PRESERVICE ELEMENTARY TEACHERS' PROBLEM POSING AND ITS' RELATIONSHIP TO MATHEMATICAL KNOWLEDGE AND ATTITUDES

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PREFACE

Teachers have an instrumental role in the implementation of problem posing in the teaching of mathematical concepts. Mathematics education reform has encouraged problem posing in the teaching of mathematics. The purpose of this study was to determine if a relationship existed between mathematical background and attitudes of preservice elementary teachers and the ability to problem pose. Mathematical background scores were obtained from high school and college mathematics courses successfully completed. Attitudes were scored encompassing four areas. Subjects problem posed with multiplication and division of fractions.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Problem posing is a method of teaching that incorporates modeling of problem solving skills by the teacher. In problem posing the generating of a story or situation to convey mathematical concepts is modeled. The teacher's role has changed from merely demonstrating procedures to helping students build on their mathematical thinking and problem solving (Fennema, Carpenter, Franke, Levi, Jacobs & Empson, 1996). In the *Professional Standards for Teaching Mathematics*, the National Council of Teachers of Mathematics [NCTM] recommends that teachers model and emphasize aspects of problem solving, including formulating and posing problems (NCTM, 1991). The NCTM in *Curriculum and Evaluation Standards for School Mathematics* (1989) recommends problem solving as the central focus of the mathematics curriculum in grades K-4. It further states problem solving should be "a primary goal of all mathematics instruction" (p. 23).

Background of the Study

Problem posing as a recommended reform in mathematics education must explore the whole picture of preservice elementary teachers. To look at only mathematics teachers' conceptions separate from research on teachers' knowledge of mathematics will result in an incomplete picture (Grouws, 1992). Preservice elementary teachers posses a diversified background in mathematics. The math courses completed at the high school and university levels range from algebra I to calculus.

Preservice elementary teachers attitudes towards mathematics are less favorable than the general university population (Kelly & Tomhave, 1985; Rech et al., 1993). The attitudes of preservice teachers play a crucial role in the implementation of reform methods in mathematics education. Strategies for improving mathematics teaching include solid understanding of mathematics and confidence in the ability to teach mathematics (Stepek & Gearhart, 1997). Without mathematical knowledge and favorable attitudes towards mathematics, the desire to reform mathematics education is limited according to Sepek & Gearhart. Research has provided the variables to examine problem posing of multiplication and division of fractions.

The research from the Third International Mathematics and Science Study [TIMSS] compared the classroom time plan of Japanese schools compared to United States schools. The classroom time factor was very different between the United States and Japan in the *Moderator's Guide* (TIMSS, 1997). The first ten to fifteen minutes of a Japanese classroom activity includes an introduction to a complex problem and the posing of a question (p. 57). In the United States, the first ten to fifteen minutes of classroom activity included checking of homework, exercises on boards, or seatwork (p. 57). Problem posing is a method heavily incorporated into Japanese teaching.

The *Professional Standards for Teaching Mathematics* states "the teacher of mathematics should orchestrate discourse by posing questions and tasks that elicit, engage, and challenge each student's thinking" (NCTM, 1991). In teaching multiplication and division of fractions, future teachers should develop a means to challenge student thinking, rather than merely stand before the class and tell the student how the algorithms work. E.A. Silver believes that

> Despite the importance of problem posing as a form of mathematical activity, and despite interest in its use as an instructional activity, there has been little systematic investigation of mathematical problem posing as a cognitive process involving generating a problem from a situation or an experience. (Silver, 1996, p. 294)

The problem posing in this study deals with the prospective teachers' ability to generate problems from a situation or experience as a means of teaching multiplication and division of fractions.

Statement of the Problem

There is no research about the relationship between preservice elementary teachers' ability to problem pose about multiplication and division of fractions and the mathematical background and mathematical attitudes of the preservice teacher. We know that mathematical attitudes and mathematical background affect preservice elementary teachers. We do not know what variables affect performance in problem posing as a method to teach a mathematical concept. The focus of this research is an attempt to gain insight into the possibility of a relationship existing between problem posing and mathematical background and mathematical attitudes. There is little research on what specific knowledge will enable teachers to teach so that students learn and understand mathematics better.

Purpose of the Study

The purpose of this study is to determine the nature of the relationship between mathematical background, attitudes of preservice elementary teachers, and the ability to problem pose about multiplication and division of fractions. If a relationship exists, the degree of relationship will be explored.

Significance of the Study

Various studies have shown the effects of attitudes and mathematical background on preservice elementary teachers (Fennema & Sherman, 1976: Minato, 1996). Research has documented the need for problem posing in the mathematics classroom (Silver, 1996). The purpose of the current study was to identify the variables that might be related to performance. If a relationship was found between these characteristics and problem posing of preservice elementary teachers this would give direction to subsequent studies. This relationship would play an important role on the teachers' ability to problem pose in the classroom. This study will add to or refine research in the area of problem posing as teaching a mathematical concept of multiplication and division of fractions by preservice elementary teachers.

Definition of Terms

Definition of significant terms as defined by the researcher for this study.

Problem Posing – Generating a problem from a situation or experience as a means of teaching a mathematical concept.

Mathematics Attitudes – One's belief related to mathematics. This will include attitudes toward success in mathematics, confidence in learning mathematics, effectance motivation in mathematics and usefulness in mathematics (Fennema-Sherman, 1976).

Mathematics Background – Mathematics courses successfully completed at the high school and college levels including remediation non-credit college mathematics courses.

Research Questions

The basis for the following questions is based on the review of selected literature that asks:

1. What relationship exists, if any, between preservice elementary teacher's mathematical background (i.e., see definition of terms) and problem posing about multiplication and division of fractions?
2. What relationship exists, if any, between preservice elementary teacher's attitudes (i.e., see definition of terms) and problem posing about multiplication and division of fractions?

Assumptions

The assumption was made that the majority of students admitted into the teacher education programs are students who will become future teachers. This affects the study by the composition of students that chose teacher education at the elementary level as a major at the university. Also, it was assumed that inadequate mathematical background was defined as insufficient mathematics courses in high school with possible remediation courses at the college level. One other assumption was the majority of preservice teachers have not been exposed to problem posing as students in their academic preparation.

Limitation of Study

The sampling for this study was limited to a four-year mid-sized university located in a metropolitan area in the midwestern section of the United States. This study was conducted with the population of thirty-seven preservice elementary teachers enrolled in the first course of a required twelve-hour mathematics sequence.

Organization of Study

This research study will be organized into five chapters. Chapter I consists of the introduction, statement of the problem, purpose, significance, definitions, questions, assumptions, limitations and organization. Chapter II includes a brief review of the literature including contextual framework. Chapter III describes the methodology with detailed descriptions of the subjects, instrument, research design, procedure and analysis of data. Chapter IV presents the results from data coding and analyses. The tables are arranged to correspond to the research questions. In Chapter V, there are discussions of results as well as the implications of findings.

Summary

In this chapter a background review helped frame the research questions. The statement of the problem, purpose of the study, significance of the study, definition of terms, research questions, assumptions, limitation of study, and organization of the study were stated. The research questions refer to the relationship between preservice elementary teachers' ability to problem pose about multiplication and division of fractions and the mathematical background and mathematical attitudes of the preservice teacher.

