PERCEPTIONS OF PRESERVICE AND INSERVICE ELEMENTARY TEACHERS TOWARD THE USE OF MANIPULATIVES IN THE CLASSROOM

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Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF EDUCATION
May, 1997

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OF MANIPULATIVES IN THE CLASSROOM

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DEDICATION

To My Mother

Who instilled a love of education

in each of her children.

ACKNOWLEDGMENTS

This study would not have been possible without the love and support of many people. The decision to begin this degree at this time of my life has been one of the most rewarding and insightful decisions of my life. I will always appreciate those who stood by me while making that decision and during the project.

I have learned so many things from my committee members. Special thanks and appreciation go to Dr. Margaret Scott, my major advisor, and Dr. Kay Reinke, my dissertation advisor. Their constant support, encouragement, and friendship have been a source of strength as well as an invaluable resource. My other committee members, Dr. Bruce Petty and Dr. Barbara Wilkinson, gave so willingly in this effort. I also wish to express gratitude to a special friend, Dr. Warren McKinney, whom we lost during this project. He is gone but will always be remembered for what he contributed.

The students who participated in this study will be very gratefully remembered, as well as my other students who continually supported me throughout this endeavor. The enthusiasm of these students will always help me remember the passion and excitement each teacher should possess.

My colleagues have become not only wonderful helpmates but also the best friends any one person could hope for. The administrative support and encouragement I received was unfathomable. Without all of these people, this study would not have been possible.

My family has always supported me with unconditional love and acceptance throughout my life. This endeavor was no exception. Each has sacrificed in different ways to make this possible. Our home has been strengthened through all of this.

Finally, my deepest debt of gratitude goes to my children who give all meaning and purpose to my life. You are my inspiration to make a world where all children can learn and grow and be happy.

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CHAPTER 1

INTRODUCTION

According to the National Council of Teachers of Mathematics (NCTM), there is a need to think of mathematics teaching as not just explaining content but also engaging students in the processes of doing mathematics (NCTM, 1989). Traditional teaching emphases have been on the mastery of symbols and procedures for the most part ignoring the processes of mathematics and dealing with real life situations (NCTM, 1989). As stated in the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989, p. 7):

> . . . We do not assert that informational knowledge has no value, only that its value lies in the extent to which it is useful in the course of some purposeful activity. It is clear that the fundamental concepts and procedures from some branches of mathematics should be known by all students . . . . But instruction should persistently emphasize 'doing' rather than 'knowing that.'

In 1989, the NCTM published the Curriculum and Evaluation Standards for School Mathematics. The overall goal of the standards is for all students in our society to become truly mathematically literate. The general aim of the NCTM standards is to lay the foundation for mathematical literacy. The document from the NCTM contains several references pertaining to teaching with manipulative materials, recommending that individuals be allowed to work, play, and experiment with concrete models that represent various mathematics concepts. Through this active manipulation, it is believed that internal "construction" of mathematic concepts takes place for each individual (NCTM, 1989). Current research also shows that the use of these manipulative materials results in higher achievement and understanding of mathematics (Kennedy, 1986; Sowell, 1989; Suydam, 1986; Williams, 1988).

What teachers teach and how they teach depend on their own beliefs concerning mathematics and how children learn mathematics. Teachers' instructional decisions are influenced by their beliefs, and these decisions affect what will be taught in classrooms (Fennema, Peterson, Carpenter & Lubinski, 1989). Children learn the attitudes, prejudices, and values of their parents, teachers, and classmates. Prospective teachers who recognize such prejudices in themselves and actively work to overcome these prejudices by analyzing how they teach will become better mathematics teachers. If negative feelings toward mathematics are apparent, the attitudes of our children could be affected (Tobias, 1978).

Little disagreement seems to exist among mathematics educators that experiencing ideas on the concrete level is very important to the learning of mathematics, since mathematics deals with abstractions. A major goal of mathematics instruction is to help children learn to operate efficiently at the abstract-symbolic level with an understanding of the concepts or skills in question. The purpose of using manipulatives is to assist students in bridging the gap from their own concrete environment to the abstract level of mathematics (Fennema, 1973).

Two of the most prominent learning theorists, Piaget (1952) and Dienes (1970), have advocated the use of any concrete object that can be used to help represent a concept. They say that students' mental images and abstract ideas are based on their experiences. Hence, students who see and manipulate a variety of objects have clearer mental images and can represent abstract ideas more completely than those who do not have these.

Research on learning provides information that throughout the years led to the theory that is based on the belief that children must physically and actively manipulate objects to enhance their understanding of abstract concepts. This research refers to the approach that appeals to several senses and can be touched, moved about, rearranged, and otherwise handled.

Statement of Problem

Children's initial experiences with mathematical ideas and concepts seem to come to them through all of the senses. Most commonly, children are asked to express themselves through writing or speaking. However, the sense of touch and manipulation of objects kinesthetically stimulates their interest and imagination and helps build understanding beyond any skill and drill or stimulus-response method used (Welchman-Tischler, 1992).

Preservice teachers as well as inservice teachers come into the classroom with preconceived ideas about how one learns mathematics. According to Thompson (1984), perceptions of mathematics influence mathematics teaching practices. There is little research on the perceptions of preservice and inservice teachers about the use of manipulatives and the relationship between manipulatives and attitudes toward mathematics. The focus of this study is to investigate the attitudes toward mathematics of both preservice and inservice teachers and the ways in which they respond to questions involving the use of manipulatives and issues including the training in the use of manipulatives.

Purpose of Study

The purpose of this study is to determine the perceptions of inservice as well as preservice elementary and middle level teachers about the use of manipulatives in the classroom and the effects these may have on their attitudes toward mathematics. This study has the potential to widen teacher concepts and promote the development of programs that would lead to more positive attitudes in the classroom.

Research Questions

1. What are the perceptions of preservice teachers about what constitutes a manipulative?

2. What is the relationship between the attitude toward mathematics of preservice teachers and their definitions of manipulatives?

3. What is the relationship between the attitude toward mathematics of preservice teachers and how they feel about training in the use of manipulatives?

4. What is the relationship between the attitude toward mathematics of inservice teachers and how they feel about training in the use of manipulatives?

5. What is the difference between preservice teachers' expectations about the use of manipulatives in the classroom and inservice teachers' expectations about the use of manipulatives in the classroom?

Limitations

1. The preservice and inservice teacher populations are limited to a restricted geographic area and the findings may not apply to all teachers.

2. This was a convenience sample not a random sample; therefore, the results may not be generalizable to a broad population.

Definition of Terms

The following are defined terms according to their use for this study:

a. Math Attitude--a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person

b. Inservice Teachers--teachers in the field who have returned for training

c. Preservice Teachers--education majors preparing to become teachers

d. Manipulatives--concrete models that incorporate mathematical concepts, appeal to several senses, and can be touched and moved around by students (NCTM, 1989)

Summary

This report is divided into five chapters. The first chapter presents a summary of the background establishing the foundation of the problem, the statement of the problem under consideration, the purpose of the study, research questions to be considered, limitations of the study, and definitions of terms used in the study. In Chapter II, relevant studies are presented and discussed. These studies are presented under the following headings:

1. Attitudes toward mathematics of preservice and inservice teachers
2. Effectiveness of inservice/preservice training
3. Use of manipulatives in the classroom
4. The effects of the use of manipulatives in the classroom

In Chapter III, details of the experiment are given. The subjects, design, measuring instruments, collection of data, and methods of analyses used in the treatment of the data are described. The results are reported in Chapter IV where the data are analyzed. In Chapter V, the summary, conclusion, and suggestions for further study are presented.

CHAPTER II

LITERATURE REVIEW

In order to examine the expectations of preservice teachers as compared to inservice teachers about the use of manipulatives in the mathematics classroom, several areas of research are relevant. These include attitudes toward mathematics of preservice and inservice teachers, effective use of inservice/preservice training, use of manipulatives in the classroom, and the effects of the use of manipulatives in the classroom.

Attitudes Toward Mathematics of Preservice and Inservice Teachers

Attitude toward mathematics is defined by Haladyna, Shaughnessy, and Shaughnessy (1983) as a general emotional disposition toward the subject. They also advocate a positive attitude toward mathematics in order to increase achievement and motivation in mathematics. A study by Reyes (1984) showing the relation among self-confidence, affinity for mathematics, and achievement indicate that students do not have to be high achievers to appreciate the subject. However, there appears to be a general consistency in the relation between confidence and achievement throughout. These studies also showed that positive attitudes lead to greater participation by students.

This seems to carry over into college courses and later even into the teaching profession. A major objective in the preparation of preservice teachers is the development of a philosophy of education which includes certain attitudes and beliefs about the concept of number and how it is learned. In a study by Phillips (1973), it was revealed that students, whose teachers in previous mathematics courses had favorable attitudes toward mathematics, had more favorable attitudes toward and higher achievement in mathematics than students of teachers who had less than favorable attitudes. The study showed that teachers' attitudes toward mathematics had a bearing on the way in which the subject is taught and on how well it is taught. Tobias (1978) backed this theory and went on to add that students who are surrounded by confident teachers, excited and positive about their role in the students' learning processes, will exhibit fewer symptoms of math anxiety than students whose teachers are themselves anxious, uncomfortable, and negative about teaching mathematics. Reseasrchers have explored attitude changes toward mathematics in education programs (Lacefield & Mahan, 1980) and found that preservice education is more effective at producicng attitude change than three years of teaching after graduation.

According to Johnson (1981), a child's attitude toward number is a learned attitude that develops through math experiences. Research by Kelly and Tomhave (1985) supports the idea that some teachers may transmit their undesirable attitudes toward mathematics to their students; therefore, perpetuating a negative attitude. Both Collier (1972) and Vance (1978) investigated the change in attitude of prospective elementary teachers as they went through stages of preparation and found that students who had completed the required content and methods courses had more positive attitudes toward mathematics.

In a particularly disturbing research study by Rech, Hartzell, and Stephens (1993), elementary education majors' attitudes toward mathematics were compared to the general college population at a large university. They found that the attitudes of the elementary education majors were significantly more negative than the attitudes of other students. The implications of this study were alarming because of the potential influence of these students on their own future students.

