PRESERVICE ELEMENTARY TEACHERS' ATTITUDES TOWARD MATHEMATICS AND THE TEACHING OF MATHEMATICS IN A CONSTRUCTIVIST CLASSROOM

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July, 1993

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
July, 1999

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ACKNOWLEDGMENTS

I wish to express appreciation to all whom contributed to this endeavor. First, sincere gratitude is expressed to Dr. Kay Reinke, my dissertation advisor, for her confidence encouragement, and guidance during this study.

Grateful appreciation is also expressed to Dr. Margaret Scott, Dr. John Wolfe, and Dr. John Steinbrink for their valuable assistance from the viewpoints of their particular areas of expertise.

I would also like to thank the many professors of the School of Curriculum and Educational Leadership who have given me the opportunity to learn from them. I have had many wonderful experiences during my doctoral program. I also want to give a heartfelt thanks to the many professors, fellow graduate students, and friends who aided in my professional growth.

As this chapter of my life comes to an end, I especially want to thank my family for their continuous encouragement and support. Their constant love and reassurance aided me over the rough spots. They continuously encouraged me to become a better person professionally. Finally, to my daughter, Brittany, this dissertation is dedicated because of her many sacrifices.

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CHAPTER I

INTRODUCTION

Mathematics is not an objective, feelingless subject. Attitudes, beliefs and emotions play an important role in the learning of mathematics (Reyes, 1981). Negative attitudes and beliefs can also transfer over into one's teaching practice.

Curriculum change in mathematics education should begin with attempting to change preservice teachers' attitudes about mathematics and the teaching of mathematics (Rech, 1993). Research shows that elementary education majors have the more negative attitudes toward mathematics than any other college majors (Rech, 1993).

Many mathematics educators focus on teachers' attitudes and beliefs about mathematics and the teaching of mathematics. Other research has focused on the relationships between attitudes or beliefs and instructional practice. Thompson (1984) discovered that attitudes and beliefs that students develop follow them into their teaching practice. Another researcher (Confrey, 1984), feels that teachers' conceptions of mathematics and the learning of mathematics plays an important role in determining the structure of the teacher's classroom. Their practice thus influences the next generation of students.

The cycle of the relationship between attitudes/beliefs and teaching practices is as follows:

Teacher's Attitudes/Beliefs ⇔ Teaching Practice⇔ Students' Attitudes/Beliefs

If preservice teachers do not have positive attitudes about mathematics and the teaching of mathematics, then the cycle becomes a negative one (Buhlman and Young, 1982) during their careers as professional teachers.

Content courses make up a significant part of teacher education programs (Thompson, 1992). Studying the relationship between a mathematics content course and attitudes/beliefs of preservice teachers can provide insight to make the cycle mentioned above a positive one. Teachers tend to teach as they were taught. One important way to help preservice teachers develop new conceptions of what can happen in their classrooms is to allow them to experience as students classrooms that enact a new approach to teaching.

One new approach to teaching is the constructivist approach. Traditionally, teaching is very much like teaching recipes to students and depriving them of the actual experience of cooking. In the end, students learn these recipes but do not know how to cook. In this case, students doubt the use of these recipes since they have had neither the experience of cooking nor a chance to taste even a bite of such dishes. In a constructivist classroom, knowledge must be actively constructed by the learner, not passively received from the environment (Lerman, 1989). Children's learning of subject matter is the product of an interaction between what they are taught and what they bring to a learning situation (Ball, 1988). Students learn through experience. Active learning results in students' actually knowing concepts instead of merely memorizing them. So the knowledge of cooking includes actual experience and the recipe.

The goal of constructivism is not to develop pedagogical strategies to help students receive or to acquire mathematics knowledge, but rather to structure, monitor, and adjust activities for students to engage in. Students must be engaged in activities that give rise to genuine mathematics problems for them (Lerman, 1989).

The National Council of Teacher's of Mathematics (NCTM) Professional Standards (1991) support a constructivist classroom. Standards 1, 4, and 5 are the most relevant for this study and are detailed below.

" Standard 1: Experiencing Good Mathematics Teaching" provides guidelines for educators of teachers. Mathematics and mathematics education instructors in preservice and continuing education programs should model good mathematics teaching by:

- posing worthwhile mathematical tasks;

  > Teachers should choose and develop tasks that are likely to promote the development of students' understandings of concepts and procedures in a way that fosters their ability to solve problems and to reason and communicate mathematically.

- engaging teachers in mathematics discourse;

  > The teacher's skill at formulating questions to orchestrate the oral and written discourse in the direction of mathematical reasoning is crucial.

- enhancing mathematical discourse through the use of a variety of tools, including calculators, computers, and physical and pictorial models;

  > Teachers must value and encourage the use of a variety of tools rather than placing excessive emphasis on conventional mathematical symbols.

- creating learning environments that support and encourage mathematical reasoning and teachers' dispositions and abilities to do mathematics;

  > A learning environment that supports problem-solving must allow time for students to think, reason, try alternative approaches and to confer with one another and with the teacher.

- expecting and encouraging teachers to take intellectual risks in doing mathematics and to work independently and collaboratively;

  > In such experiences, teachers should be encouraged to generalize solutions and communicate results from their explorations of mathematical ideas.

- affirming and supporting full participation and continued study of mathematics by all students.

> The experiences students have while learning mathematics have a powerful impact on the education they provide their students.

Standard 4: Knowing Mathematical Pedagogy addresses the modeling and study of good pedagogy. The preservice and continuing education of teachers of mathematics should develop:

- teachers' knowledge of and ability to use and evaluate: instructional materials and resources, including technology;

  > Teachers need a well-developed framework for identifying and assessing instructional materials and technological tools, and for learning to use these resources effectively in their classroom.

- ways to represent mathematics concepts and procedures;

  > Modeling mathematical ideas through the use of representations, (concrete, visual, graphical, and symbolic) is central to the teaching of mathematics.

- instructional strategies and classroom organizational models;

  > Teachers need a rich, deep knowledge of the variety of ways mathematical concepts and procedures may be modeled.

- ways to promote discourse and foster a sense of mathematical community;

  > Teachers need to focus on creating learning environments that encourage students' questions and deliberations-environments in which the students and teacher are engaged with one another's thinking and function as members of a mathematical community.

- means for assessing student understanding of mathematics;

  > Teachers need to align assessment with instructional goals and consider their purposes in assessment as they select or

develop the means of assessment.

Standard 5: Developing as a Teacher of Mathematics addresses the nature of mathematics and the teaching of mathematics. The preservice and continuing education of teachers of mathematics should provide them with opportunities to:

- examine and revise their assumptions about the nature of mathematics, how it should be taught, and how students learn mathematics;

    Observing and interviewing children can help teachers revise their assumptions about how students learn mathematics.

- observe and analyze a range of approaches to mathematics teaching and learning, focusing on tasks, discourse, environment, and assessment;

    Opportunities to examine students' thinking encourage prospective teachers to analyze various approaches.

- work with a diverse range of students individually, in small groups, and in large class settings with guidance from and collaboration with mathematics education professionals;

    The university faculty and cooperating teachers work together to help preservice teachers develop as teachers of mathematics.

- analyze and evaluate the appropriateness and effectiveness of their teaching;

    The prospective teachers are encouraged to pay attention to students' thinking and to make pedagogical decisions based on their knowledge of their students.

- develop dispositions toward teaching mathematics.

    Teaching someone else addresses the prospective teachers" assumptions about how mathematics should be taught.

The standards emphasize the need to model good pedagogy while teaching mathematics content in teacher education programs. Preservice teachers' feelings about mathematics and how mathematics should be taught are greatly influenced by past experiences. Ball (1988) states the need to examine the influence of different kinds of teacher education experiences on preservice teachers' knowledge toward mathematics and mathematics teaching and learning, as well as what they actually do in the classroom. Ball also states that knowing more about what teachers bring and what they learn from different components of and approaches to professional preparation is vital to improving the impact of mathematics teacher education and in what goes on in elementary mathematics classrooms.

Attitudes are an important part of the education of preservice teachers and must be addressed in teacher education programs (Raymond, 1993). Preservice teachers need to explore their mathematics attitudes. If they learn to be reflective about their attitudes and practices, this will enable them to become better teachers.

Statement of the Problem

The attitudes and beliefs that students develop about mathematics and the teaching of mathematics follow them into their teaching practice (Thompson, 1992). Teacher's conceptions of mathematics and mathematics teaching play a vital role in determining the structure of the teacher's classroom (Confrey, 1984). This practice will then influence the next generation of students (Meyer, 1980).

Addressing the attitudes preservice elementary teachers hold toward mathematics and the teaching of mathematics is critical to improving the mathematical performance of students, because those attitudes can have a strong influence on his/her approach to teaching mathematics. Hersh (1986) states that one's conception of what mathematics is affects one's conception of how it should be presented. Raymond, Santos, and Masingila (1991) go even further to state that teaching actions are directly influenced by teachers' attitudes, and in turn those teacher actions have a tremendous impact on students' attitudes.

Attempting to change preservice teachers' attitudes to more positive toward mathematics and the teaching of mathematics through a new approach to teaching is vital in order for these positive attitudes to carry over into their teaching practices. However, there are few studies addressing the relationship of mathematical attitudes of preservice teachers and teaching practices.

Purpose of Study

The purpose of this study is to examine the relationship of a constructivist teaching practice in a university content mathematics course with the attitudes of preservice teachers.

The following research questions will be addressed:

1. In what ways does the participation in a constructivist mathematics content course affect attitudes toward mathematics?

2. In what ways does the participation in a constructivist mathematics content course affect attitudes toward the teaching mathematics?

3. In what ways does the participation in a constructivist mathematics content course effect beliefs about classroom environment?

Assumptions and Limitations

1. Because the sample of this study involved preservice teachers in a course required for elementary education majors, this was a sample of convenience. Therefore, findings may not be generalizable to the entire population of preservice teachers.

2. The instructor for the course comes highly recommended among the students in teacher education. Therefore, attitudes upon the beginning of the course may already be somewhat positive.

3. It was assumed that the instructor observed in the course had positive attitudes toward mathematics and the teaching of mathematics.

4. It was assumed that all subjects responded honestly and thoughtfully to all surveys and interview questions.

Definition of Terms

1. Attitude toward mathematics- A subsystem of a belief system (Rokeach, 1976). The feelings, ideas and fears that a student holds toward mathematics.

2. Attitudes toward the teaching of mathematics- The feelings, ideas, and fears that a student holds toward the teaching of mathematics.

3. Preservice teachers-Those students who have been admitted to teacher education and who are currently preparing to become teachers.

