and include discussion</td>
</tr>
<tr>
<td>-homework does give more practice, practicing effectively does lead to understanding.</td>
<td>-I truly believe that the more practice in the math the better the understanding. This goes back to the WAY I was taught as a child.</td>
</tr>
<tr>
<td>*not necessarily more homework, but the part about more practice is essential to more understanding 6</td>
<td>-if the homework is being done correctly</td>
</tr>
<tr>
<td>*should include more class time to work on things than at home</td>
<td>-but too much will become boring</td>
</tr>
<tr>
<td>-even though students hate homework, it does=more understanding</td>
<td></td>
</tr>
<tr>
<td>-homework is ESPECIALLY important in math, a teacher should assign a reasonable amount of homework (1 hour) and encourage students to do more if they need it.</td>
<td></td>
</tr>
</tbody>
</table>
Q#7. Mathematics is mostly facts and procedures that have to be memorized.

Fall entering students
no 22 *not necessarily 10
- some of it involves thinking processes
* everything can't possibly be memorized since there are so many ways of solving problems.
* in later math classes you have to memorize formulas but math is also used everywhere we go so it sometimes comes naturally 2
- Math is something that must be understood, it isn't like history.
- common sense plays a big part
- math is many things, a tool, techniques, patterns, connections.
- by understanding the problem, a student should be able to figure out the solution or at least get a step in the right direction.
* formulas must be memorized, but what goes where and why must also be understood
* sometimes it needs more understanding, more teaching, more explaining 4
- however, many people tend to look at it this way possibly an outdated view, math can be challenging, fun, and mentally expanding for a student of any age.
- mathematics should be approached in real life situations so that student don't remember a "dumb" formula, they should remember the method to solve the problem.
- it's problem solving and knowing how to work through a problem. Skills that can be used in combinations with new skills. It builds on each other.
- In high school I believed that math was totally illogical, but the more I have the more logical it seems.
- need understanding not memorization 2

Exiting students
no 48
- math is tons of concepts about numbers that should be understood not memorized 2
- there are many problems that you have to know how to work out, this does not always entail memorizing facts and procedures 7
- math should be about discovery and problem solving, developing ideas not facts and procedures 29
- math is problem solving in every day living 3
- math is the manipulation of value, facts and procedures are part of math, but they aren't the cool part that a lot of people find interesting and fun.
- math is a process through models, if it is perceived as just facts and procedures they aren't really problem solving and following what math is.
- I used to think so, now I know some more concepts, but I still rely mostly on memory.
- that's the old way of thinking, people need to learn the way math is used in everyday life
Question 7 continued

- at first grade and later in upper schooling
- mathematics are concepts that must be learned and become repetitious
- That is the way it is portrayed all through elem., middle and high school. But it shouldn't be just facts to be memorized, that's what makes it boring.
- there is memorization required but also ability to relate the facts in problems to "real life" problems and solutions. 2
- math must be done a certain way.
- It's a way of life.
- This is probably the best way to describe mathematics in a broad way.
- math is concepts and the formulas have to be memorized.
- any being able to solve problems using common sense.
- Sometimes there are a lot of terms and definitions, to learn, but it always goes back to the basic operations of add, subt., mult, div. 2
- I agree. There usually are a lot of rules and fact to know in order to move to the next math level.
- math is logic and rationalizations, only formulas need to be memorized
- if there is a better way please start teaching it. People would enjoy it much more, or at least not loathe it.
- you basically use same procedures for all problems.
- math is using numerals
- this is a definite fact
- if you understand the rules and equations you can solve any problem similar to it.

yes 3

- math should be mostly facts and procedures that the students have invented, then they are learned and committed to memory or are available for easy recall.
- but it's also a lot of busy work to understand what it is that you memorized.
Q#8. Children who answer correctly all problems on a worksheet fully understand the concept that was taught.