Effectiveness of Inservice/Preservice Training

The National Council of Teachers of Mathematics (1989) has called for the improvement of the quality of mathematics offered in the nation's schools. To improve the quality of mathematics, one would conclude that it is necessary to review some of the obstacles that stand in the way of the teaching of number. The negative attitudes and approaches of these teachers may be a result of inadequate training and the lack of success in previous mathematics experiences. It is critical that teachers become positive in their attitudes about mathematics, develop competency, and feel comfortable with teaching mathematics themselves so that they can help students develop more confidence in their own ability to use, study, and enjoy mathematics (Garner-Gilchrist, 1993).

One of the obstacles that may face preservice teachers is the belief about when education ends for a teacher. Recent research by Aaronsohn (1996) tends to show that teacher education programs abandon preservice teachers as they are trying to make the transition from the rather nurturing environment of the university and the cooperating teacher's classroom to the isolation of being on their own. The usual procedure is to consider the certified teacher an essentially finished product who may or may not choose to come back to the university for further credits toward an advanced degree. These courses are often more of the same lectures. Research has established that most future teachers learn mathematical concepts and can display skills better when they are given the opportunity to work with manipulatives and/or diagrams (Gliesmann, 1986).

Research studies have been conducted by Pennsylvania State University on the use of manipulatives in teacher-education practicums and children. The results showed that prospective teachers' attitudes toward mathematics and the use of manipulatives in mathematics instruction should continue to be a concern to those interested in research and in increasing the use of manipulatives with children (Fennell & Trueblood, 1977).

In a study by Trueblood (1986), also at Penn State, indicated that the actual use of manipulatives with an individual child in a tutorial situation seems to produce the most change in prospective teachers' negative attitudes toward manipulative materials. This change was credited to the child's increased ability to describe the structure of a concept, increased attention span and motivation of the child, and immediate and concrete feedback of the student. Other influences found by Trueblood on prospective teachers' attitudes are the amount of practice they have in using manipulatives and in the self-directed activities used to demonstrate their competence with each manipulative.

Teachers of teachers spend much of their efforts trying to make their students more aware of individual differences in their future pupils (McNergney & Carrier, 1981). It needs to be remembered that teachers are individuals, too, and need to be treated as such. The concept of teacher development needs to be considered as the interaction of teacher behavior, beliefs, characteristics, surroundings, and tasks to be accomplished. Teacher development must be concerned with the growth of a teacher over time. In the course of teaching and learning over the years, a teacher changes. Teacher development should encourage one to view changes in teacher behavior as points on a continuum rather that as isolated events. The purpose of teacher education should be to encourage the growth of teachers as persons and as professionals. Teachers who are growing are becoming more open, more humane, more skillful, more complex, more complete pedagogues and human beings. They are fulfilling their own unique potentials or doing for themselves what others expect them to do for students.

Similarly, in a study by Lacefield and Mahan (1980), it was found that professional preparation, including student teaching, affected teacher attitudes more than several years of teaching. This reiterates that teacher preparation should be taken very seriously.

Christensen, Burke, Fessler, and Hagstrom (1983) called for consideration of adult learning styles and stages of teacher growth in order for effective staff development to occur. The stages of teachers' careers reflect findings about how adult development progresses from early insecurity to mid-career stability and then to a final stage of mature confidence and satisfaction. A healthy movement toward viewing teachers as evolving individuals with varying needs and abilities is evident.

Lifelong education has implications for all aspects of teacher training. The need for continuous learning on the part of educators has been strongly emphasized by Bar and Slomma (1973), who described it as very necessary if teachers are to be kept up to date on the latest teaching trends. James (1972), too, criticized the existing over-dependence on initial training and stressed the need for teachers to engage in continued learning. He described this continued learning as the third part in a three-cycle process which includes personal education, preservice training and induction, and inservice training. He saw inservice training as the most important because teachers needed to be experts in many diverse fields. So, continuous learning for teachers is vital, not only because of the need to keep their skills and knowledge up to date, but also because they may have to acquire new skills in unforeseen areas after the conclusion of their initial training (Cropley & Dave, 1978).

Use of Manipulatives in the Classroom

The use of manipulatives to establish an understanding of mathematics has been researched throughout the years by several learning theorists (Brownell, 1935; Piaget, 1952; Bruner, 1968; Dienes, 1970). Data from research have shown that students' instructional actions were results of beliefs that drill and memorization should be the main focus of mathematical learning, and the connection between procedures and concepts was seldom made (Foss, 1994). Benbow (1993), in an effort to trace the beliefs of preservice teachers, focused his study on elementary education majors and found that the students began the courses thinking that mathematics consists mostly of facts and procedures that need to be memorized. Having never used manipulatives, these prospective teachers resisted using manipulatives in their studies because of their lack of confidence in their own ability to use these materials (Trueblood, 1986).

In an effort to reform, mathematics educators are learning to direct their attention to the facilitation of students' understanding rather than the drill and practice of rote procedures (Beizuk & Cramer, 1989). The use of manipulatives in mathematics classrooms supports this attempt. Incorporating the use of concrete materials with an emphasis on the thought processes of students allows teachers a better way to assess and meet the individual needs of elementary school children as they go about constructing personal mathematical knowledge.

Based on recommendations from the National Council of Teachers of Mathematics (NCTM, 1991), many teachers believe that children need to be engaged in active learning.

Using manipulative materials has been a cornerstone of successful mathematics instruction for a number of years. Active learning means many things including exploring materials freely or engaging in cooperative learning projects or exchanges of mathematical ideas.

Studies of mathematics teaching by Stodolsky (1985) suggest that the mathematics classes many preservice teachers take show mathematics teaching as teacher-dominated settings with rules, theorems, drill, and practice. According to Franke (1990) teachers need to evaluate how mathematics should be represented in instruction. They explained this as taking complex subject matter and translating it into representations that can be understood by students. The ability to translate this matter into understandable representations is what distinguishes a mathematics teacher from a mathematician. The researchers stated that mathematics is composed of a large set of highly related abstractions, and if teachers do not know how to translate those abstractions into a form that enables learners to relate the mathematics to what they already know, they will not learn with understanding.

Early math experience should involve the use of a variety of manipulative materials. Mueller (1985) states that math is a "verb" for children. It should be something they do. Mueller also advocates the use of sequential activities using materials which are first concrete, then pictorial, and lastly symbolic. This continuation of activities using concrete materials first until children are ready to move on to a more abstract level of representation is questioned by Piaget (1952) and Kamii (1989). These experts feel that a child of any age is capable of abstract thought. Manipulatives should be used as a means of getting to that thought, not as a stage before abstract thought can be obtained. Although manipulatives have an important place in learning, they do not carry the meaning of the mathematical idea. They can even be used in a rote manner. Students may need concrete materials to build meaning initially, but they must reflect on their actions with manipulatives to do so. Later, they are expected to have a concrete understanding that goes beyond these physical manipulatives.

To back this, Piaget's cognitive theory includes three major points by which children acquire knowledge. These are: children need active involvement through direct experiences with the physical world, children's intelligence develops over time, and children are intrinsically motivated to develop intelligence (Morrison, 1991).

From infancy, children are mentally and physically active, organizing experiences with objects so that they may understand their world. Children construct their own knowledge through repeated experiences involving interaction with people and materials (Piaget, 1952). The constructivist concept of knowledge is central to Piaget's theory (Morrison, 1991). Children continuously organize, structure, and restructure experiences in relation to existing schemes of thought. Kamii (1981) states that constructivism refers to the fact that knowledge is built by an active child from the inside, rather than transmitted from the outside through the senses. Therefore, adults need to prepare an active, child-centered environment where children use concrete objects and experiences to think about their own ideas and construct their own model of the world (National Association for the Education of Young Children, 1986; Kamii, 1985).

Little disagreement seems to exist among mathematics educators that experiencing ideas on the concrete level is very important to the learning of mathematics, since mathematics deals with abstractions (Fennema, 1973). A major goal of mathematics instruction is to help children learn to operate efficiently at the abstract-symbolic level with an understanding of the concepts or skills in question. The purpose of using manipulatives is to assist students in bridging the gap from their own concrete environment to the abstract level of mathematics (Fennema, 1973).

The Effects of the Use of Manipulatives in the Classroom

Research has shown that the construction of students' own representation of concepts results in higher mathematics achievement (Suydam, 1986) and lower mathematical anxiety (Battista, 1986). In studies by Suydam (1986) and Sowell (1989), findings showed that students who use manipulatives in their mathematics classes usually outperform those who do not. This benefit held across grade level, ability level, and topic, given that using a manipulative made sense for the topic.

From an analysis of sixty-four research studies at the elementary school level, Parham (1983) reported a decided difference in the achievement scores of students who had used manipulative materials and those who had not. Those who use manipulative materials scored at approximately the eighty-fifth percentile; those not using manipulative materials scored at the fiftieth percentile. An earlier study by Suydam and Higgins (1977) agreed with Parham in their finding that lessons using manipulative materials had a higher probability of producing greater mathematics achievement than those lessons in which such materials were not used. The use of manipulatives also increases scores on retention and problem-solving tests. If students are expected to absorb materials presented and discussed in class, teachers must cultivate their attention by offering the material in an interesting and captive way (Tauber & Mester, 1994).

Piaget (1971) also found in his cognitive studies that the mode of instruction may be the problem. Children need not memorize lists of procedures that have little or no meaning to them when they can develop their own procedures and generate algorithms by themselves. Students need extensive experience with concrete models to develop their own internal mental images of a concept. Through investigations of their own, children develop conceptual understanding while discovering patterns and making generalizations. Like experiences contribute to the development of higher-level cognitive skills and a sense of accomplishment in doing mathematics (Kamii, 1985).

Another consideration is the use of manipulatives for remediation of students' mathematical skills. The general consensus is that experience with materials helps provide a strong basis for conceptual understanding, whether it be of later procedural skills or an appreciation of properties and relationships. Using materials is potentially valuable for those students in need of remediation. It may well be that misconceptions, misunderstandings, and an inability to use certain procedures are based on an originally weak conceptual understanding of the subject matter. The proper use of manipulatives at the early stages of development may remove the need for later remediation (Moser, 1986). Classroom teachers today are asked to work with a larger proportion of students with disabilities in their mathematics classes than ever before. One of the biggest obstacles for students with learning disablities is an inability to organize information to be learned. Developmental lags, poor retention, tendencies to be easily distracted, perceptual problems, logical-thinking or linguistic difficulties may account for the inability to organize. Each student is different, but most have one trait in common in that they benefit from a carefully structured, active approach to learning mathematics.