4. Constructivism-An epistemology based upon the belief that knowledge must be actively constructed by the learner, not passively received from the environment (Lerman, 1989).

Summary

This dissertation 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, limitationsof 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. Factors influencing preservice teachers attitudes
2. Constructivism
3. Attitudes, constructivism, and instructional practices

In Chapter III, the methodology of the study is given including the research questions addressed. The subjects, design, measuring instruments, and collection of data are described. The results are reported in Chapter IV where the data are analyzed. In Chapter V, the summary, conclusion, implications for teacher education, and recommendations for future research are presented.

CHAPTER II

REVIEW OF LITERATURE

In order to examine preservice teachers attitudes toward mathematics teaching and learning in a constructivist classroom several areas of research are relevant. These include:

1. Factors influencing preservice teachers' attitudes;
2. constructivism; and
3. attitudes, constructivism, and instructional practices.

Factors Influencing Preservice Teachers' Attitudes

Several educators have researched the various factors influencing preservice teachers' attitudes about mathematics teaching and learning. Studying these factors provides valuable insight on what influences attitudes and how these influences can carry over into teaching practices.

A study conducted by Meyer's (1980) investigated factors influencing preservice teachers' attitudes toward mathematics. She found that preservice teachers' dislike for mathematics could be contributed to prior teachers' negative attitudes. Two secondary reasons were lack of understanding and poor backgrounds. Helms (1990) went further to investigate the acquisition of attitudes. He found that teachers' attitudes were acquired from experiences prior to their mathematics education courses. Those preservice teachers' with positive attitudes contributed this to previous teachers' positive attitudes toward mathematics. Meyer and Helms also noted a relationship between attitudes and achievement in mathematics. Another researcher, Reyes (1984) found that students do not have to be high achievers in mathematics to appreciate the subject however, results indicated a strong relationship between attitudes and achievement.

Brown and Cooney's research (1985) strongly supports that of Meyer (1980). They found that a teacher's knowledge and attitudes strongly influence the shaping of a teacher's behavior. Therefore, negative attitudes can assist in shaping of undesired, dubious behaviors. These researchers also described three processes for the acquisition of knowledge and attitudes. These include enculturation, education, and schooling. Enculturation is when one acquires knowledge and attitudes when exposed to a diversity of teachers and their attitudes. Education is defined as the learning experiences within a school setting. Schooling is defined as the learning that takes place outside of the school setting. Preservice teachers learn appropriate classroom behaviors, and myths and traditions of the teaching profession through schooling.

In addition to Brown and Cooney, Peterson (1989) conducted research which produced similar results. Results indicated a significant positive relationship between teachers' attitudes and their knowledge. Findings suggest that teachers' attitudes, knowledge, judgments, and decisions have an extreme effect on the way they teach and the students' learning.

Raymond's research (1993) also provides evidence that past experience and prior teachers are the primary influences of preservice teachers' attitudes. Their own teaching practices and teacher education are other contributors.

Research indicates a strong relationship between prior experiences and attitudes. Educators of preservice teachers must discover ways to impact those attitudes within the teacher education programs. Shealy (1993) states in order to impact on a teacher's attitudes, one needs some understanding of the teacher's prior beliefs-including not only descriptions, but also the origins and the way the beliefs are held.

Constructivism

Background

Constructivism has become one of the main philosophies of mathematics research. It is primarily the influence of Jean Piaget (1937) which has established constructivism as a central philosophy in the psychology of mathematics education. His constructivism has a number of components including an epistemology, a structuralist view, and a research methodology. Piaget's epistemology has its roots in a biological metaphor. An evolving organism must adapt to its environment in order to survive. Likewise, the developing human intelligence also undergoes a process of adaptation in order to fit with its circumstances and remain viable. Piaget's structuralism involves a belief that in organizing itself, the human intelligence necessarily constructs a characteristic set of logico-mathematical structures.

Piaget's methodology centers on the use of the clinical interview. In this procedure an individual is required to perform certain tasks in front of, and with prompting and probing from an interviewer.

Ernst von Glasersfeld (1989) has extended the foundational work of Piaget significantly, developing a well founded and elaborated constructivist epistemology. He bases this on the following two principles: Principle A: The "Trivial" Constructivism Principle. Knowledge is not passively received but actively built up by the cognizing subject.

Principle B: The "Radical" Constructivism Principle, says that the function of cognition is adaptive and serves the organization of the new experiential world, not the discover of ontological reality.

Principle A has important psychological and educational implications. It means that knowledge is not transferred directly from the environment or other persons into the mind of the learner. Instead, any new knowledge has to be actively constructed from preexisting mental objects within the mind of the learner, possibly in response to stimuli or triggers in the experiential world, to satisfy the needs and wants of the learner himself. An immediate consequence is that the transmission model of learning, also known as the "lecture method" is seen to be an inadequate model.

One way in which research on teaching has been linked with research on learning is through the constructivist perspective. Many researchers have conducted such research:

Yackel, Cobb, Wood, Wheatley, and Merkel (1990) point out that much learning or construction of knowledge takes place through social interactions. When children are given the opportunity to interact with each other, they can verbalize their thinking, explain or justify their solutions, and ask for clarifications. Attempts to resolve conflicts leads to opportunities for students to reconceptualize a problem and to extend their conceptual framework to incorporate the alternative solution methods.

In addition to Yackel, Cobb, Wood, Wheatley, and Merkel, Lerman (1989), as did von Glasersfeld states that knowledge must be actively constructed by the learner, not passively received from the environment. Constructivism holds that children's learning of subject matter is the product of an interaction between what they are taught and what they bring to any learning situation (Ball, 1988). The students learn through experiences with their environment as well as social interactions. This means that the student is not a "passive" learner, but takes an active part in learning. It is the process of active learning which enables the learner to modify his existing schema to accommodate new ideas which leads to actual learning. The students are given an "ownership" through this process and leads to the students actually knowing the knowledge instead of simply memorizing it. Ball also believes this learning can and should be applied to the learning of preservice teachers in their teacher preparation programs.

As noted before, The NCTM Professional Standards (1991) support a constructivist classroom. Teachers are inclined to teach like they were taught. Ball

(1988) also states that by watching teachers and paying attention to their own experiences, preservice teachers develop ideas about the teacher's role, form beliefs about "what works" in teaching mathematics, and acquire a repertoire of strategies and scripts for teaching specific content. These experiences also affect the way in which prospective teachers understand the subject-particular concepts and procedures as well as the nature of mathematics itself. Many preservice teachers have never experienced mathematics being taught in a constructivist manner, with student thinking and mathematical activity as the focus. If we want teachers to teach from the constructivist perspective, we must teach them in the same way.

Attitudes, Constructivism, and Instructional Practices

Raymond's (1993) study involved a relationship between mathematics attitudes and mathematics teaching practices. Mathematics attitudes were found to be strongly influenced by past school experiences and mathematics teaching practices. They were moderately influenced by teacher education programs. Attitudes were only slightly influenced by early family experiences. Mathematics teaching practices were strongly influenced by the social teaching norms and the actual mathematics teaching practices themselves. The practices were only slightly influenced by personality traits of the teacher, and the teacher's life outside of school. The teachers that participated in this study felt that teacher education programs should explicitly address the issue of the relationship between attitudes and practice.

The processes of assimilation and accommodation help a person's attitudes develop over a long period of time. Shealy (1993) believes that attitudes are a product of experience and reflection. In order for a person to change their attitudes, one must experience and reflect upon recent ideas, with the processes of assimilation and accommodation occurring. Assimilation is the knowledge which is gained without changing existing schemes; the new event fits "as is." Accommodation is defined as those events which are unfamiliar and cause confusion, and lead s to a change in existing schemes before those events can be accepted and the resulting knowledge can be placed with the previous knowledge. The new event doesn't fit "as is" which results in having to be accommodated. The changing of attitudes is a lengthy process as was the original development of attitudes. This is a constructivist view of how attitudes develop and/or change. This process is like a description of the constructivist classroom. Constructivist ideas are a part of developing and changing attitudes and attitudes are part of a constructivist classroom. Shealy believes that changing attitudes should play a significant part in teacher preparation programs. Many preservice teachers have never been taught mathematics in a constructivist manner, where the focus is mathematical activity and student thinking. Teachers have a tendency to teach like they were taught, by "telling" without being asked or told "why."

Research was conducted by Pirie and Kieren (1992) on how to become a constructivist teacher. It should be noted that they say there is not a list of specific behaviors which would define a constructivist classroom. The pair studied teachers who practiced a constructivist epistemology. These researchers define four beliefs which teachers must hold in order to develop a constructivist classroom:

1. All students may not achieve progress toward particular mathematical goals.
2. Different pathways lead to mathematical understanding. There is not one that is best for growth in understanding.
3. Different mathematical understandings will be held by different people.
4. There are different levels of understanding for every topic.

The teacher's attitudes resulting in action creates a constructivist environment of the classroom. Pirie and Kieren (1992) also note that growth in understanding is a dynamic, organizing, and re-organizing process. It is the student's response to the situation rather than the nature of the situation which determines the student's pathway to understanding.

Etchberger and Shaw (1992) investigated teachers who went through a process in order to make change to a constructivist way of teaching. They found that a teacher must experience six things in order for classroom style to change:

1. Dissatisfaction with the present learning environment in the classroom.
2. Possess an understanding that change is essential to improve the classroom environment.
3. Commitment to change
4. Knowledge of what changes are necessary and how to accomplish them.
5. Envisioning that the class and self will successfully participate in the change.
6. The teacher must reflect upon the process and be able to make other necessary changes.

The researchers noted these experiences would enable a teacher to develop a constructivist way of teaching over time.

Conclusion

Helping preservice teachers explore their mathematics attitudes will enable them to become better teachers. They must learn to become reflective about their attitudes and teaching practices. Two researchers Grover and Kenney (1993) believe that attitudes and teaching practices should be discussed in methods courses. They must also become aware that their attitudes can strongly affect important curriculum and teaching decisions (Schmidt & Buchmann, 1983). Changing preservice teachers' attitudes should be an important part of teacher education.

A constructivist classroom allows preservice teachers to confront and change their misconceptions. Students are encouraged to become the center of their own learning. Students are also able to gain confidence and experience.

CHAPTER III

METHODOLOGY

This study was a combined quantitative and qualitative study which investigated the relationships of preservice elementary/middle school teachers' attitudes and beliefs about mathematics and the teaching of mathematics in an inquiry-based mathematics classroom. The course is a required geometry content math course for preservice elementary/middle school teachers. The course's major components are mathematical inquiry and investigation through problem solving in cooperative groups and whole-class discussions, problem assignments and projects, constructivist teaching plan, creating alternative algorithms different from conventional procedures, and journals. The instructor attempted to let students discover the "how and why" of geometry, and there were various answers to the activities. The instructor emphasized the use of many types of manipulatives for the discoveries.