Fall entering students

no 52
- students may be able to solve problems on a worksheet but if they fully understand they should be able to teach it to another. Getting problems all correct is not an implication that they fully understand. 10
- some students understand the process of trial and error therefore answering correctly, important that the teacher makes sure each student fully understands each concept.
- I have solved problems correctly but I in no way understood the concept. 4
- they might just have memorize a formula that works for those problems. got lucky 17
- don't really know where they got the answer from, some cheat (copy papers) so that they get a good grade but when it comes to test time-they are screwed 10
- kids cheat and kids pick out patterns
- I guess there will be a percentage of students that do, and others that won't. The ones who don't are the ones who will forget the concept the day after testing. They had only memorized the information for the test.
- It may have been a good day, these concepts must be used constantly in order to acquire using.
- There is a thing called guessing and copying, testing in different ways can solve this problem.
- often the child repeats what the teacher does, not realizing why
- they just "know how to play the game" and that is all that is needed to succeed in this society in this world

yes 15 *sometimes 7
- they understand what was taught 2
- they certainly have some sort of understanding
* if the majority of the answers are correct, then sounds like instruction was adequate 6
- unless they cheated, then you don't know 6
- maybe not fully, but enough to get the "gist"
- I think for the most part yes, unless they cheat? which I think is very common among younger children.
- mostly true, but you have to understand that there is luck involved with things
- I guess this is a good indicator, but you would have to test them several times on it and see if it carries over to the next chapters.
* if this is a cumulative worksheet, possibly it's true.

no 45
- might be missing the whole concept and we wouldn't know that according to the worksheet, must make sure understanding why students are doing it that way 9
- may have simply memorized procedure but not know concept 25
- students who can model or verbally explain their problems have a fuller understanding 4
- memorizing for test isn't really "learning" 3
- they may have cheated
- they may have figured out the trick, not the concept

yes *sometimes 5
* students who can explain the procedures but may make mistakes in calculations may understand more than given credit for 3
Q#9. The use of calculators enables students to avoid learning to compute with paper and pencil.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>no 27</td>
<td>no 43</td>
</tr>
<tr>
<td>-the use of calculator just simply speeds up the learning process, more logical and efficient 6</td>
<td>-calculator enhance paper/pencil activities 24</td>
</tr>
<tr>
<td>-students are usually taught how to calculate with paper and pencil before a calculator. they still go through the same thought process and instead of pushing buttons can write the calculations on paper. 5</td>
<td>-won't always have calculator so will need both</td>
</tr>
<tr>
<td>-but, only if they learn to compute with paper and pencil first 15</td>
<td>-calculator aids in critical thinking 3</td>
</tr>
<tr>
<td>-need to be taught both 4</td>
<td>-student still needs to know what numbers and in what order they need to enter the numbers into the calculator. In today's &quot;high-tech&quot; world-isn't a need to do long-hand computations when punching out the answer is so available 8</td>
</tr>
<tr>
<td>yes 42  *maybe 4</td>
<td>-help show patterns, solving longer problems</td>
</tr>
<tr>
<td></td>
<td>-are calculators, going to disappear?. They probably said the same thing about paper when it was invented?</td>
</tr>
<tr>
<td></td>
<td>-get serious... if anything calculators, reinforce those skills learned through the algorithm</td>
</tr>
<tr>
<td></td>
<td>yes 2  *sometimes</td>
</tr>
</tbody>
</table>
* can be helpful in some cases, should be used only when the teacher permits them, basically for elem. and mid school children they aren't too helpful 4 -you still have to put it down and show your work to fully understand how it is truly done -in upper levels of math it is wrong for a student to just punch the numbers in to a formula and have the calculator do all the work, doesn't show a student knows the concept, it shows that they know how to use a calculator 2 -students lose the computation skills by using calculator 5 *

* depends on type of math you're doing 2 -If calculators are used too early in the process of learning this might happen, just as students are becoming illiterate writers that can't spell without word perfect. This is not a good habit. Maybe switching back and forth would be helpful, calculator does save time. 2

-if they learn the concept first, then the use of calculator isn't as bad. elem. students should not be using calculator unless it's a lesson on learning to use a calculator. 8
-use of calculator. ONLY is bad because using pen and pencil enables one to eventually see what the pen does in his mind.
-use of calculators don't allow the student to think through some of the most basic math concepts that should at some point become relatively simple thought processes. 3
-calculators are used in advanced classes, the basics are used and learned so that the calculator becomes a TOOL similar to a ruler.
-can't learn to rely on them 2
-calculator can be beneficial if regulated, too much use in using a calculator can hinder a child's knowledge in basic math such as addition, subt, mult, and division.
-What if calculator broke and student did not know how to work pencil and paper? I don't believe calculators should be used until at least 5th or 6th grades after all basic facts are well-known.