CHAPTER II

REVIEW OF LITERATURE

The literature review that will be presented discusses the relevant issues concerning the mathematical attitudes and mathematical backgrounds of preservice elementary teachers. By examining the prior research, a framework will be developed for understanding the focus of this study. The review will begin with a discussion about mathematics background. Next, key aspects of attitudes will be examined followed by a focus on problem posing.

Mathematics Background

Improvement in mathematics education begins with improvement of mathematical knowledge (Steffe, 1990). Deeper understanding of mathematical knowledge and its construction are essential. Insufficient pedagogical emphasis has been placed on developing an understanding of the most basic and elementary concepts of arithmetic in preparing preservice elementary teachers (Zazkis & Campbell, 1996). In mathematics, it is key to have a conceptual understanding of these concepts (Zazkis & Campbell, 1996). In their study of preservice elementary teachers, Zazkis and Campbell stated that conceptual understanding in algebra requires a firm grounding in conceptual arithmetic. Mathematical knowledge is crucial in helping students build on their mathematical thinking and problem solving.

The mathematical knowledge of teachers relates to existing knowledge and its construction. Teachers' knowledge is a major factor in mathematical instruction (Fennema & Franke, 1992). The mathematical background of the teacher plays an important part in the choice of mathematical instruction.

Girls have a tendency to not enroll in higher level mathematics in high school and college. Most students are likely to enroll in courses in which they think they will do well. Expectations for success depend on the confidence the individual has in his/her intellectual abilities (Updegraff & Eccles, 1996) and, even though girls receive slightly higher mathematics grades in high school, they report lower confidence in mathematics than boys. The majority of preservice elementary mathematics courses are comprised of female students. Thus, confidence affects the enrollment in mathematics courses therefore affecting the mathematical background of preservice teachers.

Curriculum reforms as called for by the *Standards* and research depend on the classroom teachers' mathematical knowledge for success (Pejouhy, 1990). Problem-solving activities are generated through the teacher's own ability to problem pose. Teachers must have sufficient mathematical knowledge to enable students to problem solve because mathematical situations posed by teachers determine the direction for the creative problem solving by students (Gonzales, 1994). There is little evidence concerning specific mathematical background knowledge that would enable preservice teachers to teach mathematics with problem posing. If mathematical knowledge is a variable relating to problem posing, there is no research relating the mathematical knowledge needed by preservice elementary teachers to be able to problem pose.

Mathematics Attitudes

Research has that teacher attitudes are incorporated into problem-solving activities. Attitudes affect how we study mathematics and its learning (Fennema-Sherman, 1976). Self-confidence is related to what one is willing to attempt and attitudes impact the ability to implement new ideas. Problem solving attitude are similar to effectance motivation (Fennema-Sherman, 1976). Thus, the ability to problem pose is influenced by one's attitude towards mathematics.

Attitudes toward math predict math anxiety and math related choices (Hackett, 1985). Mathematical attitudes have an influential role in the amount of time an elementary teacher may spend on mathematics in the classroom. Students of teachers whose beliefs were in alignment with the NCTM *Standards* had significantly different attitudes about mathematics (Carter & Norwood, 1997). In this study, these mathematical attitudes included students working hard to solve the problem and striving for understanding. The teachers were able to construct questions to elicit understanding from the students. Thus, the research shows that confidence development is a contributing part of mathematics teacher effectiveness.

Attitudes also have been affected by Cognitively Guided Instruction [CGI] among preservice elementary teachers (Vacc & Bright, 1999). CGI involves the student constructing his/her own knowledge in solving mathematical problems. The preservice teachers involved in this study showed a positive increase in attitudes, with the greatest increase of favorable attitudes was indicated during student teaching. Research has shown that extensive field experience with theory from the classroom is essential for changing preservice teachers' beliefs (Kagan, 1992; Vacc & Bright; 1999).

Individuals' attitudes are a major determinant of persistence, choice of activity, and effort (Bandura, 1977; 1997). When individuals have a positive sense about their ability and efficacy to do a task, they are more likely to choose to do the task, persist at it, and maintain effort. Preservice elementary teachers' efficacy has been shown to be an important component of the classroom instruction.

The teacher's sense of efficacy, however, is undermined in new reform of mathematics (Smith, 1996). With reform shifts to understanding, explanation, problem solving, and posing mathematical questions, teachers are overwhelmed about how to teach. According to Smith, telling mathematics allows teachers to build a sense of efficacy. The reform challenges that teachers can only act indirectly by creating settings in which students learn mathematics. Teachers with a great sense of efficacy attribute a major causal role in students learning mathematics. Findings from research state preservice teachers are resistant to change in beliefs (Calderhead & Robson, 1991; Holt-Reynolds, 1992; Kagan, 1992). Mathematics reform may have little affect on changing preservice teacher attitudes. It is difficult for existing beliefs to be reorganized according to Calderhead and Robson.

The confidence one has about outcomes of a specific behavior is a variable in determining one's actions (Soodak & Podell, 1996). Accordingly, their study of low teacher efficacy dealt with teacher confidence levels. The teachers had a sense of futility regarding the impact of their work. Teacher confidence affects the implementation of new reform in mathematics calling for problem posing by the teacher.

Research has shown attitudes and mathematical knowledge to be improved significantly with mathematics methods courses at the university level (Quinn, 1998). A positive attitude toward mathematics is essential for educators to teach mathematics (Isenberg & Altizer-Tuning, 1984; Kerr & Lester, 1982). Many preservice elementary teachers begin the program with negative attitudes, but positive changes in attitudes toward mathematics have been acquired through a hands-on manipulative approach in methods classes for preservice elementary teachers (Putney & Cass, 1998). Part of NCTM policy endorses that teachers with positive attitudes develop positive student attitudes toward mathematics. Preservice teachers must address their own negative attitudes towards mathematics and can change their attitudes if teacher preparation courses provide current research and content (Hill, 1997).

Problem Posing

It is well researched and recognized that problem posing is an important aspect of the mathematics curriculum and is the foundation of mathematical activity (Brown & Walter, 1993: Kilpatrick, 1987: Moses, Bjork, & Goldenberg, 1990: Silver, 1990, 1994). The teacher must be able to generate mathematical situations for problem solving by the student to occur. There is little known about a teacher's ability to create his or her own problems as a method of problem solving and the teaching of a mathematical concept. Mathematics reform calls for developing problem situations that reflect diversity and engage children in investigating, formulating, representing, and reasoning. Teachers should be able to pose meaningful and enticing problems (NCTM, 1989).

English recommends a problem-posing classroom in which students pose and problem solve their own problems (1997). The necessity of the teacher to facilitate problem posing for students is at the center of the learning process. The teacher must understand the difference between problem solving and problem posing in order to establish such a classroom that elicits problem posing from students.

Studies have found that having students engage in some kind of rewriting of story problems has a positive influence on their word problem-solving achievement and attitude towards mathematics (Silver, 1996). The results suggested that even simple experiences with mathematical problem posing have a positive impact on students. The students' problem-solving performance was highly correlated with their problem posing performance. Problem posing and solving may be adapted to posing-orientation instruction.