Manipulative materials are also valuable tools for gifted students. When learning the basic facts and algorithms, these special students can benefit from experiences at the concrete level. In an enrichment curriculum for gifted students, concrete materials have an important place. The major goal for these students should be to extend their thinking to higher levels, using the physical materials as a tool.

Summary

Research has shown that many variables affect the attitudes of students all the way up to these students' teachers. Teacher beliefs are often conditioned by their attitudes about mathematics. There has been much written on the subject of teacher anxiety and attitude toward mathematics and their relationship to students' attitudes toward mathematics. Literature also points to the training of teachers in the use of manipulatives as being helpful in positively changing these negative feelings around. The fact that the use of manipulatives in the mathematics classroom can help with positive feelings about the use of numbers is quite evident.

CHAPTER III

METHODOLOGY

The focus of this study was to determine the perceptions of preservice teachers and inservice teachers toward the use of manipulatives. The research also involved the relationship between attitudes toward mathematics and the use of manipulatives of both of these groups. This chapter discusses the subjects, design, instruments, and statistical analysis used in the study. The focus of this study is guided by the following research questions:

1. What are the perceptions of preservice teachers about what constitutes a manipulative?

2. What is the relationship between the attitude toward mathematics of preservice teachers and their definitions of manipulatives?

3. What is the relationship between the attitude toward mathematics of preservice teachers and how they feel about training in the use of manipulatives?

4. What is the relationship between the attitude toward mathematics of inservice teachers and how they feel about training in the use of manipulatives?

5. What is the difference between preservice teachers' expectations about the use of manipulatives in the classroom and inservice teachers' expectations about the use of manipulatives in the classroom?

Subjects

One group involved in this study was an intact elementary mathematics methods class for preservice elementary teachers. It was taught by the researcher at a small regional university located in a rural setting in northwest Oklahoma. At the beginning of the semester, this class had 33 students, 3 males and 30 females, but later dropped to 2 males and 30 females before the end of the semester. The students were all working toward elementary certification. This undergraduate class consisted of 1 freshman, 3 sophomores, 15 juniors, 10 seniors, and 3 graduates returning for another certification (see Appendix A).

The second group in the study was composed of graduate students who participated in a mathematics manipulative workshop given in the summer of 1996 and was funded by a grant from the Eisenhower Math and Sciences Foundation. This group consisted of 20 female elementary level teachers with varied experiences and backgrounds. The teachers ranged in years of experience from 1 year to 25 years with an average of 7.9 years of experience (see Appendix B). Approval (ED-97-020) for this research was obtained through the Oklahoma State University Institutional Review Board.

Design of Study

This study used several methods of inquiry: self-report surveys on attitudes toward mathematics, questionnaires about backgrounds and feelings toward the use of manipulatives, and self-evaluations about awareness of mathematics. The research involved two groups of college students: undergraduate preservice teachers and graduate inservice teachers.

Instruments

Preservice Teachers

One method of data collection consisted of the Attitude Toward Mathematics Survey (Suydam, 1974) given to the preservice teachers of an elementary mathematics methods class as well as graduate students in a mathematics manipulatives workshop for elementary teachers (see Appendix A and B). This survey was given to the preservice teachers on the second day of class and at the end of the semester to determine attitude toward mathematics (see Appendix C).

The same survey was given to the inservice teachers after the end of the workshop. The Attitude Toward Mathematics scale is a 26 item survey which is scored on a Likert-type scale. It consists of 13 positively worded and 13 negatively worded statements about mathematics with a reliability of .95. After each statement, the student had a choice of 5 different responses: strongly agree, agree, neutral, disagree, or strongly disagree. Each response was scored on a scale of 1 to 5, with 1 representing a negative response and 5 representing a positive response. A total attitude score for each student was determined.

A questionnaire, designed by the researcher, on past experiences and meanings of manipulatives (see Appendix D) was given on the first day of the methods course to all 33 of the preservice teachers (see Table 1). Data from this survey was compiled for later use.

Table 1. Student Survey #1

1. In your own words, explain what you think a math manipulative is.
2. Circle the items you consider to be math manipulatives:

calculator	base 10 blocks
paper and pencil	chalkboard
math textbook	computer programs
geometric wooden shapes	Cuisenaire rods
counting chips	math dictionary
tangrams	deck of cards
dice	math worksheet

3. Of the ones circled, put a check beside the ones you have used personally.

A follow-up questionnaire, also designed by the researcher (see Appendix E), was given on the final day of the methods class. The questions involved the preservice teachers' thoughts about manipulatives, beliefs about the usefulness of manipulatives, and the desirability of placement of training in the use of manipulatives (see Table 2). Information was compiled and compared with the first questionnaire.

Table 2. Student Survey #2

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1. Was the use of manipulatives in this course valuable to you? Why or why not?
2. Circle the items you consider to be math manipulatives.

calculator	base 10 blocks
paper and pencil	chalkboard
math textbook	computer programs
geometric wooden shapes	Cuisenaire rods
counting chips	math dictionary
tangrams	deck of cards
dice	math worksheet

3. Do you think you would like to teach with manipulatives? Why or why not?
4. Do you think the training in manipulatives would be more beneficial in your undergraduate work or as an inservice workshop? Why or why not?

<u>Inservice Teachers</u>

An initial questionnaire was given to the inservice teachers prior to the beginning of the workshop. This questionnaire (see Appendix F), designed by the researcher, included background information about training and beliefs of these teachers (see Table 3).

Table 3. Inservice Questionnaire #1

1. Number of years teaching experience.
2. Describe your position at your school (include grade level).
3. Describe the use of manipulatives in your classroom.
4. Describe the results of using the manipulatives in your classroom.

The follow-up questionnaire (see Appendix G), also designed by the researcher, was given to the inservice teachers after their completion of the workshop (see Table 4). The teachers had been given two months to incorporate the use of the manipulatives and new ideas into their class curriculum. The instrument also included a question that asked which setting, preservice or inservice, would be more beneficial to learning about the pedagogical values of using manipulatives in the mathematics classroom.

Table 4. Inservice Questionnaire #2

1. Have you used manipulatives in your classroom?
2. Do you think the training in manipulatives would have been more beneficial in your undergraduate work or as an inservice workshop?

An Attitude Toward Mathematics Survey by Suydam (1974) was also given to the inservice teachers at the time of the questionnaire. A total attitude score was determined for each graduate student.

Statistical Analysis

An Attitude Toward Mathematics Survey (Suydam, 1974) was given at the beginning of the semester and at the end of the semester to the undergraduate preservice teachers. The two scores for each student were compared using a paired t-test to determine if the scores were significantly different. A correlation, with the same scores, was done to show the degree of the relationship of the two survey scores.

A pre- and post-questionnaire was given to the same group of undergraduate preservice teachers to determine if there had been a change in perceptions about manipulatives and their use. With these two tests, a comparison was made on the pre- and post-perceptions of the definition of a manipulative. A correlation between the selection of manipulatives by preservice teachers on the pre- and post-test was made. The scores from the Attitude Toward Mathematics Survey were divided into two parts, the upper 50% of the attitude scores and the lower 50% of the attitude scores. The two groups were compared with their respective definitions of what constitutes a manipulative. Besides looking at the differences in definitions of manipulatives, the questionnaires showed which items were personally used by each preservice teacher. Also investigated was the relationship between the upper and the lower halves of the preservice teachers and how they felt about the optimal time (preservice or inservice) of training in the use of manipulatives.

From the questionnaires and Attitude Toward Mathematics Surveys given to the graduate inservice teachers, a comparison was made between the upper half and the lower half of the class about the best time of training in the use of manipulatives. Teachers' anticipation of the use of manipulatives in the mathematics classroom and inservice teachers' use of manipulatives were determined.

Summary

This chapter discusses the methodology used in the study to determine the perceptions of preservice and inservice teachers about the use of manipulatives in the mathematics classroom. Pre- and post-attitude surveys given to the preservice teachers were compared. Pre- and post-questionnaires given to the preservice teachers were compared and then also compared to their attitude scores. Two questionnaires and one attitude survey were given to the inservice teachers and the results were compared to the results from the group of preservice teachers. The results are shown in the next chapter and discussed in Chapter V.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

The study consisted of the survey of two groups, undergraduate preservice teachers and graduate inservice teachers. The undergraduate group consisted of elementary education majors with little prior experience in methods classes (see Appendix A) who had taken two structural concepts in mathematics classes. The graduate student group had varying degrees of mathematics backgrounds and were all involved with teaching at some level. Their years of experience were also extremely varied (see Appendix B).

Quantitative analysis of two types of surveys was used to identify trends and relationships. On the first survey concerning attitudes toward mathematics, subjects were asked to respond to statements by selecting choices from a Likert-type scale. The second type of survey involved a questionnaire about feelings toward the use of manipulatives and self-evaluations about the subjects' personal attitudes about their beliefs and training in the use of manipulatives. This component examined the reasons subjects made the choices they did. The comments not only gave a glimpse into the reasoning behind the choices, but also revealed attitudes about mathematics and attitudes about the relationship of mathematics and the use of manipulatives.

Attitude Toward Mathematics Survey

The Attitude Toward Mathematics Survey (Suydam, 1974) was given as a pre- and post-test to the preservice teachers to determine if there was a change in the mathematics attitude of these teachers during the semester of the study. The inservice teachers were given only one test because of the time constraints of the two-day training workshop format. The scores of the inservice teachers were compared to the post-test scores of the preservice teachers to determine if the Attitude Toward Mathematics scores were related to the feelings about the use of manipulatives and the optimal time for training in the use of manipulatives.

On the survey, the lowest possible score was 26 and the highest possible score was 130. A low score represented a more negative attitude while a high score represented a more positive attitude. The scores on the pre-test attitude survey for preservice teachers ranged from 48 to 111. The scores on the post-test attitude survey for preservice teachers ranged from 47 to 128. There were 32 preservice teachers who completed both surveys (see Appendix A). There were 20 inservice teachers who completed the survey after the workshop (see Appendix B). The scores for the inservice teachers ranged from 40 to 125. The means were computed for both groups (see Table 5).

A paired t-test showed a significant difference between the pre- and post-test scores of the preservice teachers, $\underline{t}(32)=2.99$, $p=.005$. The means showed that scores on the post-test (M=85.718) were significantly higher than scores on the pre-test (M=79.718). The scores for the two preservice surveys had a correlation coefficient of .8609 ($p=.000$). This indicated a strong correlation between the two sets of scores (see Table 6). There was an increase in the mean of the pre-test of 79.718 to the mean of the post-test of 85.718 for the preservice teachers. Both scores were lower than the mean of 93.750 for the inservice teachers. The standard deviation for the inservice teachers showed less of a variance at 19.134 than for the preservice scores of 20.073 for the pre-test and 22.248 for the post-test.