-sadly true, many adults as well, who work with calculators and have forgotten how to compute with paper and pencil or even basic multiplication facts
Q#10. In small groups only a few students are really learning the concept.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>no 41</td>
<td>no 39</td>
</tr>
<tr>
<td>I feel that in small groups more minds bring better ideas and greater success. Many thinking strategies are brought together to create an idea and thus solve problems. 29</td>
<td>small groups are good especially when they're mixed up instead of categorized by level of understanding. It enables the advanced students to reteach it to the ones who have a harder time understanding and vice versa. 26</td>
</tr>
<tr>
<td>-cooperative learning enables a majority of the students to grasp an understanding 3</td>
<td>-students can learn a lot by listening to others, less pressure on individual student. 7</td>
</tr>
<tr>
<td>-small groups are vital for social interaction and give students the opportunity to see how others think and how to achieve a common goal with others. 2</td>
<td>-depends on if the teacher is observing and making sure that isn't happening, give every student a job and role 5</td>
</tr>
<tr>
<td>-small groups are able to see how classmates solve and comprehend problems Students usually are more willing to ask questions and usually don't feel as though they are the only one who do not understand a problem. 6</td>
<td></td>
</tr>
<tr>
<td>yes 17</td>
<td>yes 1</td>
</tr>
<tr>
<td>*maybe 16</td>
<td>*sometimes 4</td>
</tr>
<tr>
<td>*you really have to have the right group for success 14</td>
<td>*depends on the method, the group, to achieve the goals 3</td>
</tr>
<tr>
<td>-it's pretty hard, some people just don't learn well in groups and are better off as an individual learner.</td>
<td>-this is very argumentative, small groups are questionable to me. I don't always know if they work. Most of the time there is always one person who does all the work</td>
</tr>
<tr>
<td>-depends on how well the teacher explained the concept and how well the student perceived it 7</td>
<td></td>
</tr>
<tr>
<td>-in a few cases maybe, but mostly you need the input of a lot of people to understand the concepts</td>
<td></td>
</tr>
<tr>
<td>-Too many people like to remain anonymous in a group situation and don't contribute anything. If people could be matched according to ability in groups, this would be more effective. I don't agree that the more intelligent or harder worker people spur or inspire the others on. I have never seen this happen.</td>
<td></td>
</tr>
<tr>
<td>-I do think the few more outgoing and smarter students would know what they are doing while the shy people may just do what the others are doing and hope they catch on later.</td>
<td></td>
</tr>
<tr>
<td>-unless they all take the time to give their own opinions about concepts they are talking about that is the only way they will learn, just nodding your head when someone else talks isn't going to get it.</td>
<td></td>
</tr>
</tbody>
</table>
Q#1. To be good at mathematics, I need to have a mathematical mind.

Winter entering students
no 40
-need to grasp concepts 14
-need to open my mind to new concepts and accept them. This is the barrier for majority. of people. need to brainstorm, understanding 7
-you must have a T or parent to help mold your mind toward math 7
-need common sense & willingness to learn 9
-everyone can learn need to be shown how 4
-I completely agree with the practice makes perfect idea. 
-hard work is what it takes 6
-need open mind, time to decide on answer. 1
-I just need to open up my mind more for math and try different ideas and possibilities.
-You can teach math without having to be a math whiz, just as long as you understand how to teach it.
-To be good in math one has to be devoted and practice. Math is not a spectator sport.

yes 17  

-exiting students
no 44
-to be good at mathematics a MM means to think, speak, value, reason and become confident with mathematics 12
-You need to have an understanding of math concepts. 21
-If a teacher takes the time to use manipulatives and explain the basics behind the math, then anyone can learn and do it well. 2
-To be good at math, you must be able to enjoy it and view it as a challenge. Has to make sense. 2
-I need to have an understanding as applied to everyday life, understand mathematical concepts. 5
-I use to think like this now after this class I believe that anyone can learn math and be good at it w/o having a mathematical mind.
-I need to speak the mathematical language correctly and clearly.
-You have to have a "learning mind.

yes 10

-a MM means to be a logical thinker, not a genius or nerd.
-math is hard for me
-some people are better at math functions and equations than others.
-True, because if numbers are in your head and you can regurgitate them with procedure and concepts you will do well. Some people have LOTS of numbers in their head, lots of math, these people are accountants.
-We develop our mathematical mind through understanding and problem solving. Very few people are competent in math, let alone understanding math. Math at WMU incorporates understanding with technique.
-I need some kind of mathematical understanding but its not essential to be competent in all math.
Q#2. To be a good teacher of elementary mathematics, you need to encourage students to think and question.