In *A Blueprint for Problem Posing* Gonzales suggests that the teacher should emphasize posing questions and ask students to pose a related problem after using Polya's problem solving methods (1973). There are five phases of teaching problem posing to students. Phase one is getting started. Phase two is posing a related problem. Phase three is generating a task; there is no built in problem. The student is left to pose a problem inspired by the data. Phase four is finding mathematical situations. The last phase comprises generating the problem. This article discussed guided instruction to teach problem posing. The article did not deal with problem posing by the teacher, but activities to enhance problem posing by the students.

The article concludes by stating that problem posing has not been given proper attention by the mathematics community (English, 1998). There is a great deal of research on students and teachers ability to solve problems, but little information exists on problem posing. We need to develop new problem experiences that we present to children (Broody & Standifer, 1993: NCTM, 1989). National Council of Teachers of Mathematics position statements include acknowledging and building on children's accumulated knowledge by including children's experiences.

The importance of teachers learning to teach in the ways established by the NCTM Standards must be a goal (Schifter, 1999). Opportunities are needed for teachers to learn new approaches, as research has shown because traditional classrooms and instructional practices are neither providing the best opportunities for our students nor serving them well.

The traditional mathematics curriculum does not acknowledge what the student thinks or understands from everyday experiences like playing on the computer (Burrill, 1998). Problem posing consists of generating mathematical situations related to the daily life of students. Without the link, traditional curriculum is part of the past. Traditional mathematics teaching has focused on computational procedures. The TIMSS data on United States traditional curriculum provided few opportunities for students to solve challenging problems. The United States classrooms provided the most repetition of routine computation.

Teachers need to be given the opportunity to assimilate new ideas from research as recommended by the Standards (Holbeineston, 1998). Training is needed for preservice teachers and teachers in the field in order to assimilate new ideas. Support of teachers is essential for mathematics reform according to Holbeineston.

University environments can either help or hinder the development of knowledge of pedagogical tools and practices (Brown & Smith, 1997). Teacher preparation for the classroom has a responsibility of developing methods to help implement reform. Teachers need to be given the opportunity to assimilate new ideas from research as recommended by the Standards (Holbeineston, 1998). Training is needed for preservice teachers and teachers in the field. Support of teachers is essential for mathematics reform.

Research has shown students taught by CGI have demonstrated greater achievement in problem-solving situations (Villasenor & Kepner, 1993). CGI teachers problem pose with their students and ask students to explain how they arrived at their solutions. Specific strategies are not taught. The first level of CGI is the opportunity for students to solve problems. The teacher must be able to pose a mathematical problem to guide the student's mathematical learning and knowledge of students thinking helps increase mathematical knowledge of teachers (Fennema et al., 1996).

The teacher able to problem pose will allow children to actively construct their own knowledge (NCTM, 1998). Cognitively Guided Instruction (CGI) is a curriculum for teaching mathematics based on research (Fennema, Carpenter, Franke, & Carey, 1993). Its format for word problems comprises meaningful context for students. The teacher's ability to problem pose would play a crucial part in implementation of CGI curriculum.

In the CGI classroom, the teacher must initiate problem solving. The teaching strategy of asking questions that facilitate and promote children's critical thinking is a component of problem posing. Research states that students usually solved word problems written by the teacher (Fennema, et al., 1993). The importance of the teacher being able to problem pose to implement CGI in the classroom is fundamental. Students should be presented with challenging problems and communicate mathematically in solving the problem (Clark & Kamii, 1996). If students have experiences in their classrooms that encourage construction they will engage in mathematical activity encompassing many areas of mathematics (Reynolds & Wheatley, 1996).

In an article on problem posing, Walter and Brown (1977) suggest

> For a long time there has been general interest among researchers, teachers, and curriculum writers in the area of problem solving in the mathematics curriculum. The other side of the coin – problem posing – has been a neglected subject, however. (p.5)

Students cannot be expected to be problem solvers without problem posers as teachers. The mathematical knowledge of today provides the opportunity for rich problem posing, and understanding the different roles as problem solver and problem poser is imperative for preservice elementary teachers (Gonzales, 1994).

Freire theorizes problem-posing education that involves the teacher becoming both instructor and student with dialogue as the pedagogical process (1996). As the teacher communicates with students the teacher learns from them. The focus for all is to reflect and pose problems. This in turn provides opportunities for problem posing about other issues.

Generating problems in the problem-posing process can reveal strengths and weaknesses of the teacher (Bratina, 1996). Preservice elementary teachers encounter difficulties in generating problems. Wide varieties of mathematical misconceptions are reported in research when preservice teachers generate their own problems (Zaslavsky &

Peled, 1996). The act of teaching should incorporate on the spot problem posing. In the course of teaching, a deeper conceptual understanding provides more ease at producing problems to solve (Zaslavsky & Peled, 1996).

Reform in mathematics education advocates that mathematics curriculum be a connecting force rather than a series of unrelated topics (NCTM, 1989, 1991). The art of problem posing provides the connection between various parts of mathematics and daily life.

Word problems with multiplication and division of fractions compared to addition problems with fractions are the most difficult compared to addition problems with fractions in student performance (Aksu, 1997). The difficulty in problem solving with multiplication and division is a result of conceptual knowledge of fractions with the operation (Aksu, 1997).

Summary

The most significant aspect of this research places problem posing at the core of a mathematics curriculum involving mathematical discourse and problem solving. For students to become problem solvers, teachers must become problem posers. Mathematical attitudes affect how preservice elementary teachers teach mathematics and the mathematical background of the preservice elementary teacher influences mathematical choices within the classroom. These variables comprise this research study on problem posing.

CHAPTER III

METHODOLOGY

This chapter will describe the subjects of this study, the instruments used and the design of the study. The research study was conducted to determine if a relationship exists between mathematical background and preservice elementary teachers' problem posing about multiplication and division of fractions and if a relationship exists between attitudes of preservice elementary teachers problem posing about multiplication and division of fractions. This chapter also will explain procedures implemented throughout the research and the statistical procedures used in the data analysis. Research design and research procedure will be explained in detail.

Subjects

The subjects for this study were thirty-seven preservice elementary teachers at an urban mid-sized four-year university located in a metropolitan area of a midwestern state. Prospective elementary teachers were chosen as the target subject population for this study. The subjects chosen were enrolled in the first course of the required twelve hours of mathematics because the first mathematics course includes fractions, which is the math concept that was chosen for the problem posing research. Research has shown the Open Approach, which involved problem posing worked well with elementary students (Nohda, 1984). The *Curriculum and Evaluation Standards for School Mathematics* recommends that the teacher create problem situations that are appropriate for students (NCTM, 1989). Preservice elementary teacher requirements for state certification include a twelve-hour sequence of mathematics that consists of four courses. The four courses that satisfy those requirements are Structures of Mathematics, Foundations of Geometry and Measurement, Analysis of Data and Chance, Patterns and Functions. The subjects for this study were enrolled in the first course, Structures of Mathematics, of the twelve-hour mathematics sequence.

Instruments

The Fennema-Sherman Mathematics Attitudes Scales (1976) were used to measure subject's attitudes related to mathematics. The scales chosen assess attitudes related to this research study. Four areas of the Fennema-Sherman Mathematics Attitudes Scales were chosen for this research study. First, the attitude towards success in mathematics scale was chosen to measure the degree to which preservice elementary teachers anticipate positive or negative consequences as a result of successful mathematics. The confidence one has in outcomes helps determine one's actions (Soodak & Podell, 1996). Second, the confidence in learning mathematics scale was intended to measure confidence in one's ability to learn and to perform well on mathematical tasks. Expectations depend on the confidence of the individual with their abilities (Updegraff & Eccles, 1996). Third, the effectance motivation scale was intended to measure effectance from lack of involvement to active involvement in mathematics. The attitude of the individual determines persistence, choice of activity and effort (Bandura, 1977; 1997).