This research investigated how the constructivist classroom affects attitudes toward mathematics and its teaching. Specifically, the following research questions were addressed:

1. In what ways does the participation in a constructivist mathematics content course affect attitudes toward mathematics?
2. In what ways does the participation in a constructivist mathematics

content course affect attitudes toward the teaching of mathematics?

3. In what ways does the participation in a constructivist mathematics content course affect beliefs about classroom environment?

Subjects

The subjects were thirty-two undergraduate students enrolled in a section of the course during the 1999 Spring semester. The course was taught by a veteran professor of mathematics in the mathematics department of the university. Of the original thirty-two, only twenty-eight participated in the study. Four participants withdrew from the course during the semester. Of the twenty-eight participants, seven were early childhood majors, fifteen were elementary education majors, and six were completing requirements within other majors. Five males and twenty-three females participated in the study (See Appendix A). All participants were asked to sign a Human Subject Consent form during the first week of classes.

Research Design

This study used several methods for collecting data: surveys on attitudes toward mathematics and its teaching, interviews, and questionnaires. The research involved one group of students whom participated in a constructivist mathematics content course.

Procedures

Data were collected throughout the course of the semester. Two instruments were used to measure attitudes and experiences associated with math and its teaching. The first instrument was an Attitudes Toward Mathematics and Its Teaching Survey (ATMAT) (See Appendix B). It was administered to the subjects during the first and last weeks of the semester. This was a 29-item, six point Likert Scale questionnaire (Bell, 1995).

Results from the ATMAT were used to identify students to be interviewed.

The second survey was the Teacher Candidate Questionnaire (TCQ) (Madsen, 1993) (See Appendix C). This instrument was also administered the first and last weeks of the semester. This questionnaire ranged in format from Likert Scale responses to open-ended questions. It contained three parts: Part I-Conceptions of Mathematics, Part II-Classroom Procedures, and Part III- Instructional Strategies. Another instrument was the College and University Classroom Inventory (Fraser, 1994) (See Appendix D). This inventory was administered during the thirteenth week of the semester. This was a Likert-Scaled questionnaire containing seven, seven-item scales concerning the classroom environment. This survey was adminstered to validate the course instructor implements constructivism in his teaching practices as supported by the National Council of Teachers of Mathematics Professional Standards (1991). These standards provide guidelines for educators of preservice teachers. Standard One: Mathematics and mathematics education instructors in preservice and continuing education programs should model good mathematics by:

1. posing worthwhile mathematical tasks.

2. engaging teachers in mathematical discourse.

3. creating learning environments that support and encourage mathematical reasoning and teachers' dispositions and abilities to do math.

4. expecting and encouraging teachers to take intellectual risks in doing mathematics and to work independently and collaboratively.

5. representing mathematics as an ongoing human activity.

6. affirming and supporting full participation and continued study of mathematics by all students.

Standard Four: The preservice and continuing education of teachers of mathematics should develop teachers' knowledge of and ability to use and evaluate:

1. instructional materials and resources.

2. ways to represent mathematics concepts and procedures.

3. instructional strategies and classroom organizational models.

4. ways to promote discourse and foster a sense of mathematical community.

5. means for assessing the students' understanding of mathematics.

Standard Five: The preservice and continuing education of teachers of mathematics should provide opportunities to:

1. examine and revise their assumptions about the nature of mathematics, how it should be taught, and how students should learn mathematics.

2. observe and analyze a range of approaches to mathematics teaching and learning, focusing on tasks, discourse, environment, and assessment.

3. work with a diverse range of students individually, in small groups, and in large class

settings with guidance from and collaboration with mathematical professionals.

4. analyze and evaluate the appropriateness and effectiveness of their teaching; develop dispositions toward teaching mathematics.

Interviews were conducted during the fourteenth week of the semester. The results of the ATMAT pre-survey were analyzed to identify those students to be interviewed. They were selected using a stratified random sampling. All students from the section of the course were placed in two groups: (Preservice teachers and non-education majors).

Interviewees were selected only from the preservice teacher group. Three subjects were selected from this group. Total ATMAT scores were generated for the preservice teacher group. Selection from the group was as follows: One person was chosen from the ten percent with the most positive attitudes, one person from the ten percent with the least positive attitudes, and one person from the middle twenty percent of the scores.

Interview Questions

The following questions will be asked during the interview phase of the study:

1. Describe the mathematics you have learned in school. How were previous math courses taught?
2. Did this method of teaching work well with you?
3. Do you think people are naturally good or bad in mathematics? Why?
4. Can there be more than one right answer to a math problem? Explain.

5. How important is memorization in studying math? Why?
6. Is mathematics created or discovered? Is mathematics still being created or discovered?
7. Do students create/discover mathematics? Explain.
8. Should group work be used in math classes? How much and why?
9. Should your math teacher show you the exact way to answer questions you will be tested on? Why?
10. What type of questions would you put on a math test? Describe the class and the types of questions.
10. Can different methods of solving a problem lead to the same answer? Explain.
12. Things I like best about math are:
13. Things I like least about math are:
14. How does the teacher's attitude about mathematics affect your learning of math?
15. Do you find math classes interesting? Explain.
16. What would make math more interesting for you? Why?
17. How important do you think it is to discuss mathematics with your peers? Explain.
18. When you have a question in math do you want the teacher to give you the solution or to point you in a direction to help you continue working on the problem? Explain.

Conclusion

This chapter discusses the methodology used in the study to determine preservice teachers' attitudes toward mathematics and its teaching in a constructivist classroom. Several methods of data collection will be used including surveys on attitudes toward mathematics and its teaching, interviews, and questionnaires. Results are given in the next chapter.

CHAPTER IV

RESULTS

The study consisted of one group of twenty-eight undergraduates enrolled in a required geometry content math course for preservice elementary/middle school teachers. Students who are enrolled in other majors may also enroll in the course as an elective. Of the twenty-eight subjects, fifteen were elementary education majors, seven were early childhood education majors, and six had other majors. The early childhood and elmentary education majors were the focus of this research.

Two instruments were used to measure attitudes and experiences associated with mathematics and its teaching. Quantitative analysis of the two instruments was used to identify trends and relationships. On the first survey, Attitudes Toward Mathematics and Its Teaching (Bell, 1995) (See Appendix B), subjects were asked to respond to questions on a six-point Likert scale. The second survey, Teacher Candidate Questionnaire (TCQ) (Madsen, 1993),(See Appendix C), varied in format from Likert-type responses to open-ended questions.

Attitudes Toward Mathematics and Its Teaching Survey

The Attitudes Toward Mathematics and Its Teaching Survey (ATMAT) (Bell, 1995), was administered as a pre- and post-test to the twenty-eight subjects to determine if their mathematics attitude changed during the course of the semester. This was a 29-item, six point Likert Scale questionnaire. On the survey, the highest possible score was 174 and the lowest possible score was 29. A high score represented a more positive attitude and a low score represented a more negative attitude. The scores on the pretest attitude survey ranged from 70 to 168. The scores on the posttest attitude survey ranged from 83 to 174 (see Appendix A). The means were computed for the survey (See Table 1).

Table 1. Descriptive statistics for the Attitudes Toward Mathematics and Its Teaching Survey

		Pre-Test		Post-Test	
	N	Mean	SD	Mean	SD
Subjects	28	117.54	27.76	124.14	26.20

A paired t-test showed a significant difference between the pre- and post-test scores of the subjects, $\underline{t}(27)=2.24$, $p=.034$. The mean showed that scores on the post-test (M=124.14) were significantly higher than the score on pre-test (M=117.54). The scores for the pre-test and post-test had a correlation coefficient of .834 ($p=.000$). This indicated a strong relationship between the two sets of scores (see Table 2).

Table 2. Paired T-test of Attitudes Toward Mathematics and Its Teaching Survey

	N	Corr.	2-Tail Sig	Mean	SD	SE
Pre-Test	28	.834	.000	117.54	27.76	5.25
Post-Test				124.14	26.20	4.95

Paired Differences

Mean	SD	SE	T-val.	DF	2 tail sig
-6.6071	15.6237	2.9526	-2.238	27	.034*

*p<.05

Teacher Candidate Questionnaire

The Teacher Candidate Survey (Madsen, 1993) was also given to measure attitudes and experiences associated with mathematics and its teaching (See Appendix C). This questionnaire was only administered as a pre- and post-test to the twenty-two of the twenty-eight subjects who were teacher candidates. This questionnaire was administered to determine if there was a change in attitudes as measured by the three parts: Part I-Conceptions of Mathematics, Part II-Classroom Procedures, and Part III-Instructional Strategies. This questionnaire varied in format from Likert Scale responses to open –ended questions.

The first nine items of Part-I, Conceptions of Mathematics consisted of open-ended questions. When asked which subject they had studied in school was most like mathematics, the most common answer was science. Ten (45%) of the subjects answered science on the pre-test, and ten (45%) answered science on the post-test. The most common trend found was that both mathematics and science involve extensive problem-solving.

On question two, when asked which subject was least like mathematics, the most common answer was English/Composition. On the pre-test, eight (36%) answered English, and on the post-test, eleven (50%) had this response. The most common trend found was the reasoning behind the responses: English or Composition involved more personal answers rather than set ways to solve problems.

When asked to list three words that come to mind when doing mathematics the most common response was problem-solving/thinking. On the pre-test, eight (36%) felt that mathematics consisted of problem-solving/thinking. On the post-test, nine (41%) also answered problem-solving/thinking.

Question four consisted of four responses in which the subjects answered with a true or false response. On the first response, "In mathematics, there can only be one right answer," eighteen (82%) answered false, and four (18%) answered true on the pre-test. For the same statement, twenty (91%) answered false and two (9%) answered true on the post-test. Statement two was "There are some problems in mathematics with no answers." On the pre-test fourteen (64%) responded true and eight (36%) responded false. On the post-test, seventeen (77%) responded true and five (23%) responded false. The third statement was, "An answer in mathematics is always either right or wrong." On the pre-test fifteen (68%) responded false and seven (32%) responded true. The post-test results showed seventeen (77%) responded false and five (23%) responded true. The final question was, "If there were no people in the world, would math still exist?" For the pretest, fifteen (68%) responded true and seven (32%) responded true. On the post-test, eighteen (82%) responded true and four (18%) responded false.

For the fifth question, the subjects were given three responses and asked to check which one they would prefer when asked to solve mathematics problems. (See Table 3).