Winter

entering students
no 1
maybe 1
I believe it's in learning the steps of a problem, not confusing them.

^depends on the questions, for formula work you just memorize those, don't think.

yes 60
- need to be challenged 7
- need to question and think 31
- asking questions big part of understanding and math is all thinking 15
- motivation is also a part 3
- this is the purpose of elementary educ. and elem. teachers 10
- If you don't do such encouragement a student tends to behave as a mindless math robot, finding only one way to solve problems.
- All education should. 4
- To learn IS to think and question. Simply repeating materials back on an exam is not learning it is only memorizing.
- Helps student learn and keeps their mind going. It makes the students go deeper into their thinking and helps them understand better than just listening to a lecture. Active learners are the best learners. 5
- You can't always show them how to do something and expect them to immediately understand the concept. They need to think about the concept and ask questions about their concept of the problem in order to clear up misconceptions. 2

yes 56
- Stimulate their minds. 10
- To be a good teacher, you must encourage students to think and question. This means that they are processing the information given to them. 22
- You need to help them to become problem solvers. 3
- Kids need to use their minds in order to make it more powerful. I feel good teachers put the class, the academic part, in the child's hand. If we as teachers do all the talking and thinking their minds are used just as a sponge and not as an active mass. Discovery is the best way to develop active participation by students. Helping students to make connections between and with concepts will lead to clearer understanding and questioning when not understanding. 6
- Students will come up with many interesting and different viewpoints.
- This aspect is a good start, but incorporates much more. Such as knowing concepts, strategies, math language and an ability to deal with and understand children and their needs.
Q#3. There are many different ways to solve most mathematics problems.

Winter entering students
not sure, maybe 7
-most of the time use one direct way to solve a problem.
-The more ways there are to solve a problem the more confusing it can be. Students tend to take the easy way to solve a problem.
-Perhaps, but some ways are easier and easier to understand than others.
-Some ways you can find out is by trial and error. Some ways are set and there is only that way to do it.

no 4
-Most math up through algebra has different ways but algebra has only one way to find a solution.
-Generally not true. I have always been taught that there is a right and a wrong answer.
-In elementary school it would be difficult tell student this and expect them to understand. Most problems have set procedures and answers so you can't go about resolving it through different methods.
-Systematically no!

yes 51
-need to find one most comfortable with 9
-some solutions easier than others 11
-True, but teachers only looking for one way.
-new ways to solve, always more options 15
-There may also be many answers. That is what I enjoy about math. 3
-True, but there is only one right answer.
-Although as you get older, teachers discourage this and you may use "only their methods."
-Everyone thinks in their own way and therefore seeks but own strategy in solving problems. Giving children this attitude will allow them to become more active and successful in group work.
-Especially true in story problems. 3
-Problems can often be presented and solved in different ways which often makes things easier for some children. Some children must write out ALL the steps to solving a problem while others can skip steps or solve them in their heads.
-as teachers need many, not all student. think alike 1

yes 53
-concrete, hands-on, talk it, draw it, write it.
-Each way may be better for different students depending on their learning style. It is best to leave the possibilities for problem solving processes open and not say that there is only one way to do a problem. 2
-There are different procedures but the answer should be the same. Different routes to the same destination. 24
-There is no right or wrong way. Sometimes easier or more accurate ways. Every students perceives questions differently. Having them explain will clarify any misconceptions. 8
-You can use models, wrote out hypothetical answers or use different strategies to solve problems. 4
-This follows along the lines of the saying "There's more than one way to somewhere." This is what's neat about math is that with much of all the math material there is more than one way to compute the answer. This is something that all teachers should understand because a student may have a hard time learning math one way but an easier time using a different method. 3

Exiting students
maybe 2
-it just depends on the problem
-Only if it pertains to algorithms. Basic facts are pretty clear cut.
Q#4. Sometimes it is best for the teacher to act as an observer and allow the learning to happen.