Fourth, the mathematics usefulness scale was intended to measure beliefs about the usefulness of mathematics now and in the future. Problem posing's format for word problems consists of meaningful context for students(Fennema, Carpenter, Franke & Carey, 1993). The scales were as follows: (a) attitude toward success in mathematics [ATSMS]; (b) confidence in learning mathematics [CLMS]; (c) effectance motivation in mathematics [EFMS)] (d) usefulness of mathematics [UMS]. Each scale consisted of six positively stated and six negatively stated items with five response alternatives: strongly agree, agree, undecided, disagree and strongly disagree. Each response was given a score from one to five. For each scale, the weight of five was given to the response that represents a positive effect on learning of mathematics. Each subject's total score on each of the scales was their cumulative total and the higher the score, the more positive their attitude. The split-half reliabilities for the scales used were as follows: Attitude towards success in mathematics 0.87; Confidence in learning mathematics 0.93; Effectance motivation in mathematics 0.87; Usefulness in mathematics 0.88 (Fennema & Sherman, 1976).

A questionnaire form was used to obtain information about successful completion of high school and college mathematics courses including non-credit mathematics courses. A college transcript was attached verifying completed college mathematics courses. The purpose of this evaluation was not only to evaluate mathematical background, but also determine if a pattern emerged indicating mathematical background weakness.

The problem-posing task was assigned to subjects on separate sheets of paper. The task consisted of the following two questions: (1) What problem would you pose to your students to teach multiplication of fractions? Be as detailed as possible. Please respond in writing using as many pages as necessary and (2) What problem would you pose to your students to teach multiplication of fractions? Be as detailed as possible. Please respond in writing using as many pages as necessary. There was training of professionals on this form to assure agreement. The training is discussed in the section on research procedure.

Research Design

The review of the literature revealed a possible relationship between mathematical background and attitudes related to problem posing. Therefore, a correlational method was employed to determine whether or not a relationship existed. Nine scores were obtained for all members of the selected sample including (a)one score for each attitude, totaling four, (b) one score for each mathematical background, totaling three and (c) one score for each problem posing, totaling two. Each attitude and mathematical background was paired with problem posing of multiplication with fractions and problem posing with division of fractions. The paired scores were correlated using Spearman's rho.

Research Procedure

Two classes enrolled in the Structures of Mathematics course were selected for the study. These classes were chosen due to the course content that included fractions. The course content consisted of structure of number systems, operations, properties, ordering and number theory beginning with natural numbers and extending through the set of all real numbers. This course was specifically designed for elementary education, special education and early childhood majors. Each subject was given the Fennema-Sherman Mathematics Attitudes scales related to this research. The questionnaire form with the mathematical background questions was administered. The problem posing task was administered after the subjects had finished the chapter on fractions in the Structures of Mathematics course. A correlation method was employed to determine whether or not a relationship existed.

Training of three professionals familiar with problem posing was conducted to see if there was agreement of scores. Training included scoring of responses with discussion. Discussion included scoring of ambiguous examples. Student sample responses were scored by the following criteria.

1. A zero score comprised one of the following: mathematics incorrect, telling how to multiply or divide fractions using the algorithm, questions without fractions or no question at all.
2. A one was scored when the subject used a mathematical concept of multiplication or division of fractions correctly using the algorithm.
3. A two was scored when the subject posed a story or situation without multiplication or division of fractions.
4. A three was scored when the subject posed an unsolvable situation or story comprising multiplication or division of fractions.
5. A four was scored when the subject posed a situation or story comprising multiplication or division of fractions correctly, such as telling with a story.
6. A five was scored when the subject posed a situation or story generating multiplication or division of fractions correctly; the subject did not tell to multiply or divide.

Data Analysis

After the results were obtained, comparisons were made to determine if any relationship existed between attitudes, mathematical background and problem posing of multiplication and division of fractions. If the score indicated $.00 < r_{xy} < 1.00$ a positive correlation existed. If the score indicated $-1.00 < r_{xy} < .00$ a negative correlation existed. If $r_{xy} = .00$ no relationship existed. SPSS Base 9.0 statistical software package was used to analyze data.

Summary

The subjects were preservice elementary teachers that completed four mathematical attitude scales, one mathematical background questionnaire, and two problem posing tasks. Scores from both mathematical background and mathematical attitudes were paired with scores from problem posing multiplication and division of fractions. Data was correlated according to the research design and procedure.

CHAPTER IV

RESULTS

This research study dealt with the ability of preservice elementary teacher's ability to problem pose as a method of teaching multiplication and division of fractions correlating with the mathematical background and attitudes of preservice teachers. In order to answer the research questions of what relationship exists, if any, between preservice elementary teacher's mathematical background and attitudes with problem posing about multiplication and division of fractions a mathematical background form, four attitude scales and a problem posing task was administered to preservice elementary teachers. The possibility of a relationship existing between problem posing and these variables was explored. This chapter includes a presentation of the descriptive results and the results of the correlations with the problem posing task.

Mathematical Background

In order to answer the first research question of what relationship exists, if any, between preservice elementary teacher's mathematical background and problem posing about multiplication and division of fractions, three assessments were used for mathematical background. The first assessment was mathematical background courses successfully reported from high school by the subjects. The second assessment was non-credit mathematics courses successfully completed at the college level as recorded on college transcripts. The third assessment was college level mathematics courses successfully completed as recorded on college transcripts. The college transcripts were used to determine non-credit and credit college mathematics courses successfully completed.

Scores of the thirty-seven subjects ranged from zero to five on the mathematical background assessment of high school courses (see Table I). This assessment included the subjects' reported high school mathematics courses they had successfully completed. Successful completion was defined as passing the course with a grade of "D" or better. A score of one indicated successful completion of Algebra I or one year of college preparatory mathematics. A score of two was defined as successful completion of algebra I and geometry or two years of college preparatory mathematics. A score of three was defined as successful completion of algebra I, geometry, and algebra II or three years of college preparatory mathematics. A score of four was defined as successful completion of algebra I, geometry, algebra II, and trigonometry or four years of college preparatory mathematics. Precalculus was included as trigonometry due to the combination of algebra III and trigonometry in that course. A score of five indicated successful completion of calculus in high school. Fifty one percent of the students had completed three years of college preparatory high school math. One had not completed any of the college preparatory math courses. Four or 10.8% had completed calculus in high school. Six or 16.25% had completed four years of mathematics in high school that included trigonometry.

TABLE I

HIGH SCHOOL MATHEMATICS COURSES OF PRESERVICE ELEMENTARY TEACHERS

Rank	Frequency	Percent
0	1	2.7
1	2	5.4
2	5	13.5
3	19	51.4
4	6	16.2
5	4	10.8

The second score for mathematical background was determined from college transcripts recording non-credit mathematics courses (see Table II). The scores ranged from zero to two. A zero was used for those subjects without any non-credit mathematics courses on their transcript. A score of one showed successful completion of elementary algebra on the transcript. A score of two showed successful completion of intermediate algebra or both elementary algebra and intermediate algebra. Of the thirty-three subjects with transcripts, fifteen or 40.5% scored a two on the zero level. Seventeen or 45.9% scored a zero with non-credit mathematics courses on their transcript.