The scores from the preservice and the inservice attitude scales were compared using an one-way ANOVA (see Table 7). Because of the uneven sample sizes, an ANOVA was used to determine to be the best method of partitioning the error. This test was performed to see if experience in the classroom setting made an impact on the inservice teachers on their Attitude Toward Mathematics scores. There was no significant difference between the preservice and inservice scores, $F(2,50)=1.780$, $p=.1882$.

Questionnaires

Pre- and post-surveys were given to the preservice teachers asking opinions about manipulatives and their use. One question that was asked on both questionnaires was, "Which do you consider to be a manipulative?" The percentage of preservice teachers who considered each item to be a manipulative was calculated (see Table 8). Figure 1 shows the differences in the pre-survey and post-survey concerning what is considered a manipulative by the preservice teachers.

On the pre-survey, geometric shapes received the largest number of responses, while the math textbook and math dictionary received the smallest. Twenty-nine (91%) of the preservice teachers chose geometric shapes. Nine (28%) of the preservice teachers chose the textbook and the dictionary.

Table 5. Descriptive statistics for the Suydam Test of Attitude Toward Mathematics

		Pre-Test		Post-Test	
	N	Mean	SD	Mean	SD
Preservice	32	79.718	20.073	85.718	22.248
Inservice	20	--	--	93.750	19.134

Table 6. Preservice Teachers Paired T-test of Suydam Test of Attitude Toward Mathematics

	N	Corr.	2-Tail Sig	Mean	SD	SE
Pre-Test	32	.861	.000	79.718	20.073	3.548
Post-Test				85.718	22.248	3.933

Paired Differences

Mean	SD	SE	T-val.	DF	2 tail sig
6.00	11.356	2.008	2.99	31	.005

Table 7. ANOVA summary table for comparison of means of graduate and undergraduate scores on the Suydam Test of Attitude Toward Mathematics

	SS	DF	MS	F-ratio	F-prob at $\alpha = .05$
Within Groups	22300.219	50	446.004	1.780	.1882
Between Groups	793.858	1	793.858		
Total	23094.077	51	452.825		

Table 8. Responses to "Which do you consider to be a manipulative?

	Pre-Test		Post-Test	
	N	%	N	%
1. calculator	12	38	25	78
2. paper and pencil	11	34	9	28
3. math textbook	9	28	4	13
4. geometric shapes*	29	91	30	94
5. counting chips*	27	84	32	100
6. tangrams*	17	53	32	100
7. dice	26	81	31	97
8. base 10 blocks*	25	78	32	100
9. chalkboard	12	38	8	25
10. computer programs	22	69	19	59
11. Cuisenaire rods*	21	66	32	100
12. math dictionary	9	28	5	16
13. deck of cards	26	81	30	94
14. math worksheet	13	41	6	19

*true manipulatives

Note: n = 32

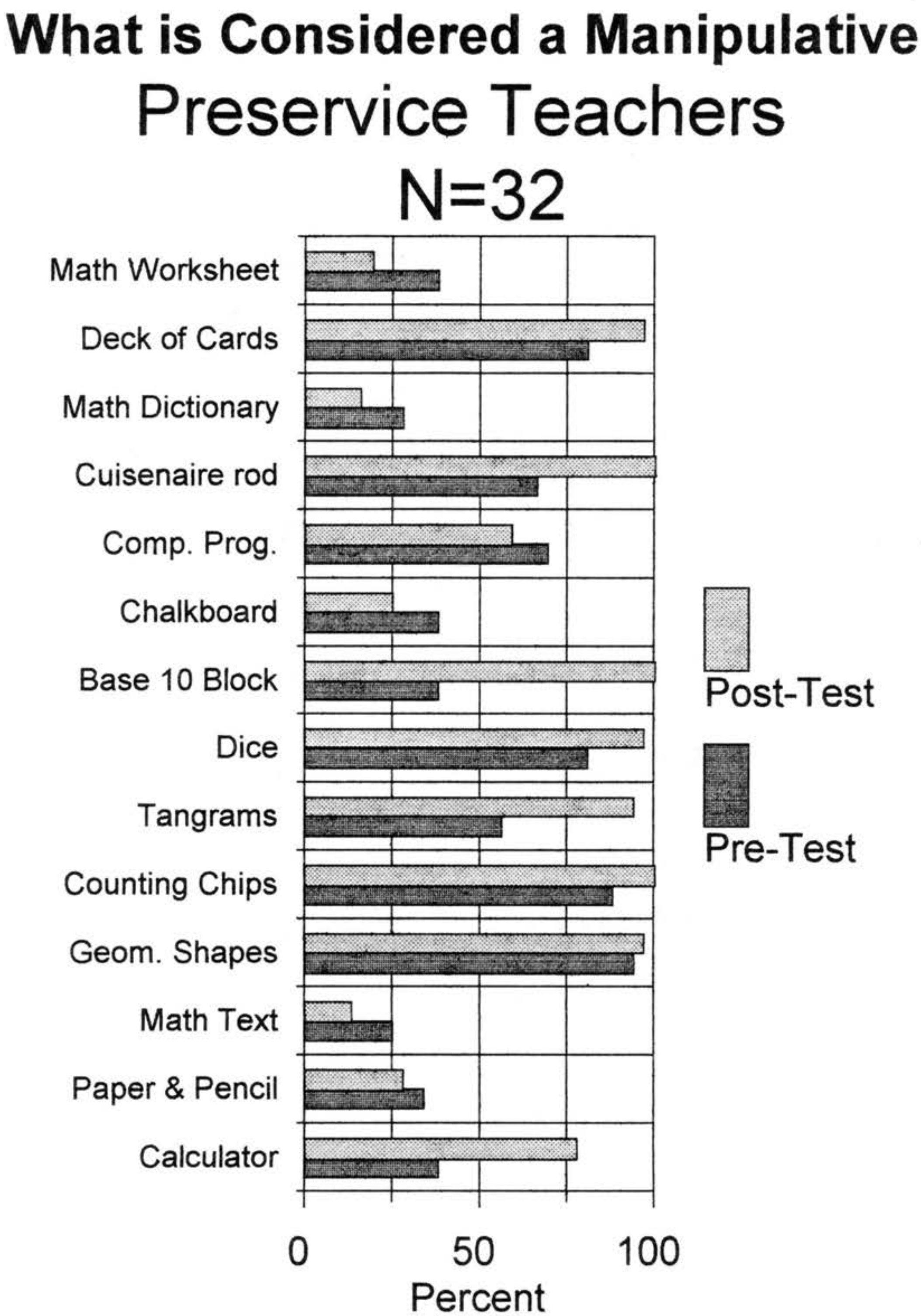

Figure 1. What is considered a manipulative

High correlation coefficients were determined between several items. On the pre-survey, manipulative #2 (M2), paper and pencil, was significantly related to manipulative #9 (M9), chalkboard, r=.7984. The math textbook (M3) was significantly related to the math dictionary (M12), r= .6908. Dice (M7) was significantly related to a deck of cards (M13) at r= .7949. Math textbook (M3) was significantly related to math worksheet (M14), r=6147.

On the post-survey, counting chips, tangrams, and Cuisenaire rods received the largest number of responses at 32 or 100% each. Math textbook came in lowest at 4 or 13% and math dictionary at 5 or 16%.

On the post-survey, M2 and M3 (paper and pencil along with math textbook) were significantly related to M9 (chalkboard), r= .7624 and r= .6547, respectively. M3 and M9 were related, r= .6547. The written items of paper and pencil (M2), math textbook (M3), chalkboard (M9), and math dictionary (M12) all were significantly related with the math worksheet (M14). Paper and pencil related with math worksheet (M14), r= .7679. A math textbook (M3) related with a math worksheet (M14), r= .7868. A chalkboard (M9) was significantly related with a math worksheet (M14), r= .8321. A math dictionary correlated with a math worksheet (M14), r= .6753. The calculator (M1) and the computer program (M10) were significantly related, r= .6397.

A chi-square distribution was determined between the upper and lower halves of the attitude scores compared to each of the manipulatives. On the pre-survey, when divided into upper and lower groups, there was a significant preference for M6 (tangrams) and M8 (base 10 blocks), χ^2 (13, N=32) = 6.026, p = .0141 and χ^2 (13, N=32) = 3.942, p = .0471, respectively.

On the post-survey, when divided into upper and lower groups, for M8 (base 10 blocks) and M11 (Cuisenaire rods) there was a significant preference of the two groups with the same response of χ^2 (13, N=32) = .000, p = .000. All had decided these two were manipulatives.

A chi-square distribution was run on each manipulative in the pre-survey compared to itself in the post-survey. Manipulative 8 (base 10 blocks), manipulative 9 (chalkboard), and manipulative 11 (Cuisenaire rods) showed significant selection patterns as manipulatives with the following scores: M8, χ^2 (13, N=32) = .0000, p = .0000; M9, χ^2 (13, N=32) = 11.378, p = .0007; and M11, χ^2 (13, N=32) = .0000, p = .0000.

Also in the comparison of the pre-survey to the post-survey, for manipulative 2 (paper and pencil) and manipulative 3 (math textbook) there was a significant indication that they were not considered to be manipulatives. The chi-square distribution was as follows: M2, χ^2 (13, N=32) = 5.788, p = .0161; and M3, χ^2 (13, N=32) = 4.969, p = .0258.

The students were asked, "Of the manipulatives above, which manipulatives have you used personally?" (see Table 9). It should be noted that only the items that were circled in the previous question could be considered. The responses are plotted in Figure 2.

The pre-test and post-test scores on the Attitude Toward Mathematics Survey of the preservice teachers were divided into two parts, upper half and lower half (see Table 10). The table shows the relationship between what the upper half of the class, according to the attitude scores, considered to be a mathematics manipulative and what the lower half of the class considered to be a mathematics manipulative. The lower half of the class made more gains, though, from the pre-survey to the post-survey and had higher counts on items that were "hands-on" or true manipulatives as opposed to the items that were more traditional. On the pre-survey, four of the five true manipulatives (geometric shapes, tangrams, base 10 blocks, and Cuisenaire rods) were identified as manipulatives more often by the upper half than by the lower half.

Table 9. Responses to "Which manipulatives have you used previously?