Table 3. Results of Teacher Candidate Questionnaire, Question Five

Pre-test	Question	Post-test
41%	1. One method which works in all cases.	32%
45%	2. More than one method which works in all cases.	45%
14%	3. More than one method that works in some cases.	23%

n=22

When asked why they thought mathematics was taught in school, 100% responded that mathematics is a part of life and students need mathematics to be able to think and problem-solve, which leads to success in life.

For question seven the subjects were given a list of math activities and were asked to circle the letter of the one with which they were the most comfortable; they were asked to underline the activities with which they were the least comfortable. Table four shows the results:

Table 4. Results of Teacher Candidate Questionnaire, Question Seven

Activity	Pre-test		Post-test	
	Most	Least	Most	Least
a. working with whole numbers	100%	0%	100%	0%
b. working with fractions	59%	41%	64%	36%
c. working with percents	73%	27%	68%	32%
d. solving story problems	23%	77%	23%	77%
e. using equations	77%	23%	86%	14%
f. studying areas and perimeter	32%	68%	50%	50%
g. working with negative numbers	82%	18%	82%	18%
h. working with discounts	50%	50%	55%	45%
i. working on applications	27%	73%	36%	64%

n=22

When asked whether they prefer working with another person or working alone when doing mathematics, the most common answer was with another person. On the pre-test, 15 (68%) preferred to work with another person and 7 (32%) preferred to work alone. It should be noted that of those seven (32%) that preferred to work alone on the pre-test, five (71%) responded that they would like to work alone at first, then with a group to express ideas and compare answers. On the post-test, eighteen (82%) preferred to work with another person and four (18%) preferred to work alone. It should also be noted that of the four (18%) that preferred to work alone on the post-test, two (50%) responded that they would like to work alone at first, then with a group to express ideas and compare answers.

When asked on question nine, "When you don't know how to work a problem what is the best way to find out?," the most common answer was to ask someone. On the pre-test twenty-two (100%) responded to ask someone. On the posttest twenty-two (100%) also responded to ask someone.

The remaining sections of the Teacher Candidate Questionnaire were five-point Likert-scale responses concerning conceptions of mathematics, classroom procedures and instructional strategies (See Appendix C). A mean and standard deviation were calculated for each individual response on the pre-test and post-test and significant differences were analyzed (See Table 5).

Table 5. Descriptive statistics for the Teacher Candidate Questionnaire

		Pre-Test		Post-Test	
Item #	N	Mean	SD	Mean	SD
20	23	3.3913	1.1962	3.9130	.7928
28a	23	1.3478	.5728	1.8261	.8869
28p	23	2.6957	1.0196	3.2174	.8505
28t	23	3.5652	.9451	3.0435	.8779
28v	23	1.8261	.9367	2.4783	1.1627
28x	23	2.7391	1.3218	3.9565	1.5805
28y	23	3.3043	1.3292	4.3913	1.2699

A paired t-test showed a significant difference on seven items on the questionnaire (See Table 6).

Table 6. Paired T-Test of Teacher Candidate Questionnaire

Item #	N	T-val.	DF	2 tail sig
20	23	-2.313	22	.030*
28a	23	-2.554	22	.018*
28p	23	-2.409	22	.025*
28t	23	- .289	22	.043*
28v	23	-2.472	22	.022*
28x	23	-3.730	22	.001*
28y	23	-4.085	22	.000*

*p<.05

The first significant difference was on Item #20, t(22)= -2.313, p=.030. When asked if they would present a math problem deductively or inductively on a five point Likert scale, the mean on the pre-test was 3.3913, and 3.9130 on the post-test. This indicated that the subjects prefer a more deductive approach in the math classroom.

The second significant difference was on Item #28a, t(22)= -2.554, p=.018. When asked on a six point Likert scale if they would use this type of instruction almost every day (1) versus not at all (6), the mean for the pre-test was 1.3478 and the post-test means was1.8261. This indicates that the subjects would utilize whole class instruction less in their own classroom.

The third significant difference was on Item #28p, t(22)= -2.409, p=.025. When asked if they would use this type of instruction almost everyday versus not at all, the pre-test mean 2.6957, and post-test mean, 3.2174, indicates that the subjects would prefer to use computer-based drill and practice less in their own classroom.

Another significant difference was on Item #28t, t(22)=2.152, p=.043. When asked if they would use this type of instruction almost everyday versus not at all, the pretest mean 3.5652, and post-test mean, 3.0435, indicates that the subjects would assign more projects to the students in their own math classroom.

A significant difference was also found on Item #28v, t(22)=2.472,p=.022. When asked if they would refer to the text for information almost every day versus not at all, the pre-test mean was 1.8261 and the post-test mean was 2.4783. This indicates that the subjects would refer to the text for information less often.

Findings indicate another significant difference in Item #28x, t (22)= -3.730, p= .001. When asked if they would use this type of instruction, the pre-test mean 2.7391, and post-test mean, 3.9565, indicates that the subjects would not have students read aloud from a textbook as often.

The final significant difference was in Item # 28y, t (22)= -4.085, p=.000. When asked if they would use this type of instruction, the pretest mean 3.3043, and post-test mean, 4.3913, indicates that the subjects would allow students to read silently from the textbook less often.

Classroom Environment Inventory

The College and University Classroom Environment Inventory (See Appendix D) was administered during the thirteenth week of the semester. This was a four-point Likert-scaled questionnaire, containing forty-nine items concerning the university classroom environment. This survey was administered to validate that the course instructor implements constructivism in his teaching practices.

Mean scores were computed for each individual item on the survey. A mean score above a 3.5 indicates that the subjects more strongly agree with the item. A mean score below a 2.5 indicates that the subjects more strongly disagree with the item. The findings indicate several items which met either criteria (See Table 7).

Table 7. Results of Classroom Environment Inventory

Item	Mean
1. The instructor considers students' feelings.	3.6923
* 6. New ideas are seldom tried out in class.	3.6538
12. Getting a certain amount of work done is important in this class.	2.1538
*13. New and different ways of teaching are seldom used in this class.	3.6154
34. The seating in this class is arranged in the same way each week.	1.6154
37. There are opportunities for students to express opinions in this class.	3.9231
41. The instructor often thinks of unusual class activities.	3.6154
*43. The instructor is unfriendly and inconsiderate toward students.	3.8462
*44. The instructor dominates class discussions.	3.7692
47. Activities in this class are clearly and carefully planned.	3.9231

* This indicates those items worded negatively, and the scale was reversed.

Interviews

Interviews were conducted during the fourteenth week of the sixteen-week semester. The results of the Attitudes Toward Mathematics and Its Teaching (ATMAT) pre-survey were analyzed to identify those students to be interviewed. They were selected using a stratified random sampling. All students from the section of the course were placed in two groups: (preservice teachers and non-education majors). Interviewees were only selected from the preservice teacher group. Total ATMAT scores were generated for the preservice teacher group. Three subjects were selected from the group of preservice teachers. Selection from the group was as follows: One preservice teacher was chosen from the ten percent with the most positive attitudes, one preservice teacher from the ten percent with the least positive attitudes, and one preservice teacher from the middle twenty percent of the scores.

Interviews were conducted to further investigate the attitudes of the students enrolled in the course about mathematics and the teaching of mathematics, and also to validate that the course instructor implements constructivism in his teaching practices.

The interview notes were carefully analyzed by the researcher and several trends were identified. The first interview question that was asked was how mathematics was previously taught in school. Each interviewee stated all their previous math courses were taught by lecture. None of the interviewees remembered many hands-on activities after the elementary school years. They all commented on how they were taught how to do the algorithms, but not necessarily why certain problems were worked in a particular way. When asked if there could be more than right answer to a math problem, all interviewees commented there can be several methods to solve a problem, but they were taught these methods. No self-discovery was encouraged. They all felt that self-discovery led to better understanding of concepts. It was also commented that their present professor often proved to them that there are several answers to one problem.

Another trend was found when the interviewees were asked about group work in mathematics. Each interviewee explained that one should try to work a problem by himself at first then come together as a group to compare the answers. They all felt that this was important because another person can be helpful in showing a different way to solve a problem and this could also be a great confidence builder for the student who needs assistance.

When asked if a math teacher should show students the exact way to work a problem, each interviewee answered that one should try to discover it first without assistance because it would allow the student to think for himself which would lead to better understanding. In addition, they all commented that the professor in the involved course never shows the exact way to do a problem; he allows them to discover the methods by facilitating class discussion permitting students to think for themselves. He wants the students to understand why they are doing what they are doing, not just how to do it.

When asked what type of math problems they would be put on a test they all referred to the types of problems done in the present class. They commented on how these types of problems were worked through self-discovery, group-work, and not focusing on getting the right answer, but that the students have an understanding of the process involved.

Another interview question addressed the importance of teachers' attitudes in mathematics. All interviewees commented that it was extremely important for teachers to have a positive attitude. Each believed that students will not be enthusiastic learners if teachers do not display a positive attitude. If teachers show that they can get as much enjoyment out of math as students should, then they are going to see that and want to learn mathematics.

When asked what made math interesting for them, all the interviewees co mmented on teaching practices used in the present course. These practices included, self-discovery, group-work, projects, and explanations from different points of view. Finally, when asked what they liked best about math, the trends discovered were self-discovery, hands-on activities, group work, and projects.

Conclusion

This study investigated the relationships of preservice elementary/middle school teachers' attitudes and beliefs about mathematics and the teaching of mathematics in a constructivist university classroom. Several methods of data collection were used and results were analyzed. The results of the data collected is presented in this chapter. Conclusions and recommendations based on the results will be discussed in the next chapter.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This study investigated preservice teachers' attitudes toward mathematics and the teaching of mathematics in a constructivist classroom. The following questions were researched:

1. In what ways does the participation in a constructivist mathematics content course affect attitudes toward mathematics?

2. In what ways does the participation in a constructivist mathematics content course affect attitudes toward the teaching of mathematics?

3. In what ways does the participation in a constructivist mathematics content course affect beliefs about classroom environment?

First Research Question

The first research question addressed the way in which participation in a constructivist mathematics content course affects attitudes toward mathematics. The preservice teachers' attitudes were determined by administering the same survey, Attitudes Toward Mathematics and Its Teaching (Bell, 1995), as both a pre- and post-test. The highest possible score was 174 and the lowest possible score was 29. A high score represented a more positive attitude and a low score represented a more negative attitude.