TABLE II

NON-CREDIT MATHEMATICS COURSES AT THE UNIVERSITY OF PRESERVICE ELEMENTARY TEACHERS

Rank	Frequency	Percent
0	17	45.9
1	1	2.7
2	15	40.5

The third score was determined from college transcripts scoring the college level mathematics courses successfully completed (see Table III). A score of zero was defined as no college mathematics courses on transcript besides the required mathematics courses for elementary majors. A score of one indicated the non-credit elementary algebra course on the transcript. A score of two indicated non-credit intermediate algebra or both non-credit elementary and non-credit intermediate algebra courses on the transcript. A score of three indicated Mathematics for General Education on the transcript. A score of four indicated College Algebra on the transcript. A score of five indicated College Algebra and Trigonometry or Calculus on the transcript. Eight or 21.6% had successful completion of College Algebra on their transcripts. Seven or 18.9% scored a two with intermediate algebra on their transcript. Six or 16.2% had no mathematics courses on their transcript. Five or 13.5% had Mathematics for General Education on transcript.

TABLE III

COLLEGE MATHEMATICS COURSES OF PRESERVICE ELEMENTARY TEACHERS

Rank	Frequency	Percent
0	6	16.2
1	1	2.7
2	7	18.9
3	5	13.5
4	8	21.6
5	6	16.2

Two significant correlations resulted (see Table IV). There was a significant negative correlation between zero level mathematics courses and high school mathematics courses. A significant negative correlation of -0.455 at the 0.01 levels was found between high school mathematics courses and zero level mathematics courses successfully completed. A significant positive correlation was found between college mathematics courses successfully completed and the number of high school mathematics courses successfully completed. The significant positive correlation of 0.445 at the 0.01 levels between college mathematics courses and high school mathematics courses was obtained.

Mathematical Attitudes

In order to respond to the second research question of what relationship exists, if any, between preservice elementary teachers attitudes and problem posing about multiplication and division of fractions, thirty-seven subjects were scored on four

TABLE IV

CORRELATION OF MATHEMATICS COURSES

Spearman's rho		HS Course	Zero	College
HS Course	Correlation Coefficient	1.000	-.455**	.445**
	Sig. (2-tailed)	.	.008	.010
	N	37	33	33
Zero	Correlation Coefficient	-.455**	1.000	-.098
	Sig. (2-tailed)	.008	.	.589
	N	33	33	33
College	Correlation Coefficient	.445**	-.098	1.000
	Sig. (2-tailed)	.010	.589	.
	N	33	33	33

Note: ** = Correlation is significant at the .01 level (2-tailed).

mathematics attitude scales. The mathematics scales selected for this study represent possible variables correlating with problem posing. Four scores were tabulated as measures of each subject's attitude. The scores were determined from the following scales: Attitudes toward Success in Mathematics Scale [ATSMC], Confidence in Learning Mathematics Scale [CLMS], Effectance Motivation of Mathematics Scale [EFMS], Usefulness for Mathematics Scale [UMS]. Overall scores were used to identify subjects with high or low positive attitudes towards success in mathematics. The higher the score indicates the more positive attitude.

The scores ranged from thirty-four to sixty (out of sixty) on the ATSMC scale with sixty being the most positive answer (see Table V). Thirteen or 35.1% scored between fifty and fifty-four. Thirteen or 35.1% scored between thirty-four and forty-nine. Eleven or 29.7% scored between fifty-five and sixty. The mean [standard deviation] score was 51.149[6.744].

TABLE V

FREQUENCIES OF ATTITUDES TOWARDS SUCCESS IN MATHEMATICS SCALE

Rank	Frequency	Percent
34.0	1	2.7
37.0	2	5.4
42.0	1	2.7
43.0	1	2.7
46.0	2	5.4
46.5	1	2.7
47.0	1	2.7
48.0	3	8.1
49.0	1	2.7
50.0	3	8.1
51.0	2	5.4
52.0	2	5.4
53.0	1	2.7
54.0	5	13.5
55.0	2	5.4
56.0	1	2.7
58.0	2	5.4
60.0	6	16.2
Totals	37	100.0

CLMS scores of the thirty-seven subjects (see Table VI) ranged from seventeen to sixty (out of sixty). The mean [standard deviation] score was 51.149[6.744].

TABLE VI

FREQUENCIES OF CONFIDENCE LEVEL
IN MATHEMATICS SCALE

Rank	Frequency	Percent
17.00	1	2.7
18.00	1	2.7
21.00	1	2.7
23.00	1	2.7
26.00	1	2.7
29.00	2	5.4
30.00	1	2.7
31.00	1	2.7
32.00	1	2.7
33.00	1	2.7
33.50	1	2.7
37.00	1	2.7
38.00	1	2.7
40.00	1	2.7
42.00	1	2.7
43.00	3	8.1
44.00	1	2.7
45.00	2	5.4
46.00	1	2.7
49.00	2	5.4
50.00	2	5.4
51.00	1	2.7
52.00	1	2.7
54.00	2	5.4
56.00	1	2.7
58.00	2	5.4
59.00	1	2.7
60.00	2	5.4
Totals	37	100.0

The scores ranged from nineteen to fifty-nine (out of sixty) on the EFMS scale (see Table VII). Five or 13.5% scored a forty-seven. The largest range was forty-five to fifty-two with 40.5%. The mean [standard deviation] score was 42.608[10.736].

TABLE VII

FREQUENCIES OF EFFECTANCE MOTIVATION IN MATHEMATICS SCALE

Rank	Frequency	Percent
19.0	1	2.7
21.0	1	2.7
24.0	1	2.7
27.0	2	5.4
29.0	1	2.7
30.0	1	2.7
32.0	2	5.4
33.0	1	2.7
39.0	2	5.4
41.0	1	2.7
43.0	1	2.7
43.5	1	2.7
44.0	1	2.7
45.0	2	5.4
46.0	2	5.4
47.0	5	13.5
48.0	2	5.4
49.0	2	5.4
52.0	2	5.4
53.0	1	2.7
56.0	3	8.1
58.0	1	2.7
59.0	1	2.7
Totals	37	100.0

UMS scores of the thirty-seven subjects (see Table VIII) ranged from forty-two to sixty (out of sixty). The mean [standard deviation] score was 54.838[5.210].

TABLE VIII

FREQUENCIES OF USEFULNESS IN MATHEMATICS SCALE

Rank	Frequency	Percent
42.0	1	2.7
46.0	1	2.7
47.0	2	5.4
48.0	3	8.1
50.0	2	5.4
51.0	3	8.1
53.0	2	5.4
54.0	1	2.7
55.0	1	2.7
56.0	2	5.4
57.0	3	8.1
58.0	2	5.4
59.0	4	10.8
60.0	10	27.0
Totals	37	100.0

There was a significant positive correlation between all four mathematics attitude scales (see Table IX). The six pairings indicated significant positive correlations. The correlations ranged from the 0.01 levels to the 0.05 levels.