		N	Used Previously (%)
1.	calculator	12	38
2.	paper and pencil	10	31
3.	math textbook	7	22
4.	geometric shapes*	5	16
5.	counting chips*	14	44
6.	tangrams*	3	9
7.	dice	19	59
8.	base 10 blocks*	8	25
9.	chalkboard	11	34
10.	computer programs	14	44
11.	Cuisenaire rods*	5	16
12.	math dictionary	2	6
13.	deck of cards	20	63
14.	math worksheet	11	34

*true manipiulatives

Note: n = 32

Many changes were made concerning perceptions of what a manipulative is in both upper and lower halves of the class of preservice teachers (see Table 10). The amount dropped considerably for worksheets and math textbook. The upper half of the class went from 41% to 18% who marked math worksheets as a manipulative. The lower half of the class went from 40% to 20% on math worksheets. On math textbook, the upper half of the class went from 29% to 18%. The lower half went from 27% to 7%. There were still a few in the post-survey who felt all items were manipulatives (3 in the upper half of the class and 1 in the lower half). Figure 3 compares and contrasts all groups.

In the upper half of the preservice teachers, the largest growth in the true manipulatives was for the tangrams, from 71% to 94%. The geometric shapes actually dropped in count from 94% to 88%. The other three true manipulatives, counting chips, base 10 blocks, and Cuisenaire rods, rose. In the lower half, the largest gain was definitely the tangrams from 33% to 100%. Another large gain was for Cuisenaire rods from 53% to 100%. All of the five true manipulatives in the lower half were at 100% for the post-survey.

Comparatively, the gains from the pre-survey to the post-survey were distinctly higher for the lower half of the preservice teachers. All of the five true manipulatives in the lower half were considered manipulatives, whereas none of the true manipulatives was selected 100% of the time in the higher half of the group. The geometric shapes were selected fewer times in the pre-survey than in the post-survey.

Table 10. Comparison between upper and lower half of preservice teachers

	Upper Half				Lower Half			
	Pre		Post		Pre		Post	
	N	%	N	%	N	%	N	%
Calculator	6	35	12	71	6	40	13	87
Paper & Pencil	5	29	5	29	5	33	4	27
Math Text	5	29	3	18	4	27	1	7
Geom. Shapes	16	94	15	88	13	87	15	100
Counting Chips	14	82	16	94	13	87	15	100
Tangrams	12	71	16	94	5	33	15	100
Dice	15	88	15	88	11	73	15	100
Base 10 Block	15	88	16	94	10	67	15	100
Chalkboard	6	35	4	24	6	40	4	27
Comp. Prog.	11	65	10	59	11	73	9	60
Cuisenaire Rods	13	76	16	94	8	53	15	100
Math Dictionary	5	29	4	24	4	27	1	7
Deck of Cards	14	82	15	88	12	80	15	100
Math Worksheet	7	41	3	18	6	40	3	20

The way a comparison was made between the preservice teachers' Attitude Toward Mathematics scores and their perceptions about training in the use of mathematics (see Table 11) is shown, using the percentage of the class as a whole. The majority of the preservice teachers, 56%, felt that they were in the optimal time during which they should be taught to use manipulatives. When asked on the post-survey, "Do you think the training in manipulatives would be more beneficial in your undergraduate work or as an inservice workshop?," many made comments about learning to use manipulatives now before their teaching strategies and philosophies were fully developed. Included in their comments were the following:

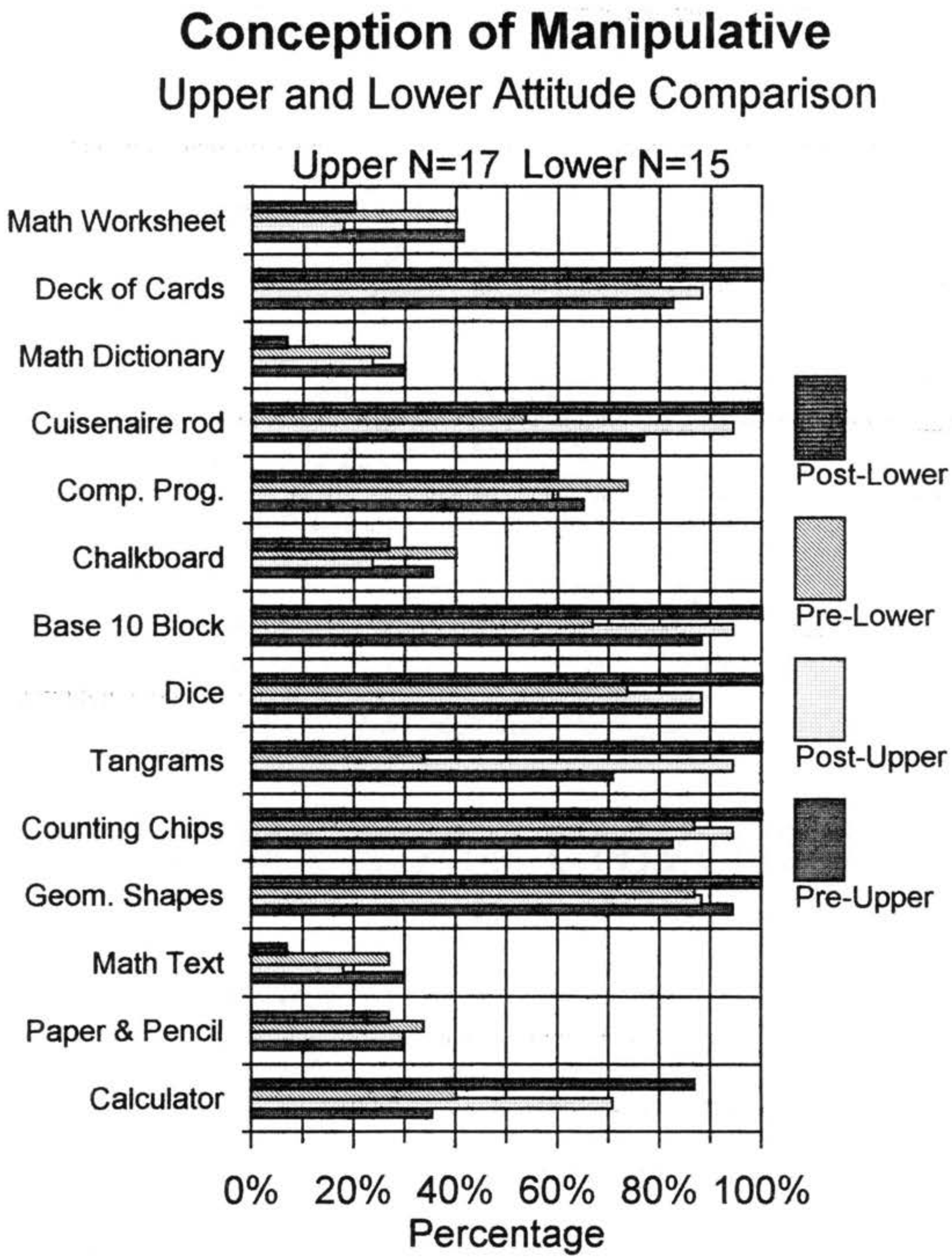

Figure 2. Conception of manipulative

"Teachers should be trained as undergraduates before they have totally developed one way of thinking."

"They can start out using manipulatives instead of having to change their teaching style."

"It is easier to change teaching styles before they are in practice."

"Undergraduates seem to be more open-minded to new teaching methods."

"Many resist change, so teachers would be more apt to use manipulatives if they were taught their use in college."

Several, 38%, did state that they felt education was an ongoing process throughout their careers. These preservice teachers had this to say:

"Undergraduates shouldn't be sent out without that (manipulative) experience, and inservice teachers need it to further develop their curriculum."

"As an undergraduate, one can learn about how to use them (manipulatives), and as an inservice teacher, one would know the children and what would be good for each one."

The inservice teachers were asked when they thought the training in the use of manipulatives should take place (see Table 12). The answers were divided into upper half and lower half categories according to their scores on the Attitude Toward Mathematics Survey (Suydam, 1974). A total of 55% felt training in the use of manipulatives should be at both times, 50% from the upper half and 60% from the lower. A total of 20% in the inservice group felt training should be in the preservice curriculum, 10% in the upper half and 30% in the lower. Twenty-five percent felt training should be after teaching had begun, 40% in the upper and 10% in the lower.

Table 11. Preservice teachers' perceptions according to attitude scores

Training should occur during:	Upper Half of att. scores		Lower Half of att. scores		Total	
	N	%	N	%	N	%
Preservice	9	53	9	60	19	56
Inservice	1	6	1	7	2	6
Both preservice and inservice	7	41	5	33	12	38
Total	17		15		32	

Note: The percents for the total refers to the entire group. All other percents refer to upper left or lower half of the group.

Table 12. Inservice teachers' attitude scores and feelings about training

Training should occur during:	Upper Half of att. scores		Lower Half of att. scores		Total	
	N	%	N	%	N	%
Preservice	1	10	3	30	4	20
Inservice	4	40	1	10	5	25
Both preservice and inservice	5	50	6	60	11	55
Total	10		10		20	

Note: The percents for the total refers to the entire group. All other percents refer to the upper left or the lower half of the group.

The majority of the inservice teachers in both the upper and the lower groups felt that preservice training in the use of manipulatives was appropriate, but only followed up by inservice workshops and additional training. Their statements included:

"Inservice teachers realize what one is up against and have experience teaching math concepts."

"The more exposure that you have, the more comfortable you feel in using manipulatives."

"Inservice workshops are beneficial later as refresher information or to get new ideas."

Many felt that they had missed out by not getting the appropriate training during undergraduate courses that would have helped shape their philosophies and techniques on how to teach. Their thoughts included:

"Undergraduates, because if you have never been exposed to this style of teaching, you definitely won't use it."

"There is so much to be learned that an inservice isn't enough time."

"I could have been using this information all along."

"This would have saved me frustration with some of my students who needed hands-on learning."

Others mentioned that they probably wouldn't have had the background knowledge to know how to incorporate new ideas and materials until they had had some experiences to help back up these ideas. These teachers said:

"Sometimes information gathered in undergraduate studies will be stored and never used because of lack of experience."

"Keeps a teacher up to date and I had some previous knowledge to help understand the concepts we were learning about."