The scores on the pre-test ranged from 70-168. The scores on the post-test ranged from 83-174. The mean was 117.54 on the pre-survey and 124.14 on the post-survey. A paired t-test, $t(27)=2.24, p=.034$, showed a significant difference between the pre- and post-test scores of the subjects on the survey. This suggests that participation in a constructivist mathematics content course does affect attitudes. This research is supported by Steele (1994). She found that participation in a constructivist mathematics course allowed students to address their mathematical attitudes and become willing to take intellectual risks. Attitudes of the subjects at the end of the course were more positive change regarding the learning of mathematics.

On another questionnaire, Teacher Candidate Questionnaire (Madsen,1993), a pre- and post-survey was also administered. This questionnaire was administered only to the twenty-two subjects who were teacher candidates. This questionnaire contained three parts: Conceptions of Mathematics, Classroom Procedures, and Instructional Strategies. The first part, Conceptions of Mathematics was used to determine the attitudes and beliefs of the subjects toward mathematics.

The analysis of the open-ended questions suggested that 41% of the students felt that mathematics was thinking and problem-solving. When asked if there could only be one right answer in mathematics, 82% responded false on the pre-test, and 91% responded false on the post-test. This was a difference of 9%. On another question when asked if an answer in mathematics is either right or wrong. On the pre-test 68% responded false. The post-test scores indicated 77% responded false, a difference of 9% between the pre- and post-tests. When asked about what type of math problems they would prefer when asked to solve them, the most significant change between the pre- and post-test was more than one method which works in some cases. On the pre-test there were 14% of the subjects who responded with this answer, and on the post-test 23% responded with the same answer. This was also a difference of 9%. Finally, when asked why mathematics was taught in school, 100% of the subjects responded that mathematics is a part of life and students need mathematics to be able to think and problem-solve which leads to success in life. This suggests a strong correlation between their conceptions of mathematics as problem-solving and the reason it is taught in school. These findings indicate that their conceptions changed during the semester and as a result of participating in the constructivist mathematics content course. This is supported by the research of Steele (1994). Results of her study indicate that participation in a constructivist math course changed preservice teachers' conceptions of how mathematics is learned. At the end of the course, the subjects saw mathematics as a personal construction of knowledge, rather than memorization of facts.

Interviews were conducted to further investigate the attitudes of the students enrolled in the course about mathematics and the teaching of mathematics. When asked if there could be more than one answer to a math problem, all the interviewees responded there could be several ways to answer a math problem.

Interview Question: Can there be more than one answer to a math problem?

Interviewee One: Yes, I think our professor has shown us that! I think if you can prove it, I think you can."

Interviewee Two: "I think if you show good enough evidence and prove to a teacher why you think it's right. In this class we are showing him."

Interviewee Three: "It happens more often when you get to more accelerated math like calculus, but there are some that can have more than one answer like in geometry."

This strongly supports the responses of the subjects on the Teacher Candidate Survey when asked if there could only be one right answer. The results of the Teacher Candidate Survey indicated that 82% of the subjects believed that there could be more than one answer when doing mathematics.

Each interviewee described the math courses they had previously taken. All interviewees identified the teaching as by the lecture method. Each felt that this method was not the best for students. Comments were made by each that if self-discovery was encouraged in mathematics classrooms, it would lead to better understanding of concepts.

Interviewees were asked: How were your previous math courses taught?

Interviewee One: "Lecture... it was really boring, and I didn't get a whole lot out of it."

Interviewee Two: "They pretty much told us the way you do it."

Interviewee Three: "They mostly just taught us algorithms."

Interviewees were asked: Did this method work well with you?

Interviewee One: "No, not at all."

Interviewee Two: "Well, I'm not going to say I'm the best math person, but math is one of my favorite subjects. Compared to English, I would prefer to math any day."

Interviewee Three: "For me, yes, but I've always been good at math."

Interviewees were asked: What makes math more interesting for you?

Interviewee One: "Group work and self-discovery. I think self-discovery is really important. I feel like my confidence just goes up when allowed more self-discovery. The projects and working on projects and being able to explain something from your point of view, I think it really helps."

Interviewee Two: "Projects and hands-on stuff. I think if students work with hands-on things it is less boring and they can also grasp concepts better with something visual. Not showing them exactly how to do something helps them to better understand too."

Interviewee Three: "I like the hands-on stuff. I like getting into groups. I love origami! I like playing around with the shapes. It's really fun trying to figure out the process of the construction by myself."

This suggests that the participation in the constructivist classroom does affect attitudes and beliefs toward mathematics. The excitement and positive attitudes of the interviewees which were observed by the researcher supports research by Thompson, (1992). Thompson states that one way to help preservice teachers develop new conceptions of what can happen in their classrooms is to allow them to experience, *as students*, classrooms that enact a new approach to teaching. This new approach to teaching can thus carry over into their own teaching practices (Thompson, 1984).

Second Research Question

The second research question addressed how participation in a constructivist mathematics content course affects attitudes toward the teaching of mathematics. Again, the significant difference on the t-test, $\underline{t}(27)=2.24, p=.034$, of the Attitude Toward Mathematics and Its Teaching strongly suggests that participation in a constructivist mathematics content course does affect attitudes toward mathematics <u>and</u> the teaching of mathematics.

Two parts of the Teacher Candidate Questionnaire were carefully analyzed to determine how participation in the constructivist mathematics content course affected attitudes. A paired t-test, $\underline{t}(22)= -2.313$, $p=.030$, for Part II-Classroom Procedures showed only one significant difference in classroom procedures. When asked if they would present a mathematics problem deductively or inductively on a five point Likert-scale, with one being inductive and five being deductive, the subjects responded on the pre-test (M=3.3913), and on the post-test (M=3.9130). This indicated that the subjects prefer a more deductive approach in the math classroom. This finding suggests that the subjects felt this way because this was the common procedure of the instructor of the course. This finding is supported by research of Thompson (1992). Thompson found that teachers tend to teach as they were taught.

Part III of the Teacher Candidate Questionnaire addressed instructional strategies. Results of the paired t-tests were carefully analyzed to determine if participation in a constructivist mathematics content course affected attitudes toward the teaching of mathematics. Participants were asked to respond on a six point Likert-scale if they would use a particular type of instruction almost every day (1) versus not at all (6). The first significant difference was found when asked how often they would use whole class instruction. The results, $\underline{t}(22)=-2.554$, $p=.018$, indicated that the subjects would utilize whole class instruction less in their own classroom.

The second significant difference was found when asked if they would use computer-based drill and practice in their own classroom. Results, $\underline{t}(22)= -2.409$, $p=.025$, indicated they would use this strategy less often in their own classroom.

When asked about utilizing projects in a math classroom, results, $t(22) = -.289$, $p = .043$, indicated that participants would assign more projects to the students in their own math classroom. Two more significant differences were found when asked how often they would allow their students to read aloud or silently from the textbook. The results, $t(22) = -3.730$, $p = .001$ for reading aloud, and $t(22) = -4.085$, $p = .000$ for reading silently, indicated the students would have their students read from textbooks less often in their own classroom.

All of the findings suggest that participation in a constructivist mathematics content course does affect attitudes toward the teaching of mathematics. The findings also suggest that there was a significant difference in the responses because these instructional strategies were used by the instructor in their current constructivist mathematics course. These findings support the research by Koch (1992) which indicated that participation in a classroom in which a teacher utilizes constructivist instructional practices allows students the opportunity to change their misconceptions about how mathematics should be taught and learned.

Many of the interview questions were also used to address how participation in a constructivist mathematics content course affects attitudes toward the teaching of mathematics. It should be noted that interviewee one is the subject found to have the least positive attitude toward mathematics and its teaching as measured by the ATMAT. Interviewee two's score was in the middle twenty percent of the scores and interviewee three was found to have the most positive attitude. Each interviewee suggested that the method of self-discovery seemed to be more useful in the classroom. They responded that the lecturing and teaching students to work problems in only one way did not work well with them. They suggested that self-discovery would allow students to think for themselves which would lead to better understanding of content and better understanding the importance of why they are doing what they do, rather than just how to follow a rule.

Interviewees were asked: How were your previous math courses taught?

Interviewee One: "Lecture… it was really boring, and I didn't get a whole lot out of it."

Interviewee Two: "They pretty much told us the way you do it."

Interviewee Three: "They mostly just taught us algorithms."

Interviewees were asked: Did this method work well with you?

Interviewee One: "No, not at all."

Interviewee Two: "Well, I'm not going to say I'm the best math person, but math is one of my favorite subjects. Compared to English, I would prefer to math any day."

Interviewee Three: "For me, yes, but I've always been good at math."

These responses lead the researcher to the conclusion that methods of instruction assist in shaping attitudes toward a particular subject. Interviewee one had the least positive attitude toward mathematics and also felt the lecture method of instruction did not work well and is attributing this to the negative attitude in which she holds.

Interviewees were asked: What makes math more interesting for you?

Interviewee One: "Group work and self-discovery. I think self-discovery is really important. I feel like my confidence just goes up when allowed more self-discovery. The projects and working on projects and being able to explain something from your point of view, I think it really helps."

Interviewee Two: "Projects and hands-on stuff. I think if students work with hands-on things it is less boring and they can also grasp concepts better with something visual. Not showing them exactly how to do something helps them to better understand too."

Interviewee Three: "I like the hands-on stuff. I like getting into groups. I love origami! I like playing around with the shapes. It's really fun trying to figure out the process of the construction by myself."

The fact that each interviewee preferred hands-on activities and self-discovery as methods of instruction gives the researcher reason to believe that educators should begin to "move away" from the traditional lecture method of instruction and begin to enact the recent method of instruction, constructivism. This not only leads to better understanding of the concepts presented, but also contributes to shaping a more positive attitude toward mathematics and its teaching.

Interviewees were asked: Can there be more than one answer to a math problem?

Interviewee One: Yes, I think our professor has shown us that! I think if you can prove it, I think you can."

Interviewee Two: "I think if you show good enough evidence and prove to a teacher why you think it's right. In this class we are showing him."

Interviewee Three: "It happens more often when you get to more accelerated math like calculus, but there are some that can have more than one answer like in geometry."

These subjects changed their perception of how mathematics can be approached. They mentioned being taught only one right way to work problems. This finding has important implications regarding attitudes. If students are allowed to self-discover and find different ways to solve one problem, then they become more confident in their ability to do mathematics and their attitudes become more positive.

As noted before, the interviewees also suggested that working in groups was successful in mathematics because other people can be helpful in showing different ways to solve a problem and can also be a great confidence builder for the students who need assistance.

Interviewees were asked: Should group work be used in math classes? How much and why?

Interviewee One: "Yes, I think you can learn from one another. I know it helps my self-confidence if I couldn't solve a problem and someone in the group can show me how they solved it."

Interviewee Two: "For comparing answers I think group work is good, and it helps them work together as a team on problem-solving."