The ATSMS mean score from Fennema Sherman was 47.64 compared to the mean score of 51.15 with these subjects. From Fennema Sherman the CLMS mean score of 44.7 was greater compared to the mean score of 41.9 from these subjects. The EFMS mean score from Fennema Sherman was 40.88 compared to the mean score of 42.61 from these subjects. The mean score for UMS from Fennema Sherman at 47.80 was lower compared to the mean score of 54.84 from these subjects.

TABLE IX

CORRELATIONS OF FOUR ATTITUDE SCALES

Spearman's rho		ATSMC	CLMS	EFMS	UMS
ATSMC	Correlation Coefficient	1.000	.416*	.422**	.529**
	Sig. (2-tailed)	.	.010	.009	.001
	N	37	37	37	37
CLMS	Correlation Coefficient	.416*	1.000	.730**	.433**
	Sig. (2-tailed)	.010	.	.000	.007
	N	37	37	37	37
EFMS	Correlation Coefficient	.422**	.730**	1.000	.603**
	Sig. (2-tailed)	.009	.000	.	.000
	N	37	37	37	37
UMS	Correlation Coefficient	.529**	.433**	.603**	1.000
	Sig. (2-tailed)	.001	.007	.000	.
	N	37	37	37	37

Note: *. = Correlation is significant at the .05 level (2-tailed),
**. = Correlation is significant at the .01 level (2-tailed).

Problem Posing

The two research questions refer to what relationship exists, if any, between preservice elementary teacher's mathematical knowledge and attitudes with problem posing about multiplication and division of fractions. In order to address these questions problem posing was evaluated. Early in the semester, the students used and became familiar with Polya's four- step method for solving problems (Polya, 1973). The model includes understanding of the problem, devising a plan, carrying out the plan and looking back. Problem-solving skills were stressed throughout the semester. Mathematical discourse about problem solving was part of the course activities. Later in the semester problem posing was incorporated into the course. Explanation of problem posing as a means to teach a mathematical lesson by generating a story or situation was discussed. The following example was used to clarify problem posing teaching a mathematical concept. The mathematical concept introduced was least common multiple [LCM]. This example was discussed in detail with each class. The number of students in the problem is not known. The problem posed refers to the number of hot dogs in a package and the number of hotdog buns in a package. Also, it is explained that hotdogs come in packages of ten, while hotdog buns come in packages of eight.

> You are at the grocery store. Several classes are having a party on Friday. Your task is to purchase hotdogs and buns. Every student will eat one of each, but we do not want any leftovers. How many students are able to eat without leftovers?

At the next meeting, the subjects were given the problem posing task. Problem posing scores of the thirty-seven subjects were compiled according to the rubric (see

Table X). Three professionals were trained in scoring the problem posing. Training included scoring of responses with discussion to see if there was agreement of scores.

TABLE X

RUBRIC FOR PROBLEM POSING

Score	Skill
0	Mathematics incorrect/telling how to multiply or divide fractions using the algorithm/question without fractions/or not question at all.
1	Multiplication or division of fractions correctly using the algorithm.
2	Posed a story or situation without multiplication or division of fractions.
3	Posed an unsolvable situation or story comprising multiplication or division of fractions.
4	Posed a story or situation comprising multiplication or division of fractions correctly, such as telling with a story.
5	Posed a story or situation comprising multiplication or division of fractions correctly, did not tell to multiply or divide.

Problem posing produced scores (see Table XI) that ranged from zero to five on multiplication and division of fractions. The mean [standard deviation] score for problem posing multiplication of fractions was 2.68[2.26]. Of the thirty-seven subjects 32.4% scored zero. A score of five was obtained from 43.2% of the subjects on problem posing with multiplication of fractions. More subjects scored a two (43.2%) on problem posing with division of fractions. The mean score for problem posing with division of fractions was 2.30. The standard deviation was 1.78 with the thirty-seven subjects.

TABLE XI

FREQUENCY TABLE OF PROBLEM POSING MULTIPLICATION OF FRACTIONS AND PROBLEM POSING DIVISION OF FRACTIONS

Validity	Frequency	Percent
PPMULT		
0	12	32.4
1	3	8.1
2	3	8.1
3	2	5.4
4	1	2.7
5	16	43.2
Totals	37	100.0
PPDIV		
0	8	21.6
1	2	5.4
2	16	43.2
3	2	5.4
5	9	24.3
Totals	37	100.0

Significant positive correlations of problem posing with multiplication of fractions with three attitude scales resulted (see Table XII). There was a significant positive correlation between problem posing multiplication of fractions and CLMS at the .004 levels. There was a significant positive correlation between problem posing multiplication of fractions and EFMS at the .006 levels. There was a significant positive correlation between problem posing multiplication of fractions and UMS at the .039 levels. No significant correlation was obtained for ATSMS and problem posing with multiplication of fractions.

Problem posing with division of fractions did not result in significant correlations. No significant correlation was obtained between problem posing with division of fractions and mathematical background. No significant correlation was obtained between problem posing with division of fractions and all four attitudes.

TABLE XII

CORRELATIONS OF PROBLEM POSING MULTIPLICATION OF FRACTIONS AND PROBLEM POSING DIVISION OF FRACTIONS

Spearman's rho	PPMULT	PPDIV	ATSMC	CLMS	EFMS	UMS
PPMULT						
Correlation Coefficient	1.000	.482**	.210	.457**	.445**	.341*
Sig. (2-tailed)	.	.003	.211	.004	.006	.039
N	37	37	37	37	37	37
PPDIV						
Correlation Coefficient	.482**	1.000	-.285	.075	-.012	.059
Sig. (2-tailed)	.003	.	.087	.661	.944	.729
N	37	37	37	37	37	37

Note: *. = Correlation is significant at the .05 level (2-tailed),
**. = Correlation is significant at the .01 level (2-tailed).

Summary

Of the most important aspects and results as discussed in the narrative and displayed in the table(s), there were two. The first most important aspect was a positive significant correlation between three mathematical attitudes and problem posing with multiplication of fractions by preservice elementary teachers. The second most important aspect was no significant correlation resulted between mathematical background and problem posing with multiplication or division of fractions by preservice elementary teachers in this study.

CHAPTER V

DISCUSSION, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The nature of this study was to determine if a relationship existed between mathematical background and attitudes of preservice elementary teachers and their ability to problem pose about multiplication and division of fractions. The major objective was to evaluate the problem posing of preservice elementary teachers as it relates to these variables. This discussion of problem posing will be divided into sections identifying the variables of mathematical background and attitudes and the relationships between them. Problem-posing behaviors of preservice elementary teachers will complete the discussion section. Conclusions and implications with recommendations will follow the discussion.

Discussion

Problem posing with multiplication of fractions was easier for most subjects in the study compared to problem posing with division of fractions. The conceptual understanding of division of fractions is difficult for preservice elementary teachers. Aksu discusses that fraction rules can easily become the focus of rote learning and produce artificial feelings of accomplishment (1997). With fraction rules, using the algorithm, rote memorization produces the answer. If the main source of teaching fractions is using the algorithm correctly, knowledge of understanding fractions conceptually is not evaluated. The source of difficulty may lie in the subjects' lack of understanding of different ways operations are in a word problem (Aksu, 1997). The algorithm is learned without conceptual understanding of fractions therefore when applications arise in word problems the correct operation of multiplication or division is confused. This may have influenced why division of fractions failed to show a significant correlation yet a significant positive correlation was found in problem posing about multiplication of fractions. More preservice elementary teachers were able to problem pose with the mathematical concept of multiplication of fractions.