Finally, the study addressed how preservice teachers' expectations compared to inservice teachers' expectations. The preservice teachers were asked if they thought they would like to teach with manipulatives and were asked to give reasons why. All preservice teachers definitely felt the use of manipulatives in the mathematics classroom was vital. Some of their answers included quotes such as: "It is more interesting and fun."

"It reinforces concepts that you are teaching."

"I believe teaching with manipulatives strengthens and deepens the students' understanding of the math concepts."

The inservice teachers were also unanimously in favor of the use of manipulatives. The question on the questionnaire sent to the inservice teachers was, "Have you used manipulatives in your classroom?" Their statements included: "Manipulatives need not be limited only to younger students. Older students need the exposure, too."

"I use manipulatives to reinforce the current concepts being studied and to extend the lesson and give the advanced students a challenge."

"It really helps the visual/kinesthetic learners."

The inservice teachers recorded varying amounts of time in use of manipulatives from a couple of times a week to everyday including free and math- center time.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

This study was designed to investigate the attitudes toward mathematics of both preservice and inservice teachers and the ways in which they respond to questions involving the use of manipulatives and issues including the training in the use of manipulatives. The following questions were researched:

1. What are the perceptions of preservice teachers about what constitutes a manipulative?

2. What is the relationship between the attitudes toward mathematics of preservice teachers and their definitions of manipulatives?

3. What is the relationship between the attitudes toward mathematics of preservice teachers and how they feel about training in the use of manipulatives?

4. What is the relationship between the attitudes toward mathematics of inservice teachers and how they feel about training in the use of manipulatives?

5. What is the difference between preservice teachers' expectations about the use of manipulatives in the classroom and inservice teachers' expectations about the use of manipulatives in the classroom?

First Research Question

The first question asked, "What are the perceptions of preservice teachers about what constitutes a manipulative?"

The preservice teachers were asked, in two different questionnaires, to choose from a list of fourteen items the ones each considered to be a manipulative. One questionnaire was given at the beginning of the semester before any instruction was given; the second one was given after regular instruction at the end of the semester. During the course of the semester, the instructor never gave a direct definition of what is considered to be a manipulative. The textbook addressed manipulatives and how the *Standards* (NCTM, 1989) look upon manipulatives but never directly specified which items were manipulatives and which were not.

For the 32 preservice teachers, the item most frequently chosen, 29 times, as a manipulative in the pre-survey was the 3-D geometric shapes, and the least chosen, 9 times, were math textbook and math dictionary. In the post-survey, the geometric shapes were selected 30 times, the math textbook was selected 4 times, and the math dictionary was selected 5 times. In the post-survey, several items were selected by 100% of the students: counting chips, tangrams, base 10 blocks, and Cuisenaire rods. The items that were used the most in the course of the class typically were the ones that were selected most often in the post-survey. In the post-survey, the math textbook was selected by 13% of the students while the math dictionary was selected by 16% of the students.

Along with a commonality of the count on similar items, there were high correlation coefficients determined between several items. In the pre-survey, the paper and pencil was significantly related to the chalkboard, possibly because both are used to write. The pre-survey percent for paper and pencil was 34% compared to 38% for chalkboard. The post-survey percent for paper and pencil was 28% compared to 25% for chalkboard. The math textbook and math dictionary are both books used for information and were significantly related. The pre-survey percent for both the textbook and the dictionary was 28%. The post-survey percent for the textbook was 13% compared to 16% for the dictionary. The dice and the deck of cards share the commonality of both being games. The pre-survey percent for both dice and deck of cards was 81%. The post-survey percent for dice was 97% compared to 94% for the deck of cards.

The items with decreased percents from the pre-survey to the post-survey were items that were more apparent in a traditional classroom, such as paper and pencil, chalkboard, and worksheets. It was noted on some of the pre-survey answers that the preservice teachers were unsure of what some of the items were, such as tangrams and Cuisenaire rods. At the end of the semester, the largest gains were the items that had been used most frequently (i.e. base 10 blocks, Cuisenaire rods, and tangrams). The dice and cards were used throughout the semester for various games. There was an increase in the number of students who selected these items. Dice jumped from 81% to 97% and deck of cards went from 81% to 94%.

Also on the post-survey, there was a significant relation among paper and pencil, math textbook, chalkboard, math dictionary, and math worksheet. The preservice teachers had begun to put these aside as items they were favorable toward. The chi-square distribution also showed definite patterns of this selection from pre-survey choices to post-survey choices. The chi-square also showed there was a significant indication that paper and pencil and math textbook were not manipulatives.

A section on the use of calculators for advancement in problem solving skills was discussed in depth during the semester. The percent for calculators jumped from 38% in the pre-survey to 78% in the post-survey. A cognitive theorist, researcher, and author, Constance Kamii, visited campus prior to the semester of the study. During her presentation and also in her articles and books, Kamii encouraged the use of dice and cards in the mathematics classroom to help develop children's concept of number. Kamii's theories as well as her writings were discussed throughout the semester. This could have affected the percents for the items considered to be manipulatives.

The perceptions of most of the preservice teachers seemed to switch from more traditional items such as worksheets and textbooks in the classroom to more hands-on items, such as base 10 blocks and Cuisenaire rods. The true manipulatives this study used were: 3-D geometric shapes, counting chips, tangrams, base 10 blocks, and Cuisenaire rods. This is determined by the definition of manipulatives in Chapter I: "concrete models that incorporate mathematical concepts, appeal to several senses, and can be touched and moved around by students." The identification of true manipulatives was confirmed by two preservice math educators. The perceptions of what a manipulative is seemed to be fairly well defined by the preservice teachers at the end of the semester. This was shown by the fact that the selection of all of the true manipulatives was increased. Four of the true manipulatives (counting chips, tangrams, base 10 blocks, and Cuisenaire rods) all had 100% each. The selection of three-dimensional geometric shapes totaled 94%.

It should be noted that in the question the preservice teachers were asked, "Which manipulatives have you used previously?," the options were only the items that had been circled in the preceding question. The preservice teachers were unable to check that they had used, for example, dice if they had not circled it in the question that asked which they considered a manipulative. Of the items circled as manipulatives, the highest percent was for deck of cards at 63%. The lowest was 6% for math dictionary. It was evident from the comments and actions that the preservice teachers lacked experience in the use of manipulatives from their own elementary educations.

Second Research Question

The second question asked, "What is the relationship between the attitude toward mathematics of preservice teachers and their definitions of manipulatives?"

The wide range of attitudes of preservice elementary teachers was determined by administering the Attitude Toward Mathematics Survey (Suydam, 1974) twice during the semester. The maximum number of possible points on each survey was 130, obtained by selection of the most positive responses on the Likert scales. The minimum number of possible points was 26, obtained by the selection of the most negative responses on the Likert scales. The scores ranged from 48 to 111 on the first survey and from 47 to 128 on the second survey. The mean was 79.718 on the first survey and 85.718 on the second survey. This supports data reported in the research by Sharp-Laird (1992) who administered the same survey to preservice elementary teachers. The mean in that study was 81.198 which is close in score to this study. Another study by Reinke (1995) that investigated the attitudes toward mathematics of preservice elementary teachers showed similar pre-survey and post-survey scores on the same survey of 83.264 on the first survey and 83.716 on the second survey. These scores suggest a stability of attitudes among preservice elementary students and support the use of the survey to determine positive and negative attitudes.

A paired t-test indicated a statistically significant difference in the pre-test and post-test scores on the Attitude Toward Mathematics Survey (Suydam, 1974). The scores had a correlation coefficient of .8609 ($p=.000$). The scores were divided into upper half and lower half and then compared to the questions asked the preservice teachers on the two questionnaires. The results were compared for both the pre-test scores and the post-test scores concerning how the preservice teachers believed which of the items were manipulatives.

In the upper half of the class, according to attitude scores, the true manipulatives all showed an increase from the pre-survey to the post-survey except for one, geometric shapes. That percent went from 94% in the pre-survey to 88% in the post-survey. The gains in the other manipulatives were not large since the pre-survey count was fairly high. Counting chips went from 82% in the pre-survey to 94% in the post-survey. Tangrams rose from 71% in the pre-survey to 94% in the post-survey. Base 10 blocks went from 88% to 94% while Cuisenaire rods increased from 76% in the pre-survey to 94% in the post-survey.

For students with attitude scores in the lower half, all the true manipulatives showed an increase from pre-survey scores to post-survey scores. The item with the largest increase was the tangram which had a pre-survey percent of 33% and was raised to a post-survey percent of 100%. Geometric shapes and counting chips both had an 87% score in the pre-survey that went to 100% in the post-survey. Base 10 blocks showed an increase from 67% on the pre-survey to 100% on the post-survey. Cuisenaire rods showed a 53% on the pre-survey and a 100% on the post-survey. There were several items that had question marks or "not-known" written by them by the lower half of the preservice teachers on the pre-survey questionnaire, so it was evident that they did not know what certain manipulatives were. By the end of the semester, all in this group felt confident of the "true" manipulatives.

From the chi-square distribution between the upper and lower halves of the preservice teachers, there was a significant preference on the pre-survey from both halves for base 10 blocks, but a difference of preference on tangrams. The upper half was convinced a tangram was a manipulative, but the lower half was not. On the post-survey, there was a significant preference from both groups that base 10 blocks and Cuisenaire rods were manipulatives.

Many changes were noted concerning perceptions of what a manipulative is in both upper and lower halves of the group of preservice teachers, some small and some much larger. Over all, the amount for the traditional items such as textbook, paper and pencil, and worksheets, dropped due, in part, to the training in "doing" math, not the skill-and-drill exercises of the past. The largest gains were in the lower half of the class when tangrams and Cuisenaire rods both went from low percents to 100%, due partially to the fact that students had never seen or worked with these manipulatives.

The gains from the pre-survey to the post-survey were distinctly higher for the lower half of the preservice teachers. The lower half of the group even chose all five of the true manipulatives 100%, possibly due to the fact that these teachers may have needed the concrete, hands-on help that manipulatives seem to provide.

Third Research Question

The third question asked, "What is the relationship between the attitudes toward mathematics of preservice teachers and how they feel about training in the use of manipulatives?"

The use of manipulatives to establish an understanding of mathematics has been researched throughout the years by several learning theorists (Bruner, 1968; Brownell, 1935; Piaget, 1952; Dienes, 1970), but much disagreement on this subject is quite common. Research in preservice education has established that most future teachers learn mathematical concepts better and can display skills better when they are given the opportunity to work with manipulatives and/or diagrams (Gliesmann, 1986). This was confirmed by the students in the study who expressed statements such as:

"It (manipulatives) helps reinforce and also helps students who need hands-on or visual aids."