Winter entering students
no 5 * sometimes 12
*sometimes, if teacher explain all the relevant points and then just see if the student understand then OK otherwise no. 9
-teacher is there to lead and instruct, not watch. 1
-Children need some form of instruction and many need individual help. Allowing "it to happen" could jeopardize the understanding of many children.
-No, because the learning doesn't just happen on its own. Most of the time about 60% of the students in a class are confused. 2
-Never observe. Help. That's what the teacher is there for.

yes 38
-It enables the teacher to sit back and see the process on how their class is operating and see what changes need to be made. 11
-this encourages others to work together and provides social interaction 6
-in this way children are allowed to think and problem solve for themselves. When they reach a correct solution, a sense of accomplishment is felt. 4
-If the teacher always did it for the student, they would never learn. Math is like a lab in science class.
-Anyone can memorize what you want them to know and parrot the facts and processes back to you but real understanding will happen if the teacher stands back and acts as a guide and lets the children make their own concepts.
-If a teacher is constantly ramming ideas down a students throat the student doesn't have a change to absorb the information.

Exiting students
no 1 * maybe 4
* but the teacher must also direct and guide learning 3
*A teacher has to be careful to keep involved and make sure that the students don't get lost down the wrong path and develop misconceptions that would hurt the students understanding of math.
-Not when it comes to math. The teacher needs to explain the reasons why an algorithm works

yes 50
-by observing you are able to monitor students progress
-If children discover a concept for themselves they will have learned it and understand it not just memorized it. 20
-Facilitator might be more appropriate. It is good to allow students to be managers at their own learning since that would be a goal. 7
-Most of the time teaching is a facilitating process. Redirection is necessary. Let them discuss and help each other, debate why and how. 6
Q#5. The purpose of testing is only for the teacher to get information on student performance.

<table>
<thead>
<tr>
<th>Winter entering students</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>no</strong>: 46</td>
<td><strong>no</strong>: 41</td>
</tr>
<tr>
<td>-testing is for student to see how much progress is being made by the student.</td>
<td>-The student wants to know as well as the parent.</td>
</tr>
<tr>
<td>-shows where the teacher may need to explain more for easier understanding.</td>
<td>-Testing is not a very accurate assessment of knowledge or learning.</td>
</tr>
<tr>
<td>-A test many also be used as a learning experience. A student may apply what they have learned to a new experience really using the concepts.</td>
<td>-It helps students know how well they are doing as well as telling the teacher how well the students are grasping the concepts and how effectively the teacher is teaching the information.</td>
</tr>
<tr>
<td>-No, it forces students to study which makes them learn the information.</td>
<td>-It's a way for students to practice formally.</td>
</tr>
<tr>
<td><strong>yes</strong>: 13</td>
<td><strong>maybe</strong>: 1</td>
</tr>
<tr>
<td>-basically true, tests show teacher what student learned and how much effort student put in to learn it.</td>
<td>--and to make sure the teacher is properly reaching each student.</td>
</tr>
<tr>
<td>-This is true but testing also prepares us and gives us a push to learn the material. Testing does not only happen in school but also in life. The rest of our lives we will also be tested in the work place or in aspects of our personal lives.</td>
<td>-and to manage the students comprehension and that information is often misleading or inaccurate.</td>
</tr>
<tr>
<td>-Students need to challenge their memory and understanding with tests.</td>
<td>-True, I believe this is how it should be because I don't think you should test on what students don't know, but on what they do know, what they've learned, to see if they can apply what they have been exposed to.</td>
</tr>
<tr>
<td></td>
<td><em>not always the case</em></td>
</tr>
<tr>
<td></td>
<td>-Unfortunately, this is probably true for the most past.</td>
</tr>
</tbody>
</table>
Q#6. The more homework = more practice = more understanding.