There was a significant positive correlation between confidence in learning mathematics, effectance motivation of mathematics, usefulness for mathematics and problem posing with multiplication of fractions. These three mathematics attitudes correlated with problem posing about multiplication of fractions. The attitudes towards success scale in mathematics did not correlate with the problem posing of multiplication of fractions.

Mathematical Background

The significant negative correlation between college level non-credit mathematics courses and high school mathematics courses reflects the assumption that the higher number of secondary high school mathematics courses students successfully completed at the high school level resulted in less college non-credit mathematics courses. This is reconfirmed in the significant positive correlation between college and high school mathematics courses. The higher number of high school mathematics courses successfully completed, the more likely for preservice elementary teachers to take additional college mathematics courses. Success expectations depend on the confidence of intellectual abilities (Upedgegraff & Eccles, 1996). The preservice elementary teachers with successful completion of three to four years of mathematics at the high school level were enrolled in a higher number of college mathematics courses other than non-credit college mathematics courses.

There was no significant correlation between mathematical background and problem posing with multiplication or division of fractions. Since state requirements include three years of college preparatory mathematics, or the equivalent at the university level, the mathematical background of preservice elementary teachers is more closely related than in the past. The subjects with fewer successful mathematics courses in high school subsequently completed a higher number of non-credit college mathematics courses.

Mathematical Attitudes

The confidence level mean score compared to effectance motivation, usefulness in mathematics, and attitudes towards success mean scores was lower. The lowest mean score for attitudes was confidence level in learning mathematics [CLMS] at 41.8514. The effectance motivation scale [EFMS] mean score was 42.61. Preservice elementary teachers' confidence in their ability to learn mathematics mean score (41.9) was lower in comparison to the Fennema-Sherman mean score (44.7). An example of a question with favorable attitude from the confidence level form was "Generally I have felt secure about attempting mathematics". An answer of agree on six positively stated comments indicated favorable attitude. An answer of disagrees on six negatively stated comments indicated favorable attitude. Examples of this include "most subjects I can handle O.K., but I have a knack for flubbing up math" and "math has been my worst subject". The CLMS mean score confirms research. Preservice elementary teachers consist mostly of a female population with less favorable attitudes towards mathematics than other students at the university level (Kelly & Tomhave, 1985; Rech et al., 1993). The lack of confidence in mathematics affects the actions of preservice elementary teachers (Soodak & Podell, 1996). If a preservice elementary teacher's confidence in mathematics were low, he/she would not enroll in additional college mathematics courses.

The mean score of effectance motivation in learning mathematics [EFMS] was 42.608. This mean score is slightly higher than the confidence level mean score. Effectance motivation refers to the subject's active involvement or lack of involvement in solving mathematical problems. Examples of these included "I like math puzzles." and "When a question is left unanswered in math class. I continue to think about it afterward." Examples of those marked disagree indicating a favorable attitude were "I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself." and "I am challenged by math problems I can't understand immediately." As Fennema-Sherman discussed, effectance motivation is similar to problem solving attitude (1976). Preservice elementary teachers' focalization on exploration with confidence is lower partially due to the lack of encouragement of students, especially young girls, to focus on problem solving skills.

The attitudes towards success in mathematics scale [ATSMS] mean score (54.84) was higher than effectance motivation mean score (42.608) and confidence mean score

(41.854). Examples on attitudes towards success measurement scale include "I'd be happy to get top grades in mathematics." and "I'd be proud to be the outstanding student in math." A negative statement on the scale included "I don't like people to think I'm smart in math." A disagree mark indicated positive attitude. Preservice elementary teachers ATSMS mean score indicates desired success in mathematics.

The highest mean score was calculated on the usefulness in mathematics scale. Usefulness in mathematics scale [UMS] mean score was 51.15. Examples included "I'll need mathematics for my future work." and "I will use mathematics in many ways as an adult." Some of the negatively stated comments on usefulness in mathematics scale included "Taking mathematics is a waste of time" and "In terms of my adult life it is not important for me to do well in mathematics in high school." Answers of disagree indicated positive attitudes on negative statements. Preservice elementary teacher's scores indicated that learning mathematics would be useful to them. Since all subjects were preservice elementary teachers, all these subjects will be teaching mathematics; therefore the usefulness of mathematics.

The confidence in learning mathematics of the subjects was lower compared to the other mean scores. Preservice elementary teachers are a predominantly female population with a similar mathematical background. The mean scores of the preservice elementary teachers were higher for ATSM, EFMS, and UMS of the attitudes compared to the Fennema-Sherman mean scores. The confidence level mean score for preservice elementary teachers in this study was lower compared to Fennema-Sherman results.

Problem Posing

When given the problem-posing task, the majority of the thirty-seven preservice elementary teachers finished in less than thirty minutes. Six subjects finished in thirty to forty-five minutes while four subjects finished in approximately sixty minutes.

Mathematical discourse on the scoring of problem posing by the professionals took place. Following completion of the problem posing task, discussion included determination of scoring if multiplication of fractions or division of fractions included only one fraction. The use of only one fraction was decided by the professionals to be scored a five if the problem was posed correctly. In order to problem pose correctly, the generated problem did not tell the operation of multiplication or division. The operation of multiplication or division of fractions must have been generated from the story or the situation to score a five.

The research questions, dealing with the subject's ability to problem pose to students in order to teach multiplication or division of fractions, generated many problems. The following preservice elementary teachers illustrated the difficulty they had in problem posing with fractions.

Subject #4 – "Your parents give you chores to do. They tell you 'When you get one-third of one-half of your chores done you can stop for a break.'"

Subject #17 – "I have ½ of a pie. Eight of you want one piece. How many times can 1/8 go into that ½?"

Subject number four used fractions with a meaningful situation but did not pose a question for students to solve. This illustrates the difficulty preservice elementary teachers have in understanding problem posing as a means of teaching a mathematical concept. Subject number four posed no question therefore received a score of zero. Subject number seventeen had difficulty with the mathematical concept of multiplying fractions. This subject did not conceptually understand how to pose a question to elicit the answer desired by the original problem. Subject number seventeen scored a zero for incorrect mathematics since the answer to the posed question did not relate to the posed story. The subject could have posed "What part of the pie would each receive if they all received equal amounts?" One-half of a pie cut into eight pieces, the result is 1/16 with the operation of division of fractions. Subject number seventeen did not conceptually understand which operation to use or how to pose a question to solve the problem.

The traditional teaching method of telling mathematics was used in the problem-posing task. This method tells the students how to solve the problem by naming the operation. The traditional teaching method of telling does not allow construction of knowledge or problem solving skills. Two of the subjects had difficulty generating a story or a situation comprising multiplication of fractions therefore used the traditional telling method to solve the problem.

<u>Subject #13</u> – "There is a candy bar. Now students, tell me what 2/5 times ½ means?"

<u>Subject #35</u> – " I would tell them what division of fractions means. 'How many ¼ are in a whole?'"

Subject number thirteen and subject number thirty-five scored a one for using the traditional teaching method telling how to solve the problem. The subjects were unable to generate a story or situation that comprised fractions without using this traditional teaching method.