"Not every student can learn by reading out of a book and writing it down."

"It would make learning fun."

"All children learn in a different manner."

The post Attitude Toward Mathematics Survey (Suydam, 1974) scores of the preservice teachers were divided into upper half and lower half. The upper half scores ranged from 91 to 128. The lower half scores ranged from 47 to 86. The preservice teachers' perceptions, according to attitude scores, about when training should occur were overwhelming in both halves for preservice training. A total of 56% of the total class of preservice teachers felt that training should take place during the preservice course work. The 56% was divided into 53% or 9 teachers of the upper half and 60% or 9 teachers for the lower half. Those who felt inservice training was the best place for training in the use of manipulatives were 6% or 1 teacher in the upper half and 1 in the lower half or 7% of the class. Seven preservice teachers or 41% in the upper half and 5 teachers or 33% in the lower half of the class thought that training in the use of manipulatives should be in both areas of training, preservice and inservice. There was little difference between the upper and the lower halves in the preservice teachers. It should be noted that "both" was not an option on the questionnaire, but it had been written in several times. Some of the other students may have indicated a choice of "both" if they had been given that option. It is difficult to make any inferences from this.

Researchers have explored attitude changes toward mathematics in education programs (Lacefield & Mahan, 1980). The results indicated that preservice education is more effective at producing attitude change than three years of teaching after graduation. This would back the findings in this study where 56% of the preservice teachers felt training in innovative ideas such as the use of manipulatives needs to take place in undergraduate work. They felt philosophies of teaching are formed during that time. Thirty-eight percent of the preservice teachers thought training should begin in undergraduate studies and be continued as inservice training.

Fourth Research Question

The fourth question asked, "What is the relationship between the attitude toward mathematics of inservice teachers and how they feel about training in the use of manipulatives?"

The same attitude survey by Suydam (1974) was given to the inservice graduate teachers. The survey was only administered once since the workshop lasted two days and a change in attitude would not seem to have occurred in such a short amount of time. The lowest possible score was 26 and the highest possible score was 130. A low score represented a more negative attitude while a high score represented a more positive attitude. The mean for the inservice group was 93.750 with scores ranging from 40 to 125. This was considerably higher than the preservice mean post-test score of 85.718 with a range of scores from 47 to 128. The individual means of the inservice teachers were consistently higher than the scores of the preservice teachers which tends to indicate that the attitudes and feelings of teachers in the classroom tend to focus more positively on mathematics after a few years of experience in the classroom.

The inservice teachers' perceptions, according to attitude scores, about when training should occur was somewhat different from the preservice perceptions. Only 10% of the teachers in the upper half and 30% of the teachers in the lower half, or a total of 20% of the inservice group, felt that training should take place during the undergraduate courses. Forty percent or 4 of the upper half and 10% or 1 in the lower half felt that training should take place on the inservice level. This was backed by statements from the inservice teachers such as:

"I could have been using this information all along."

"This would have saved me frustration with some of my students who needed hands-on learning."

The largest number, 11, or 55% of the inservice group felt that training should begin on the undergraduate or preservice level and continue as an ongoing process in the graduate or inservice level. This was backed by such statements:

"The more exposure that you have, the more comfortable you feel in using manipulative."

"Inservice workshops are beneficial later as refresher information or to get new ideas."

There was a significant decrease in the inservice teachers' perceptions about the optimal time of training being during the preservice years. More of the inservice teachers felt strongly that the best time was an ongoing process, throughout the preservice and inservice courses. They had written "both" on the questionnaire. More may have written "both" if it would have been an option, but it is difficult to predict either way.

Fifth Research Question

The fifth question asked, "What is the difference between preservice teachers' expectations about the use of manipulatives in the classroom and inservice teachers' expectations about the use of manipulatives in the classroom?"

Both groups of teachers were asked of the future plans about the use of manipulatives in their mathematics classroom. All teachers, both preservice and inservice, unanimously stated that they felt the use of manipulatives would be beneficial to their classrooms and that they all planned to use them. The inservice teachers' unanimous decision was not that surprising since they were all enrolled in a workshop which was specifically for instruction in the use of manipulatives and was an elective.

Prospective teachers resist using manipulatives in the classroom for two reasons: a lack of confidence in their own ability to use manipulative materials correctly and the general belief that children will become too dependent on these materials and, as a result, will not master basic computational algorithms and related concepts (Trueblood, 1986). Two important influences that Trueblood found to make a difference on prospective teachers' attitudes are the use of manipulatives with an individual child in a tutorial situation and practice each has in the self-directed activities used to demonstrate their competence with each manipulative (1986). Trueblood also has found that prospective teachers use manipulatives in their teaching in the same manner in which they are taught. With Trueblood's information, along with the results from this study, teacher preparation classes should definitely include modeling the use of manipulatives along with field-based experience that incorporates preservice teachers working with elementary students.

Recommendations for Further Research

Recommendations for further research include:

1. Similar studies should be conducted with a larger sampling of both groups (preservice as well as inservice) and involving a wider geographic area. The results would be compared to the results from this study to determine if teachers with more specific training at both levels would be more knowledgeable about current practices in the use of manipulatives in the mathematics classroom.

2. Similar studies should be conducted using personal taped interviews rather than a paper and pencil survey. This might provide the opportunity and time for more explicit responses, thus reducing the chance that the teachers might limit written responses due to questions asked, lack of available time, or questionnaire space. If more specificity of use is found, these suggestions might be organized and used as part of a more widely disseminated program.

3. Further research should be conducted to determine the present status of elementary mathematics curricula. There is a need for a comprehensive study of current practices. The most appropriate ways for generating these data would be through long-term observations and/or other case study research.

4. Through identification of instructional activities that are most effective in preparing prospective teachers to use manipulatives, on-going research should be required as an integral part of a teacher-education program. To support and encourage

the participation of classroom teachers in such research, it is important to disseminate the results to the participants and to the profession at large.

5. Research is further recommended at the elementary and secondary school level to note how mathematics is currently being taught, specifically in the use of manipulatives. An interesting study would be a comparison of public school mathematics classes that do and do not use manipulatives in instruction.

Implications for Teacher Preparation

In order to help bring about the necessary changes in teacher preparation, preservice teachers need to experience mathematics as an active process themselves, which most seem to lack in their own educational experiences, as well as to have a number of clinical experiences. During these experiences they should interact with teachers who practice and support this type of teaching using a manipulative approach for active learning addressed in the Professional Standards for Teaching Mathematics (NCTM, 1991). Using a manipulative approach to mathematics instruction requires several things: knowledge, skills, and experiences. The National Council of Teachers of Mathematics (1991) states that teachers are influenced by the teaching they see and experience.

Research by Frank (1990) indicates that not only do future teachers have misconceptions about mathematics, they also may feel inadequate about their understanding and knowledge of mathematics content and may inadvertently convey negative attitudes about mathematics to their students. The majority of preservice teachers had never experienced the use of manipulatives during any of their education or training. Teachers are the most important part of the learning environment (Cruikshank,

1980) and their beliefs and anxieties about mathematics can affect what and how mathematics is taught (Ball, 1990).

Each teacher enters the education profession with different experiences in mathematics classrooms. Wilcox, Lanier, Schram, and Lappan (1992) determined that content and task decisions used in mathematics classrooms are influenced by attitudes. Therefore, this wide spectrum of attitudes points to an expected wide range of approaches to issues in the classroom.

Recognition that changes in the classroom depend on teachers changing their approaches to teaching is vital to the importance of looking for explanations of teachers' conception of mathematics (Thompson, 1992). Educators (Kelly & Tomhave, 1985) argue that elementary teachers transmit their avoidance and fear of mathematics to their students by teaching as they were taught and thereby perpetuating mathematics anxiety in their students. Previous research on the effects of teachers' attitudes toward mathematics provides support for this argument (Aiken, 1976).

It is imperative that elementary school teachers have additional training in how to teach math more effectively (NCTM, 1991). The Mathematical Association of America (MAA,1991) firmly states that teachers should be taught to "do" mathematics, to construct their own knowledge, and to apply higher-order thinking skills in mathematics. Teachers must be able to analyze problems, explore solutions, construct models, collect data, and present arguments to help students develop their own mathematics potential. If we are going to teach preservice teachers to use manipulatives, we cannot ignore the fact that they do not know what a manipulative is. Teacher educators must begin with this.

There is much concern in this country about the mathematical competence of our young people. Increasing research is being devoted to how young children learn mathematics. Mathematics instructors are learning to direct their attention to the facilitation of students' understanding rather than the drill and practice of rote procedures. The use of manipulatives in mathematics classrooms supports this. Incorporating the use of concrete materials with an emphasis on the thought processes of students allows teachers to better meet the individual needs of elementary children as they construct personal mathematical knowledge. Learning theories and evidence from research and classroom practice support the use of manipulative materials to help children learn and understand mathematics. Well-chosen and properly used manipulative materials enhance children's learning, generate interest, relieve boredom, and promote problem-solving and computational skills.

With the knowledge of the importance of manipulatives, teacher educators must come to a commitment to provide initial training in preservice courses as well as continuing training as part of inservice experiences. If favorable attitudes toward mathematics by teachers can help students' attitudes and beliefs about mathematics, a major objective in the preparation of preservice teachers should be the development of a philosophy of education that would incorporate these feelings. These positive attitudes can lead to greater participation and achievement by all involved.