Interviewee Three: "Yes, if there is more than one answer other people may not see that answer, and someone else can explain it much better. Being in a group helps you have more input than just your own."

Learning in cooperative groups gave them the opportunity to hear how other students were thinking, to verbalize their own thinking, and to clarify for themselves their own approaches to thinking. Again, this allows students to become confident in their ability to do mathematics which can result in more positive attitudes.

The types of problems the interviewees would put on a test were problems similar to the problems presented in the present class. It was commented how these types of problems were worked through self-discovery, group-work, and not focusing on getting the right answer, but focused on an understanding of the process involved. This finding contradicts the finding of Reinke (1995) which found that preservice teachers who were not participating in a constructivist class felt that students should be given procedural rather than conceptual problems on tests.

> Interviewees were asked: What types of problems would you put on a math test?
>
> Interviewee One: "I would refer back to the problems we had done in class, or problems we had done in a group, discovery. I would go back to things like that."
>
> Interviewee Two: "I would do paper-folding and stuff like we have learned in class. I would ask them to do something like bisect an angle using paper-folding like we do in class. I would probably let them discover things."
>
> Interviewee Three: "Not necessarily that there has to be a right answer, but where they can show me that they kind of understand. You see the process going on in their head, but somewhere in there something just happened and it didn't click the right way or something. Maybe they just made a computational error."

These findings suggest that participation in a constructivist mathematics content course affects attitudes toward the teaching of mathematics. Participation in a constructivist classroom enables students to become aware of their attitudes and beliefs toward mathematics and its teaching and gives them the opportunity to change their misconceptions (Koch, 1992). Addressing these attitudes about mathematics and its teaching can prove useful in teacher education programs (Shealy, 1993).

Third Research Question

The third research question addressed how participation in a constructivist mathematics content course affects beliefs about the classroom environment. A College and University Classroom Environment Inventory (Fraser, 1994) was administered to validate that the course instructor implements constructivism in his teaching practices as addressed by the National Council of Teachers of Mathematics (NCTM) Professional Standards (1991).

Mean scores were computed for each individual item on the four-point Likert scaled survey. A mean score above a 3.5 indicates that the subjects more strongly agree with the item. A mean score below a 2.5 indicates that the subjects more strongly disagree with the item. Results of this survey were carefully analyzed by the researcher. The findings indicated several items which met these criteria. It was found that the instructor considers students' feelings and is friendly and considerate toward students. The students were given opportunities to express their opinions in classes, therefore the instructor does not dominate class discussions. The subjects felt like new and different ways of teaching were often used in the class, and the instructor frequently thought of unusual class activities that were clearly and carefully planned.

Interviews were also conducted to further investigate the attitudes of the students enrolled in the course about mathematics and the teaching of mathematics. They were also conducted to validate that the course instructor implements constructivism in his teaching practices as supported by the National Council of Teachers of Mathematics Professional Standards (1991). These standards provide guidelines for educators of preservice teachers. Standard One: Mathematics and mathematics education instructors in preservice and continuing education programs should model good mathematics by:

1. posing worthwhile mathematical tasks.

2. engaging teachers in mathematical discourse.

3. creating learning environments that support and encourage mathematical reasoning and teachers' dispositions and abilities to do math.

4. expecting and encouraging teachers to take intellectual risks in doing mathematics and to work independently and collaboratively.

5. representing mathematics as an ongoing human activity.

6. affirming and supporting full participation and continued study of mathematics by all students.

Standard Four: The preservice and continuing education of teachers of mathematics should develop teachers knowledge of and ability to use and evaluate:

1. instructional materials and resources.

2. ways to represent mathematics concepts and procedures.

3. instructional strategies and classroom organizational models.

4. ways to promote discourse and foster a sense of mathematical community.

5. means for assessing the students' understanding of mathematics.

Standard Five: The preservice and continuing education of teachers of mathematics should provide opportunities to:

1. examine and revise their assumptions about the nature of mathematics, how it should be taught, and how students should learn mathematics.

2. observe and analyze a range of approaches to mathematics teaching and learning, focusing on tasks, discourse, environment, and assessment.

3. work with a diverse range of students individually, in small groups, and in large class settings with guidance from and collaboration with mathematical professionals.

4. analyze and evaluate the appropriateness and effectiveness of their teaching;develop dispositions toward teaching mathematics.

Findings indicated several trends which showed evidence of positive attitudes toward mathematics and its teaching. Findings also revealed evidence of constructivist teaching practices in the course which was the focus of this research. The interviewees felt like self-discovery led to better understanding of concepts. They expressed that self-discovery was strongly encouraged in the content course and that the instructor often proved to them that there are several answers to one problem.

Interviewees were asked: What makes math more interesting for you?

Interviewee One: "Group work and self-discovery. I think self-discovery is really important. I feel like my confidence just goes up when allowed more self-discovery. The projects and working on projects and being able to explain something from your point of view, I think it really helps."

Interviewee Two: "Projects and hands-on stuff. I think if students work with hands-on things it is less boring and they can also grasp concepts better with something visual. Not showing them exactly how to do something helps them to better understand too."

Interviewee Three: "I like the hands-on stuff. I like getting into groups. I love origami! I like playing around with the shapes. It's really fun trying to figure out the process of the construction by myself."

In addition, the interviewees commented that the instructor in the involved course never shows the exact way to do a problem; he allowed them to discover the methods by facilitating class discussion permitting students to think for themselves.

Interviewees were asked: When you have a question in math do you want the teacher to give you the solution or to point you in a direction to help you continue working on the problem?

Interviewee One: "Point me in a direction. If the teacher is going to show you how to solve it then it's all about memorization, not really knowing the reason why. It seems like you go back and think about all the kids in the class asking, 'why do we have to learn this, or why do we have to do this' and it's always because you're being told how to do it and that's the only way. When you figure it on your own you just don't ask that question as often."

Interviewee Two: "Point me in the right direction. I want to be confident in what I'm doing on my own by the teacher saying, 'ok, right here, you need to check yourself.' If the teacher is saying 'wrong, wrong, wrong,' the kids are going to know they can't do it. Our instructor doesn't tell us exact answers, he makes us think for ourselves and how to do it."

Interviewee Three: "I want them to point me in the right direction so I can work it on my own. In our class now he allows us to work it out on our own. We, as a class, answer our own questions. I like it that way."

All the subjects wanted direction from the teacher when presented with a problem they did not understand. The role of the teacher, for them, became a facilitator whose responsibility is to create an environment where students could think and verbalize their ideas.

They felt that group work was important in mathematics, but one should try to work a problem by himself at first then come together as a group to compare the answers. The interviewees felt this was important because another person can be helpful in demonstrating different ways to solve a problem. This can be a great confidence builder for the student who needs assistance.

Interviewees were asked: Should group work be used in math classes? How much and why?

Interviewee One: " Yes, I think you can learn from one another. I know it helps my self-confidence if I couldn't solve a problem and someone in the group can show me how they solved it."

Interviewee Two: "For comparing answers I think group work is good, and it helps them work together as a team on problem-solving."

Interviewee Three: "Yes, if there is more than one answer other people may not see that answer, and someone else can explain it much better. Being in a group helps you have more input than just your own."

When asked what types of math problems would be put on a test they all referred to the types of problems presented in the involved course. These problems were conceptual problems which encouraged self-discovery. They were conceptual problems which enabled students to create alternative algorithms different from conventional procedures. They commented on how these types of problems were worked through self-discovery, group-work, and not focusing on getting the right answer, but that the students have an understanding of the process involved.

Interviewees were asked: What types of problems would you put on a math test?

Interviewee One: "I would refer back to the problems we had done in class, or problems we had done in a group, discovery. I would go back to things like that."

Interviewee Two: "I would do paper-folding and stuff like we have learned in class. I would ask them to do something like bisect an angle using paper-folding like we do in class. I would probably let them discover things."

Interviewee Three: "Not necessarily that there has to be a right answer, but where they can show me that they kind of understand. You see the process going on in their head, but somewhere in there something just happened and it didn't click the right way or something. Maybe they just made a computational error."

All interviewees in this study expressed the importance of teachers' attitudes in mathematics. All commented that it was extremely important for teachers to have a positive attitude. Each believed that students will not be enthusiastic learners if teachers do not display a positive attitude.

Interviewees were asked: How does the teacher's attitude about mathematics affect your learning of math?

Interviewee One: "It makes a huge difference! Who wants to walk into a classroom with a teacher who doesn't want to teach math? I had that experience in algebra, and now I walk into a classroom where everyone is talking and working things out and the instructor is going around the room helping and I think it makes a huge difference."

Interviewee Two: "I think it is important. If the teacher looks like they're not having fun or not energizing the students, then the kids won't want to learn it."

Interviewee Three: "If the teachers show that they can get as much enjoyment out of math as the students should, then the students are going to see that and they are going to want to learn it. The attitude of the teachers affect s the students a great deal."

These findings support the research of Raymond (1993) which found that one of the primary influences of preservice teachers' attitudes were those attitudes of prior teachers.

Finally, when asked to describe how math could be more interesting and fun, all commented, "self-discovery, hands-on activities, group work, and projects." These findings indicate that participation in a constructivist mathematics course does affect beliefs about the classroom environment. The findings give evidence that the instructor of the course does use constructivist teaching practices as supported by the National Council of Teachers of Mathematics Professional Standards (1991). Those practices include evidence of Standard 1: posing worthwhile mathematical tasks, engaging teachers in mathematical discourse, creating learning environments that support and encourage intellectual risks in doing mathematics, and working independently and collaboratively. Evidence of Standard 4 was also found by developing: ways to represent mathematics concepts and procedures,and ways to promote discourse and foster a sense of mathematical community. There was also evidence of Standard 5 by providing preservice teachers with opportunities to examine and revise their assumptions about the nature of mathematics, how it should be taught and learned, and to observe and analyze a range of approaches to mathematics teaching and learning by focusing on tasks, discourse, and environment. They were also provided with the opportunity to develop dispostions toward teaching mathematics. These findings support research by Ball (1988) which states that preservice teachers' feelings about mathematics is greatly influenced by past experiences. He also states the importance of the need to examine the influence of different kinds of teacher education experiences.

Conclusions and Implications to Teacher Education

The geometry content course investigated in this study was taught using constructivist teaching practices, using mathematical inquiry and investigation through problem solving in cooperative groups and whole class discussions, problem assignments, manipulatives, and projects. This approach to teaching mathematics content to elementary/middle school preservice teachers enabled the future teachers to experience a non-traditional approach to teaching and the modeling of good pedagogy. The completion of this course appeared to support the participants change in their attitudes about mathematics and the teaching of mathematics.