<table>
<thead>
<tr>
<th>Winter entering students</th>
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</tr>
</thead>
<tbody>
<tr>
<td>no 19</td>
<td>no 44</td>
</tr>
<tr>
<td>-good teaching methods=understanding 4</td>
<td>-The more creative, kinesthetic, environment-rich learning, the more understanding. 2</td>
</tr>
<tr>
<td>-homework is not the key to more understanding, hands on and manipulatives help w/ more understanding 2</td>
<td>-More practice does not equal more understanding, more practice could be just more practice of rote procedures. 15</td>
</tr>
<tr>
<td>-Not really, that just shows the student there is only one way to solve a problem and to arrive at an answer.</td>
<td>-First need to understand. 3</td>
</tr>
<tr>
<td>-Homework should only reinforce lesson taught at school. No more than 10 problems need to be assigned to practice a certain concept. If children are not exactly sure how to do a set of problems it does not matter if they have 100 or 30 to practice they will just get more frustrated. 2</td>
<td>-Understanding comes with discovery. Homework can be memorization with no concept of how things work. 2</td>
</tr>
<tr>
<td>-Homework should be given but it is quality not quantity 3</td>
<td>-Students learn best from each other and by working with manipulatives. Homework should only be assigned for extra practice if the student understands the concepts. 6</td>
</tr>
<tr>
<td>-more homework=more frustration</td>
<td>-A few good practice problem can see if children understand. 3</td>
</tr>
<tr>
<td>-homework without understanding is useless 2</td>
<td>-Practice homework should be assigned only when you are positive that the student understands the concept.</td>
</tr>
<tr>
<td>-no, it can become busywork</td>
<td>-The more different approaches=more practice, with the same concept=more manipulatives=more understanding.</td>
</tr>
<tr>
<td>yes 27 *maybe 16</td>
<td>yes 6 *maybe 5</td>
</tr>
<tr>
<td>-the more you do something the easier it becomes and the better you are at it. 5</td>
<td>-I feel practice does make perfect.</td>
</tr>
<tr>
<td>*not necessarily more homework, but the part about more practice is essential to more understanding. 5</td>
<td>-I agree as long as the homework is beneficial to student learning and not just busy work.</td>
</tr>
<tr>
<td>*more homework may equal a greater dislike of math</td>
<td>-I do believe this is true. The more exposure to something, the better. You can never get enough or know enough.</td>
</tr>
<tr>
<td>-Very true, the teacher should make sure they keep up with this but not assign too much that the student feels he/she must rush through it to get it done but not remember anything about the lesson.</td>
<td>-Some students may understand right away and others will need more practice.</td>
</tr>
<tr>
<td>-If the homework is done, then this is possible. I figure, do the practice in the classroom with some exercises for home. That way you know the practice is in there somewhere.</td>
<td>*Understanding comes in many different forms.</td>
</tr>
</tbody>
</table>
Q#7. Mathematics is mostly facts and procedures that have to be memorized.

<table>
<thead>
<tr>
<th>Winter entering students</th>
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</tr>
</thead>
<tbody>
<tr>
<td>no 28</td>
<td>no 49</td>
</tr>
<tr>
<td>maybe 7</td>
<td></td>
</tr>
<tr>
<td>*formulas must be memorized, but what goes where &amp; why must also be understood 5</td>
<td>-Math is understanding procedures to solve problems. 5</td>
</tr>
<tr>
<td>-need understanding not memorization 7</td>
<td>-Mathematics allows you to solve problems and helps you to become a critical thinker. 3</td>
</tr>
<tr>
<td>-it its mostly facts and procedures that have to be retested, redone, reprove etc.</td>
<td>-We need to understand the basics and reasons behind those memorized facts. 15</td>
</tr>
<tr>
<td>*This is only part of mathematics as concepts and understanding is another part.</td>
<td>-Learn key ideas which can be applied to a variety of different problems or learn strategies to help in solving problems. 8</td>
</tr>
<tr>
<td>-Although math does involve facts and formulas that need to be memorized it also involves a complex thought process which cannot be memorized. It must come from the person.</td>
<td>-Mathematics is very applicable and useful and makes sense-negating need for memorization.</td>
</tr>
<tr>
<td>-Especially not at the elementary school age.</td>
<td>-That has been the theory in the past, but it is now concepts that underlay procedures.</td>
</tr>
<tr>
<td>-not memorized. LEARNED 2</td>
<td>-Mathematics can be found everywhere and in everyday life. Math can be fun!</td>
</tr>
<tr>
<td>-Math is thinking of new ideas or facts</td>
<td>-Mathematics is facts and procedures that have to be learned.</td>
</tr>
<tr>
<td>*Well, almost, you also need to be able to visualize your problem, especially in story problems.</td>
<td>-Its concepts and ideas that can be shown and demonstrated through manipulatives. 2</td>
</tr>
<tr>
<td>*There are certain things you can memorize but as many of my teachers have expressed in the past, LEARN the material and UNDERSTAND, Don't MEMORIZE.</td>
<td>-I use to believe this. Now I know that everything has a reason for being done. These &quot;rules&quot; can be taught in much more interesting manners than just harsh fact and procedures.</td>
</tr>
<tr>
<td>*There are no facts in math except 1 + 1 = 2. Everything else is derived from something else.</td>
<td>yes 3</td>
</tr>
</tbody>
</table>