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APPENDIXES

APPENDIX A

PRESERVICE ROSTER

PRESERVICE ROSTER

ID #	Upper Half	Age	Classification	Gender	Pre-Test	Post-Test
1		20	Junior	Female	55	47
2	*	19	Sophomore	Female	96	91
3	*	21	Junior	Female	94	116
4	*	21	Senior	Female	110	103
5	*	20	Junior	Female	102	118
6	*	20	Junior	Female	90	62
7	*	20	Junior	Male	88	103
8	*	20	Junior	Female	111	128
9		21	Senior	Female	54	57
10	*	46	Junior	Male	88	92
11	*	20	Junior	Female	101	111
12	*	37	Sophomore	Female	93	103
13		22	Junior	Female	78	71
14		40	Junior	Female	59	86
15		33	Senior	Female	76	79
16		45	Junior	Female	52	70
17		22	Junior	Female	69	71
18		21	Senior	Female	48	61
19	*	25	Graduate Student	Female	98	104
20	*	21	Senior	Female	94	101
21	*	20	Junior	Female	94	97
22	*	30	Junior	Female	97	105
23		32	Senior	Female	54	64
24	*	21	Senior	Female	95	109
25		21	Junior	Female	71	83
26	*	20	Sophomore	Female	101	102
27		29	Graduate Student	Female	51	53
28		21	Senior	Female	55	81
29		27	Graduate Student	Female	74	75
30		24	Senior	Female	50	54
31		27	Senior	Female	64	52
32	*	38	Freshman	Female	89	94

APPENDIX B

INSERVICE ROSTER

INSERVICE ROSTER

ID #	Upper Half	Years Experience	Classification	Gender	Post-Test	Grade Level
1		22	Graduate Student	Female	88	LD K-4
2		7	Graduate Student	Female	92	4
3		6	Graduate Student	Female	78	3
4	*	3	Graduate Student	Female	96	2
5	*	11	Graduate Student	Female	105	5
6	*	12	Graduate Student	Female	113	5
7	*	7	Graduate Student	Female	103	5
8		5	Graduate Student	Female	64	3
9	*	7	Graduate Student	Female	101	2
10	*	5	Graduate Student	Female	96	3
11		8	Graduate Student	Female	90	3
12	*	25	Graduate Student	Female	125	3-4
13		3	Graduate Student	Female	90	Adult
14	*	13	Graduate Student	Female	101	4
15		23	Graduate Student	Female	94	5-6
16		2	Graduate Student	Female	80	6
17	*	3.5	Graduate Stndent	Female	99	5
18		8	Graduate Student	Female	40	3
19	*	6	Graduate Student	Female	125	6
20		9	Graduate Student	Female	95	7-8

APPENDIX C

ATTITUDE TOWARD MATHEMATICS SURVEY

ATTITUDE TOWARD MATHEMATICS

For the following statements, circle SA if you STRONGLY AGREE; A if you AGREE; N if you NEITHER agree or disagree; D if you DISAGREE; and SD if you STRONGLY DISAGREE.

1. Mathematics often makes me feel angry.	SA	A	N	D	SD
2. I usually feel happy when doing mathematics problems.	SA	A	N	D	SD
3. I think my mind works well when doing mathematics problems.	SA	A	N	D	SD
4. Mathematics is an interesting subject.	SA	A	N	D	SD
5. When I can't figure out a problem, I feel as though I am lost in a mass of words and numbers and can't find my way out.	SA	A	N	D	SD
6. I avoid mathematics because I am not very good with numbers.	SA	A	N	D	SD
7. I feel sure of myself when doing mathematics.	SA	A	N	D	SD
8. My mind goes blank and I am unable to think clearly when working mathematics problems.	SA	A	N	D	SD
9. I sometimes feel like running away from my mathematics problems.	SA	A	N	D	SD
10. When I hear the word mathematics, I have a feeling of dislike.	SA	A	N	D	SD
11. I am afraid of mathematics.	SA	A	N	D	SD
12. Mathematics is fun.	SA	A	N	D	SD
13. I like anything with numbers in it.	SA	A	N	D	SD
14. Mathematics problems often scare me.	SA	A	N	D	SD

15. I usually feel calm when doing mathematics problems.	SA	A	N	D	SD
16. I feel good towards mathematics.	SA	A	N	D	SD
17. Mathematics tests always seem difficult.	SA	A	N	D	SD
18. I think about mathematics problems outside of class and like to work them out.	SA	A	N	D	SD
19. Trying of work mathematics problems makes me nervous.	SA	A	N	D	SD
20. I have always liked mathematics.	SA	A	N	D	SD
21. I would rather do anything else than do mathematics.	SA	A	N	D	SD
22. Mathematics is easy for me.	SA	A	N	D	SD
23. I dread mathematics.	SA	A	N	D	SD
24. I feel especially capable when doing mathematics problems.	SA	A	N	D	SD
25. Mathematics class makes me look for ways of using mathematics to solve problems.	SA	A	N	D	SD
26. Time drags in a mathematics class.	SA	A	N	D	SD

APPENDIX D

STUDENT SURVEY #1 FOR PRESERVICE TEACHERS

STUDENT SURVEY

This survey is for research purposes and will not in any way affect your grade.

Name:

Age:

Freshman, Sophomore, Junior, or Senior? Circle one.

What math classes did you take in high school? (Put * by any that were considered Honors/Gifted & Talented.)

Give your overall approximate letter grade average in math in high school.

What math classes did you take in college? (Include mathods classes.) Give a letter grade for each.

Do you like math? Why or why not?

Did you like math in elementary school? Why or why not?

Did you like math in high school? Why or why not?

What is your most vivid memory (good and bad) about math in elementary school?

What is your most vivid memory (good and bad) about math in high school?

What is your most vivid memory (good and bad) about math in college?

Do you think that you have math anxiety? Why or why not?

Why do you think some people may have math anxiety?

Why do you think about people don't have math anxiety?

In your own words, explain what you think a math manipulative is.

Circle the items you consider to be math manipulatives:

calculator	Base 10 blocks
paper and pencil	chalkboard
math textbook (software)	computer programs
3-D geometric wooden shapes	Cuisenaire rods
counting chips	math dictionary
tangrams	deck of cards
dice	math worksheet

Of the ones circled, put a check beside the ones you have used personally.

Have you had a previous course that used manipulatives?

Do you think you would like to teach with manipulatives? Why or why not?

APPENDIX E

STUDENT SURVEY II FOR PRESERVICE TEACHERS

STUDENT SURVEY II

1. Do you like math? Why or why not?

2. Do you think that you have math anxiety? Why or why not?

3. Why do think some people may have math anxiety?

4. Why do you think other people don't have math anxiety?

5. In your own words, explain what you think a math manipulative is.

6. Was the use of manipulatives in this course valuable to you? Why or why not?

7. Circle the items you consider to be math manipulatives.

calculator	paper and pencil
math textbook	3-D geometric wooden shapes
counting chips	tangrams
dice	Base-10 blocks
chalkboard	computer programs
Cuisenaire rods	math dictionary
deck of cards	math worksheet

8. Do you think you would like to teach with manipulatives? Why or why not?

9. Do you think the training in manipulatives would be more beneficial in your undergraduate work or as an inservice workshop? Why or why not?

APPENDIX F

PARTICIPANT QUESTIONNAIRE FOR

INSERVICE TEACHERS

PARTICIPANT QUESTIONNAIRE

Questionnaire must be submitted on or before June 15, 1996.
Grant funded by Oklahoma Regents for Higher Education under Dwight D. Eisenhower Mathematics and Science Education PL 100-297.

SUMMER MATHEMATICS WORKSHOP

Preparation to Achieve Learner Outcomes (PASS)
Using Inquiry-Based Experiences

Name ____

School District ______________________________________

School Building ______________________________________

School Mailing Address ________________________________
Street or Box

____
City State Zip

School Phone Number (____) ____________________________

Home Mailing Address _________________________________
Street or Box

____
City State Zip

Home Phone Number (____) _____________________________

List content area(s) or grade level(s) for which you are certified:

____

Briefly describe your position at your school (include grade level):

____
____
____
____

Number of years in present position ________

Number of years teaching experience ________

Average number of students in class ________

Describe any opportunities you have to work with students of underrepresented and underserved populations* in your present position.

____

____

____

*Underrepresented/underserved populations in math/science careers included girls and students from low socioeconomic backgrounds, or different ethnic groups, particularly American Indians, Blacks, Hispanics, and Southeast Asians.

Describe any mathematics education courses or computing courses you have taken.

____

____

____

Identify the quantity and type of calculators used in your classroom.

____

Describe briefly your experience in working with calculators.

____

____

____

Identify the quantity and type of computers used in your school or classroom.

____

____

____

Describe briefly your experience working with computers.

____

____

____

____

Check any of the following math manipulatives you have used.

_____ Base Ten Blocks _____ Pattern Blocks _____ Pentominoes

_____ Geoboards _____ Tangrams _____ Mirrors

_____ Cuisenaire Rods _____ Fraction circles _____ Dice

_____ Transparent Chips _____ Two-Colored Counters

_____ Spinners

Describe the use of mathematics manipulatives in your classroom.

____

____

____

____

Describe the results of using the manipulatives in your classroom, giving highlights and problems.

____

____

____

Indicate opportunities you will have to implement workshop information in your classroom and to present staff development programs for other teachers.

____

____

____

____

Describe why you have elected to participate in this workshop and your expectations of this workshop.

____

____

____

____

APPENDIX G

QUESTIONNAIRE FOR INSERVICE TEACHERS

QUESTIONNAIRE FOR INSERVICE TEACHERS

Name:

School

Grade Level:

Years of teaching experience:

Educational Background:

High school:

Undergraduate:

Graduate:

How was the Manipulative Workshop beneficial to you? Explain your answer.

Were you trained in college in the use of manipulatives? Please explain.

Have you used manipulatives in your classroom? Please explain and include frequency of use.

If you have not used manipulatives in your classroom, do you anticipate the use of manipulatives in your classroom in the future? Please explain.

Do you think the training in manipulatives would have been more beneficial in your undergradate work or asan inservice workshop? Please explain.

2

VITA

Martie Gibson Rockenbach

Candidate for the Degree of

Doctor of Education

Thesis: PERCEPTIONS OF PRESERVICE AND INSERVICE ELEMENTARY TEACHERS TOWARD THE USE OF MANIPULATIVES IN THE CLASSROOM

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born in Enid, Oklahoma, on August 10, 1952, the daughter of Oscar and Lou Gibson.

Education: Graduated from Medford High School, Medford, Oklahoma, in May, 1970; received Bachelor of Science degree from Northwestern Oklahoma State University in December, 1983; received Master of Education degree from Northwestern Oklahoma State University in May, 1989; completed requirements for the Doctor of Education degree at Oklahoma State University in May, 1997.

Professional Experience: Classroom, Chapter I, and Special Education Teacher, Wakita Public Schools, Wakita, Oklahoma, 1986-1989; Education Instructor, Northwestern Oklahoma State University, Alva, Oklahoma, 1989-1990; Federal Programs and Special Education Director, Special Education Teacher, Alva Public Schools, Alva, Oklahoma, 1990-1994; Adjunct Instructor, Education Department, Northwestern Oklahoma State University, Alva, Oklahoma, 1990-1994; Education Instructor and Assistant Professor, Northwestern Oklahoma State University, Alva, Oklahoma, 1994-present.