Results of this study combined with previous research findings indicate a greater need for future research addressing preservice teachers' attitudes about mathematics and its teaching. Past research shows the first step to help preservice teachers identify their attitudes/beliefs about mathematics and its teaching is to address these attitudes through reflection (Thompson, 1984). Addressing these attitudes/ beliefs about mathematics and its teaching is useful in teacher education programs (Shealy, 1993). Participation in a classroom in which a teacher utilizes constructivist instructional practices allows students the opportunity to change their misconceptions (Koch, 1992). Results of this study indicate that the participation in a constructivist mathematics course can result in a positive change in attitudes and allow the opportunity for students to change their misconceptions of how mathematics is taught and learned.

In order for educators to address the changing of attitudes in teacher education programs, they must first understand how and why students' attitudes change. Educators must find ways to help teachers become aware of the implied rules and beliefs that operate their classrooms and help them to examine their consequences (Thompson, 1992). The findings of this study coupled with the research of Thompson presents evidence that allowing preservice teachers the opportunity to confront their attitudes about mathematics teaching and learning can result in a positive change in attitudes toward mathematics and its teaching.

The second step in attempting to change preservice teachers' attitudes toward mathematics and its teaching and to help them to develop new conceptions of what can happen in their classrooms is to allow them to experience, as students, classrooms that enact a new approach to teaching (Thompson, 1992). This can happen since content courses make up an important part of teacher education programs.

One relatively new approach to teaching is the constructivist approach. In a constructivist classroom, knowledge must be actively constructed by the learner, not passively received from the environment (Lerman, 1989). Results of this study indicate that participation in a classroom which enacts the constructivist approach to teaching and learning enables a more positive change in preservice teachers' attitudes toward mathematics and its teaching. Attitudes of preservice teachers can carry over into their own teaching practices (Reyes, 1991) therefore, attitudes are an important part of the education of preservice teachers and must be addressed in teacher education programs (Raymond, 1993). What goes on in a classroom is directly related to the beliefs and attitudes teachers hold toward mathematics. Elementary/middle school teacher have a significant role in students' achievement, as well as their formulation of beliefs and attitudes toward mathematics. A teacher education program should better prepare all prospective elementary teachers to teach with a constructivist focus. Courses should use a constructivist approach to help preservice teachers gain the understanding of the mathematics they will be required to teach in their own classrooms.

Recommendations for Further Research

The area of teachers' attitudes toward mathematics and methods of instruction requires further research. The more educators know about teachers' attitudes and how they are influenced, the better teacher education programs can address the needs of preservice teachers. Recommendations for further research include:

1. Similar studies should be conducted with a larger sampling of preservice teachers in various teaching environments. The results could be compared to those of this study to determine if the findings are consistent.
2. A larger sample of interviewees should be used. This would increase the validation of the responses. Also, a shorter list of interview questions should be used. During the actual interview, secondary questions are elicited allowing the researcher to obtain responses to the primary questions in greater detail.
3. Further research should be conducted regarding the current instructional practices in university classrooms. A comparative study of traditional and non-traditional

instructional practices in university classrooms would be appropriate.

4. A longitudinal study of the students participating in this constructivist geometry content course could be conducted. Results would indicate whether or not these instructional practices transfer into the classroom when these students begin teaching.

5. A study could be conducted which investigates the relationships of methods of teaching to students' achievement.l

Although the results of this study indicate that this constructivist classroom influenced the preservice teachers' attitudes toward mathematics and its teaching, there are many other factors that need to be considered in future research. These factors include internal validity, history, maturation, testing, and instrumentation.

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APPENDIXES

APPENDIX A

PRESERVICE ROSTER

PRESERVICE TEACHER ROSTER

ID#	MAJOR	GENDER	PRETEST	POSTTEST
2	Elem. Education	Female	114	117
3	Elem. Education	Female	127	147
4	Early Childhood	Female	168	174
5	Other	Female	122	114
6	Other	Male	136	131
7	Elem. Education	Female	158	157
8	Early Childhood	Female	131	142
9	Elem. Education	Female	90	114
10	Early Childhood	Female	109	85
11	Other	Female	110	118
12	Other	Male	161	154
14	Elem. Education	Female	100	83
15	Early Childhood	Female	90	96
16	Elem. Education	Female	161	168
17	Other	Male	168	171
18	Early Childhood	Female	126	139
19	Early Childhood	Female	95	94
20	Early Childhood	Female	83	91
21	Elem. Education	Female	96	123
22	Elem. Education	Female	79	90
23	Elem. Education	Female	115	120
24	Elem. Education	Female	109	140
25	Other	Male	118	126
26	Elem. Education	Female	107	100
27	Elem. Education	Female	70	120
28	Elem. Education	Male	119	110
30	Elem. Education	Female	87	114
31	Elem. Education	Female	142	138

APPENDIX B

ATTITUDES TOWARD MATHEMATICS

AND ITS TEACHING SURVEY

Attitudes Toward Mathematics and Its Teaching Survey

ID# __________ Gender____________ Classification _______________

D.O.B. ___________________

DIRECTIONS: Each of the statements on this survey expresses a feeling which a particular person has toward mathematics. You are to express, on a six point, the extent of the agreement between the feeling expressed in each statement and your own personal feeling. The six points are: (1) Very Strongly Agree, (2) Strongly Agree, (3) Agree,(4) Disagree, (5) Strongly Disagree, (6) Very Strongly Disagree. You are to encircle the letter(s) which best indicates how closely you agree or disagree with the feeling expressed in each statement AS IT CONCERNS YOU TODAY. Please mark **only one** answer.

	VERY STRONGLY AGREE					VERY STRONGLY DISAGREE
*1. Mathematics is very interesting to me, and I enjoy math courses.	1	2	3	4	5	6
2. My mind goes blank, and I am unable to think clearly when doing math.	1	2	3	4	5	6
3. I feel a sense of insecurity when doing math.	1	2	3	4	5	6
4. Mathematics makes me feel uncomfort-able, restless, irritable, and impatient.	1	2	3	4	5	6
5. I approach math with a feeling of hesitation, resulting from a fear of not being able to do math.	1	2	3	4	5	6
*6. Mathematics is a course in school which I have always enjoyed studying.	1	2	3	4	5	6
7. It makes me nervous to even think about having to do a math problem.	1	2	3	4	5	6
*8. I feel a definite positive reaction to mathematics; it's enjoyable.	1	2	3	4	5	6
9. If I am confronted with a new mathematical situation, I can cope with it because I have a good background in mathematics.	1	2	3	4	5	6
10. I get flustered if I am confronted with a problem different from the problems worked in class.	1	2	3	4	5	6

	VERY STRONGLY AGREE				VERY STRONGLY DISAGREE	
11. I do not attempt to work a problem without referring to the textbook or class notes.	1	2	3	4	5	6
*12. I can draw upon a wide variety of mathematical techniques to solve a particular problem.	1	2	3	4	5	6
13. I do not feel that I have a good working knowledge of the mathematics courses I have taken so far.	1	2	3	4	5	6
*14. I believe that if I work long enough on a mathematics problem, I will be able to solve it	1	2	3	4	5	6
15. I have forgotten many of the mathematical concepts which I have learned.	1	2	3	4	5	6
*16. I learn mathematics by understanding the underlying logical principles, not by understanding rules.	1	2	3	4	5	6
*17. If I cannot solve a mathematics problem, at least I know a general method of attacking it.	1	2	3	4	5	6
18. I would hesitate tutoring anyone in mathematics in grades K-3.	1	2	3	4	5	6
19. I would hesitate tutoring anyone in mathematics in grades 4-6.	1	2	3	4	5	6
20. I would hesitate tutoring anyone in mathematics in grades 7-9.	1	2	3	4	5	6
21. I would hesitate tutoring anyone in mathematics in grades 10-12.	1	2	3	4	5	6
*22. Mathematics problems are a challenge; solving problems provides satisfactions similar to those of winning a battle.	1	2	3	4	5	6
*23. Problem solving fascinates me.	1	2	3	4	5	6

	VERY STRONGLY AGREE					VERY STRONGLY DISAGREE
*24. I have more confidence in my ability to deal with mathematics than in my ability to deal with other academic subjects.	1	2	3	4	5	6
*25. Mathematics classes provide the opportunity to learn values which are useful in other parts of daily living.	1	2	3	4	5	6
26. The idea of teaching mathematics to grades K-3 makes me feel insecure.	1	2	3	4	5	6
27. The idea of teaching mathematics to grades 4-6 makes me feel insecure.	1	2	3	4	5	6
28. The idea of teaching mathematics to grades 7-9 makes me feel insecure.	1	2	3	4	5	6
29. The idea of teaching mathematics to grades 10-12 makes me feel insecure.	1	2	3	4	5	6

APPENDIX C

TEACHER CANDIDATE

QUESTIONNAIRE

Student Number__________

TEACHER CANDIDATE QUESTIONNAIRE

The following questions were designed to discover how you think about mathematics and teaching mathematics. There are no right or wrong answers. Answer each question according to how you really feel.

PART I: CONCEPTIONS OF MATHEMATICS

1. To you, mathematics is **most like** what other subject you have studied in college? Explain why.

2. To you, mathematics is **least like** what other subject you have studied in college? Explain why.

3. List three words you think of when you think of the phrase "doing math."
   1.
   2.
   3.

4. Mark each statement either true **(T)** or false **(F)**.
   ____In mathematics, there can never be more than one right answer.
   ____There are some problems in mathematics with no answers.
   ____An answer in mathematics is always either right or wrong.
   ____If there were no people in the world, mathematics would still exist.

5. Which of the following would you prefer when solving mathematics problems? (Check one.)
   ____One method which works in all cases.
   ____More than one method which works in all cases.
   ____More than one method which works in some cases.
   Explain why.

6. Why do you think mathematics is taught in school?

7. Circle the letters of the activities from the list below with which you are the **most comfortable**. Underline the letters of the activities from the list below with which you are the **least comfortable**.

   a. working with whole numbers
   b. working with fractions
   c. working with percents
   d. solving story problems
   e. using equations
   f. studying areas and perimeter
   g. working with negative numbers
   h. working with discounts (buying and selling)
   i. working on applications

8. When doing mathematics, is it better to work with another person or to work alone? Please explain your answer.

9. When you don't know how to work a problem what is the best way to find out?

10. Put an **X** in the blank between the two words which best describes your feelings about mathematics.

A. Mathematics is PREDICTABLE.

____ (6)
____ (5)
____ (4)
____ (3)
____ (2)
____ (1)

Mathematics is SURPRISING.