yes 23 
-Formulas have to be memorized—procedures are learned through practice. 2 
-Mostly at lower levels this seems true. Yet at some higher levels it seems as a tool for producing a better thinking mind. 
-That is how it seems. 
-This is the method I was taught, now I don't like math. I needed more enjoyment. 
-You just have to learn the steps either you know it or you don't—there's no BSing in math. 
-Once a generalized understanding is grasped, procedures come naturally. But I do agree that there are some things that just have to be committed to memory. 
-Yes, most of them. 
-Early on yes but not in problem solving. 
this is what math has been in my experience but I'm sure that is not always true 
-It's a big part of math. 
-It seems to be taught that way. Understanding simple problems is taught but algebra seems to be facts and procedures. 

yes 3 sometimes 1 
-But if you apply these to real world situations they can be more easily memorized. 
-Once you have the basic rules math should be easy. 2
Q#8. Children who answer correctly all problems on a worksheet fully understand the concept that was taught.

<table>
<thead>
<tr>
<th>Winter entering students</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>no 44</strong></td>
<td><strong>no 43</strong></td>
</tr>
<tr>
<td>- Student may be able to solve problems on a worksheet but if they fully understand they should be able to teach it to another. Getting problems all correct is not an implication that they fully understand. 14</td>
<td>- They could just be doing procedures without understanding why it's done that way. 24</td>
</tr>
<tr>
<td>- They have solved problems correctly but in no way understood the concept. 3</td>
<td>- Just shows they are good test takers.</td>
</tr>
<tr>
<td>- They might just have memorized a formula that works for those problems, got lucky 8</td>
<td>- They may have memorized steps. Diverse word problems would be a better assessment.</td>
</tr>
<tr>
<td>- They might have memorized the answers. 8</td>
<td>- Worksheets are necessary sometimes but they are a horrible way to assess a student's understanding of a topic. 2</td>
</tr>
<tr>
<td>- They may be cheating or regurgitating procedures. 4</td>
<td>- They may have figured out the pattern or looked at someone's sheet. A better way is through talking and writing.</td>
</tr>
<tr>
<td>- They may have just guessed.</td>
<td>- They may have guessed correctly. You need to talk with them about how they arrived at their answer. 6</td>
</tr>
<tr>
<td>- If they show the work and come up with the correct answer they know what they are doing.</td>
<td>- There are such things called luck and unfortunately cheating. 3</td>
</tr>
<tr>
<td>- May not care and may forget the next day, may not be able to relate it for future use.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>yes 8 *sometimes 5</th>
<th>yes 2 *sometimes 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>*If the majority of the answers are correct, then sounds like instruction was adequate. 2</td>
<td>*They might understand or they could just know how to get the right answer without comprehension. 3</td>
</tr>
<tr>
<td>*An answer can be made from many different steps and procedures. If you watch me do a problem, you know that there is another way to solve it.</td>
<td>*It depends on the concepts being taught and if the child understands the process or not. 2</td>
</tr>
</tbody>
</table>
Q#9. The use of calculators enables students to avoid learning to compute with paper and pencil.

<table>
<thead>
<tr>
<th>Students</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter entering students</td>
<td>- but, only if they learn to compute with paper and pencil first.</td>
</tr>
<tr>
<td>- If you don't know procedure to punch it in on the calculator you can't solve the problem.</td>
<td></td>
</tr>
<tr>
<td>- They only cut down on frustration and minor errors that may occur.</td>
<td></td>
</tr>
<tr>
<td>- Calculators are available and should be used.</td>
<td></td>
</tr>
<tr>
<td>- It helps students get things done quicker and use different ideas.</td>
<td></td>
</tr>
<tr>
<td>- Calculators provide students with a way to do some of the quick computation without error.</td>
<td></td>
</tr>
<tr>
<td>- Calculators are good learning tools.</td>
<td></td>
</tr>
<tr>
<td>Exiting students</td>
<td>- It avoids tedious computations. It is an added benefit to help students learn.</td>
</tr>
<tr>
<td>- This allows students to show what they know.</td>
<td></td>
</tr>
<tr>
<td>- They need to know what to put in to the calculator first.</td>
<td></td>
</tr>
<tr>
<td>- It helps to create an understanding of the paper pencil activities.</td>
<td></td>
</tr>
<tr>
<td>- Not if they are used as a tool and not a crutch.</td>
<td></td>
</tr>
<tr>
<td>- It is a real world tool for practical use.</td>
<td></td>
</tr>
<tr>
<td>- Calculators can encourage learning. The students will be able to check their answer with a calculator.</td>
<td></td>
</tr>
<tr>
<td>- Calculators help to see patterns, avoid long paper and pencil computations, reinforces estimations.</td>
<td></td>
</tr>
</tbody>
</table>