B. Mathematics is DOUBTFUL.

____(6)
____(5)
____(4)
____(3)
____(2)
____(1)

Mathematics is CERTAIN.

C. Mathematics is INTERESTING.

____(6)
____(5)
____(4)
____(3)
____(2)
____(1)

Mathematics is BORING.

D. Mathematics is FIXED OVER TIME.

____(6)
____(5)
____(4)
____(3)
____(2)
____(1)

Mathematics is CHANGING.

E. Mathematics is CLEAR.

____(6)
____(5)
____(4)
____(3)
____(2)
____(1)
Mathematics is CONFUSING.

F. Mathematics is CONSISTENT.

____(6)
____(5)
____(4)
____(3)
____(2)
____(1)
Mathematics is VARYING.

11. Put an **X** in the blank between the two phrases which best describes where your feelings about mathematics fall between the two.

A. I am sure I could learn more advanced math.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
I don't think I could handle more advanced math.

B. Math has been my best subject.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
Math has been my worst subject.

C. I'd be proud to be an outstanding math student.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
I don't like people to think I'm smart in math.

D. I'll need math for my future work.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
Math will not be important to me in my life's work.

E. Knowing math is useful to me.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)

Knowing math is a waste of time.

PART II: CLASSROOM PROCEDURES

Put an **X** in the blank between the two phrases which most accurately describes where your thinking about teaching mathematics fall between the two.

17. When students have trouble, I would ask them leading questions.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)

When students have trouble, I would explain how to do it.

18. In class, I would have students frequently work together on assignments.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)

I would have students seldom work together on assignments in class.

19. I would encourage students to solve a given math problem the way I have demonstrated.

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)

I would encourage students to solve math problems in a variety of ways.

20. I would present a math topic first, then illustrate that concept by working several problems (deductive).

____ (5)
____ (4)
____ (3)
____ (2)
____ (1)

I would present the class with a series of similar problems, then together we would develop concepts and methods of solving the problems (inductive).

21. I would repeat certain topics (but more in depth) on a regular basis throughout the year.
____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
Once a topic is covered, I would not cover that same topic again except during reviews.

22. When teaching a new topic, I would spend 1/3 of the time trying to teach students to see the similarities and differences between new and previously learned math ideas.
____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
I would teach new topics with limited reference to previously learned math ideas.

23. I would keep the furniture arrangement the same for every math lesson.
____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
I would vary the furniture arrangement according to the lesson.

24. In my math class I would emphasize the basic computational skills 3/4 of the time or more.
____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
In my math class I would emphasize concept development 3/4 of the time or more.

25. Almost all my questions in math class could be answered with yes, no, or a number.
____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
Almost all my questions in math class would require the students to give explanations.

26. I would usually start a new math unit by giving examples and showing students how to work them.
____ (5)
____ (4)
____ (3)
____ (2)
____ (1)
I would not usually start a new math unit by giving examples and showing students how to work them.

PART III: INSTRUCTIONAL STRATEGIES

28. Circle the number which best describes how frequently you would use the following strategies in your math class. The five point scale is: (1) ALMOST EVERY DAY, (2) ONCE/WEEK OR MORE, (3) A FEW TIMES/MONTH, (4) ONCE/MONTH OR LESS, and (5) DON'T USE.

	ALMOST EVERY DAY					DON'T USE
a. Whole class instruction	1	2	3	4	5	6
b. Whole class discussion	1	2	3	4	5	6
c. Small work group	1	2	3	4	5	6
d. Films, film strips, videotapes	1	2	3	4	5	6
e. Individual seatwork during which I move around the room and help individual students.	1	2	3	4	5	6
f. Individual seatwork during which I do routine paperwork.	1	2	3	4	5	6
g. Posing open-ended questions	1	2	3	4	5	6
h. Gathering and organizing student responses.	1	2	3	4	5	6
i. Teacher demonstrations.	1	2	3	4	5	6
j. Analysis of data from statistics, probability, or other activities.	1	2	3	4	5	6
k. Analysis of information from newspapers, magazines, etc.	1	2	3	4	5	6
l. Assigning homework.	1	2	3	4	5	6
m. Discussing homework.	1	2	3	4	5	6
n. Giving written feedback on homework.	1	2	3	4	5	6
o. Simulations and games.	1	2	3	4	5	6

	ALMOST EVERY DAY					DON'T USE
p. Computer-based drill and practice.	1	2	3	4	5	6
q. Computer-based labs and simulations	1	2	3	4	5	6
r. Student reports.	1	2	3	4	5	6`
s. Student demonstrations.	1	2	3	4	5	6
t. Assigning projects to students	1	2	3	4	5	6
u. Assigning student reading in magazines or books.	1	2	3	4	5	6
v. Referring to the text for information.	1	2	3	4	5	6
w. Referring to reference books for information.	1	2	3	4	5	6
x. Students reading aloud from the textbook.	1	2	3	4	5	6
y. Students reading silently from the textbook.	1	2	3	4	5	6
z. Teacher-led question and answer session	1	2	3	4	5	6
aa. Teacher presentations more than 10 minutes long	1	2	3	4	5	6
bb. Quizzes	1	2	3	4	5	6
cc. Tests	1	2	3	4	5	6

APPENDIX D

COLLEGE AND UNIVERSITY

CLASSROOM INVENTORY

Student Number ________

COLLEGE AND UNIVERSITY
CLASSROOM ENVIRONMENT INVENTORY

The purpose of this questionnaire is to find out your opinions about the class you are attending right now. Your answers are completely anonymous. Please tell me your opinion about what this class is *actually* like. Thanks for your help.

DIRECTIONS: Circle the number that best describes what you think or feel about this class. The four-point scale is: (1) STRONGLY AGREE, (2) AGREE, (3) DISAGREE, and (4) STRONGLY DISAGREE.

	STRONGLY AGREE			STRONGLY DISAGREE
1. The instructor considers students' feelings.	1	2	3	4
2. The instructor talks rather than listens.	1	2	3	4
3. The class is made up of individuals who don't know each other well.	1	2	3	4
4. The students look forward to coming to classes.	1	2	3	4
5. Students know exactly what has to be done in our class.	1	2	3	4
6. New ideas are seldom tried out in class.	1	2	3	4
7. All students in the class are expected to do the same work, in the same way, and in the same time.	1	2	3	4
8. The instructor talks individually with students.	1	2	3	4
9. Students put effort into what they do in class.	1	2	3	4
10. Each student knows the other members of the class by their first names.	1	2	3	4
11. Students are dissatisfied with what is done in class.	1	2	3	4
12. Getting a certain amount of work done is important in this class.	1	2	3	4
13. New and different ways of teaching are seldom used in this class.	1	2	3	4
14 Students are generally allowed to work at their own pace.	1	2	3	4
15. The instructor goes out of his way to help the students.	1	2	3	4

	STRONGLY AGREE			STRONGLY DISAGREE
16. Students "clock watch" in this class.	1	2	3	4
17. Friendships are made among students in this class.	1	2	3	4
18. After the class, the students have a sense of satisfaction.	1	2	3	4
19. The group often gets sidetracked instead of sticking to the point.	1	2	3	4
20. The instructor thinks up innovative activities for students.	1	2	3	4
21. Students have a say in how class time is spent.	1	2	3	4
22. The instructor helps each student who is having trouble with the work.	1	2	3	4
23. Students in this class pay attention to what others are saying.	1	2	3	4
24. Students do not have much chance to get to know each other in class.	1	2	3	4
25. Class periods are a waste of time.	1	2	3	4
26. This is a disorganized class.	1	2	3	4
27. Teaching approaches in this class are characterized by innovation and variety.	1	2	3	4
28. Students are allowed to choose activities and how they will work.	1	2	3	4
29. The instructor seldom moves around the classroom to talk with students.	1	2	3	4
30. Students seldom present their work to the class.	1	2	3	4
31. It takes a long time to get to know everybody by his/her first name in this class.	1	2	3	4
32. Classes are boring.	1	2	3	4
33. Class assignments are clear so that everyone knows what to do.	1	2	3	4
34. The seating in this class is arranged in the same way each week.	1	2	3	4

	STRONGLY AGREE			STRONGLY DISAGREE
35. Teaching approaches allow students to proceed at their own pace.	1	2	3	4
36. The instructor is not interested in students' problems.	1	2	3	4
37. There are opportunities for students to express opinions in this class.	1	2	3	4
38. Students in this class get to know each other well.	1	2	3	4
39. Students enjoy going to this class.	1	2	3	4
40. This class seldom starts on time.	1	2	3	4
41. The instructor often thinks of unusual class activities.	1	2	3	4
42. There is little opportunity for a student to pursue his/her particular interest in this class.	1	2	3	4
43. The instructor is unfriendly and inconsiderate toward students.	1	2	3	4
44. The instructor dominates class discussions.	1	2	3	4
45. Students in this class are not very interested in getting to know other students.	1	2	3	4
46. Classes are interesting.	1	2	3	4
47. Activities in this class are clearly and carefully planned.	1	2	3	4
48. Students seem to do the same type of activities in every class.	1	2	3	4
49. It is the instructor who decides what will be done in our class.	1	2	3	4

APPENDIX E

INSTITUTIONAL REVIEW BOARD

FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

DATE: 12-03-98 **IRB #: ED-99-054**

Proposal Title: PRESERVICE TEACHERS' ATTITUDES TOWARD MATHEMATICS AND THE TEACHING OF MATHEMATICS IN AN INQUIRY-BASED GEOMETRY CLASSROOM

Principal Investigator(s): Kay Reinke, Dana Smith

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

Signature: Carol Olson (sc) Date: December 3, 1998

Carol Olson, Director of University Research Compliance
cc: Dana Smith

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

VITA

Dana Michelle Smith

Candidate for the Degree of

Doctor of Education

Thesis: PRESERVICE ELEMENTARY TEACHERS' ATTITUDES TOWARD MATHEMATICS AND THE TEACHING OF MATHEMATICS IN A CONSTRUCTIVIST CLASSROOM

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born in Lawton, Oklahoma, on August 2, 1968, the daughter of Howard and Sharon Smith.

Education: Graduated from Eisenhower High School, Lawton, Oklahoma, in December, 1985; received Bachelor of Science degree from Cameron University in May, 1992; received Master of Education degree from Southwestern Oklahoma State University in July, 1993; completed the Requirements for the Doctor of Education degree at Oklahoma State University in July, 1999.

Professional Experience: Classroom teacher, Oklahoma City Public Schools, Oklahoma City, Oklahoma, 1992-1998; graduate research and teaching assistant, Department of Curriculum and Instruction, Oklahoma State University, 1998-present.