**Yes:** 17 *sometimes* 5
- I think students need to use the paper and pencil method more often so they have to rely on themselves and not the calculator.
- *It depends on the operation. I would not want to imagine square roots and cube roots being done by hand.*
- Calculators are nice and convenient, but they replace the hands-on learning that plays a big part for the students full understanding of the concepts.
- I feel calculator are helpful but often we rely TOO much on them! Our world is becoming too computerized. We are losing ability to create within ourselves.
- I think it is not a good idea to let children use calculators from earlier. I think that is not learning.
- In elementary calculators shouldn't be used. In higher level calculator or something are necessary for graphing etc.
- *Calculators aids the learning process by allowing students to reach answers quicker but also takes away from students learning by figuring it out themselves.*
- For higher math a calculator is necessary. For beginning math it would be best they learn to compute the simple things in their heads.
- If they learn the concept first, then the use of calculator isn't as bad.
- *Some children will rely solely on calculators but if the teacher sets limits on when the student may use the calculator, then they will learn that there are other ways to work through a problems.*
- *Just punch in the numbers.*

**No:** 50
- It avoids tedious computations. It is an added benefit to help students learn.
- This allows students to show what they know.
- They need to know what to put in to the calculator first.
- It helps to create an understanding of the paper pencil activities.
- Not if they are used as a tool and not a crutch.
- It is a real world tool for practical use.
- Calculators can encourage learning. The students will be able to check their answer with a calculator.
- Calculators help to see patterns, avoid long paper and pencil computations, reinforces estimations.
Q#10. In small groups only a few students are really learning the concept.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>no 32</td>
<td>no 45</td>
</tr>
<tr>
<td>I feel that in small groups more minds bring better ideas and greater success. Many thinking strategies are brought together to create an idea and thus solve problems. 18</td>
<td>Students tend to learn better cooperatively. 5</td>
</tr>
<tr>
<td>-small groups are able to see how classmates solve and comprehend problems. Student usually are more willing to ask questions and usually don't feel as though they are the only one who do not understand a problem. 9</td>
<td>-Everyone is responsible for their own learning and responsible to help everyone else. 14</td>
</tr>
<tr>
<td>-In small groups it's harder for students to go unnoticed.</td>
<td>-It depends on how the concept is taught. Small groups may facilitate learning for some students. 6</td>
</tr>
<tr>
<td>-In small groups all students learn the concept better because the group members can explain it to them more individually than a teacher screaming instructions to 40 students.</td>
<td>-It is definitely helpful for some, frustrating for others.</td>
</tr>
<tr>
<td>yes 4</td>
<td>yes 1</td>
</tr>
<tr>
<td>* you really have to have the right group for success. 11</td>
<td>* sometimes 6</td>
</tr>
<tr>
<td>-Sometimes in groups there are some people who will work on the problems but there are others who will just sit back and copy. Be careful with group work!</td>
<td>* Small group is beneficial to students but students can also learn in a group. It depends upon the teaching approach used. 2</td>
</tr>
<tr>
<td>-It depends on whether the group knows the topic to begin with. Sometimes things can be taught in small groups. I think the teacher should also have some way of testing the concepts of these small groups.</td>
<td>* If only the intelligent or outspoken ones are doing the work.</td>
</tr>
<tr>
<td>yes 1</td>
<td>yes 1</td>
</tr>
<tr>
<td>* sometimes 6</td>
<td>* sometimes 6</td>
</tr>
<tr>
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<td>yes 1</td>
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</tr>
<tr>
<td>* sometimes 6</td>
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