Subject #25 –

> Write a recipe on the board. "If I wanted to make a double batch of brownies, how would I find out how much of each ingredient to use? You take each amount and multiply by two to get double the amount. Does everyone understand?"

Subject number twenty-five understood problem posing with a mathematical concept. However, the subject reverted back to the traditional teaching method of telling how to solve the problem. The difficulty preservice elementary teachers had with problem posing as a new teaching method was brought to light.

Generating a story or situation was accomplished with the following subject, while the mathematics was unclear.

Subject # 11 – "Fractions made sense to me when I pictured a jug of milk or juice, thinking to myself, 'How much is left?'"

This subject problem posed without the operation of multiplication of fractions as directed. The situation in the posed-problem did not elicit a mathematical operation. Without a mathematical concept to convey, the score was two.

A subject that confused the operation of multiplication of fractions with division of fractions is depicted by this example.

Subject #23 – "You are giving ½ of the package of paper. If you have to share with your sister, then how many sheets will you get if it comes 100 sheets to a package?"

This subject posed this situation for division of fractions. Subject number twenty-three did not conceptually understand which operation to use from the posed problem. The score was a two, since the task required multiplication of fractions instead of division of fractions. Perhaps, the subject was confused with the algorithm for division of fractions.

The following subjects also posed ambiguous problems. Not enough information was given by the posed problem in order to solve the problem.

Subject #12 –

> I brought a cake to school today in order to share it with my friends. My little brother got into it though and now only ¾ of the cake is left. I offered it to my friends but only 1/3 of them are hungry. How much of the cake will each hungry friend get to eat?

Subject #18 –

> If ¾ of the fifth graders went to the zoo and the other students didn't. ½ of those ¾ that went to the zoo were males. How many males and females went to the zoo?

Subject number twelve's posed problem did not include how many friends therefore the problem posed was unsolvable. The score was three for problem posed without enough information. Also, subject number eighteen posed a problem that is unsolvable due to lack of information. The problem, in order to be solved, must tell the number of students in the class. Therefore, the subject received a score of three due to not enough information. Preservice elementary teachers must be able to pose solvable problems for students.

Twelve subjects used pizza stories similar to problems in their textbook and the ones discussed in class. The following subjects used a similar problem to a homework problem with fractions.

Subject #21 –

> You order two large pizzas for dinner. After dinner you put one-half of the last pizza in the refrigerator as leftovers. The next day, you went to get the leftover pizza out for lunch to feed five children. How much will each person get?

Subject #30 –

> You and three of your friends are hungry so you order pizza. If everybody eats 3/8 of a pizza, then how many pizzas should you order?

The problem from homework used pizza, refrigerator and fractions. Both subjects posed problems similar to the homework. Subject number twenty-one posed a problem correctly with division of a fraction therefore the subject scored a five. Subject number thirty scored a five for problem posing correctly with multiplication of fractions. Following examples from textbook and in class provided modeling of problem posing. Some preservice elementary teachers used examples that they had seen modeled.

Other successful examples of problem posing with fractions occurred. Subject number five posed a problem correctly with multiplication of fractions, while subject number twenty posed a problem correctly with division of fractions.

Subject #5 – "Pretend your grandfather is a farmer and he has 3 fields containing ¼ of corn. How much corn do you have all together?"

Subject #20 –

> Bradley was given ¾ of a birthday cake and asked to share it evenly with his 5 friends. How would you divide the cake evenly so that Bradley and his friends would each get one slice of cake?

Subject number five's problem posing included a generated story with a problem to solve that required multiplication of a fraction. Since the subject did not tell the students how to solve the problem, the score was five. Subject number twenty scored a five for problem posing correctly for division of fractions. Both subjects were able to correctly problem pose as a method of teaching a mathematical concept.

Conclusions and Implications

This research study exemplifies the difficulty a teacher has in teaching mathematical concepts with problem posing. In theory, preservice elementary teachers should be able to problem pose as a method of teaching mathematics. The difficulty in problem posing was seen by the responses from the subjects. This dissertation study has brought about more understanding of problem posing as a means of teaching a mathematical concept by preservice elementary teachers with variables consisting of attitudes and mathematical background. This study reconfirmed the difficulty of teaching for understanding in mathematics.

The preservice elementary teachers in this study had a similar background of mathematics courses. Successful completion of mathematics courses does not indicate conceptual knowledge of mathematics, such as conceptual knowledge of multiplication and division of fractions. No significant correlation existed between mathematical background and ability to problem pose with multiplication or division of fractions. The mathematical background comprised high school mathematics courses and college mathematics courses successfully completed. Thirty-six out of thirty-seven subjects completed algebra II or equivalent non-credit college mathematics courses. This constitutes three years of mathematics at the high school or college level. The one subject that did not complete three years of mathematics at the high school level and did not compensate at the university level did not reside in the United States.

Research has shown mathematical attitudes affect mathematical choices. The significant positive correlation of problem posing multiplication with confidence level of mathematics (CLMS) correlates the preservice elementary teachers in this study with the most confidence with attempting new teaching mathematics methods as understood by them. A significant positive correlation did exist between confidence level mathematics scale and problem posing multiplication of fractions. The subjects with high effectance motivation were more likely to successfully problem pose with multiplication of fractions. A significant positive correlation did exist between effectance motivation mathematics scale and problem posing multiplication of fractions. Effectance motivation ranges from lack of involvement in mathematics to active enjoyment and seeking of challenge. The problem solving skills of the preservice elementary teachers correlated with the ability to problem pose as a teaching method for multiplication of fractions.

Subjects that connected usefulness of mathematics were more likely to problem pose with multiplication of fractions. A significant positive correlation did exist between usefulness of mathematics scale and problem posing multiplication of fractions. The significant positive correlation of usefulness in mathematics with problem posing multiplication reinforces the concept of understanding mathematics to be useful. This enables subjects to problem pose in multiplication with fractions.

The subject's anticipation of consequences as a result of success in mathematics did not influence their problem posing with multiplication of fractions. The attitude towards success had no significant correlation with the subject's ability to problem pose with multiplication of fractions. This scale measures the degree to which students anticipate positive or negative consequences as a result of success in mathematics. Preservice elementary teachers desired success in mathematics with the highest mean score while no significant correlation was established with problem posing.

Research has stated preservice elementary teachers should construct creative problems for students to solve. Student's conceptual knowledge is enhanced by the problem solving of meaningful text problems. In this study preservice elementary teachers were more successful at problem posing a mathematical concept they conceptually understood. Research found the belief held by many preservice elementary teachers about fractions consisted of multiplication of fractions as producing larger answers and division of fractions as producing smaller answers (Vacc & Bright, 1999). Problem posing with division of fractions did not have a significant correlation to mathematical background or attitudes. No significant correlation was found with all four attitude scales with problem posing of division of fractions. Problem posing with division of fractions was more difficult for the subjects. The difficulty of students to divide fractions helps to explain the lack of significant correlation. The mean score on problem posing division of fractions was 2.3 and problem posing multiplication of fractions was 2.68. Preservice elementary teachers in this study were more likely to problem pose correctly with multiplication of fractions than division of fractions.

In practice, most preservice elementary teachers return to the method of telling students how to solve the problem as opposed to problem posing that allows students to construct their own knowledge. Most preservice elementary teachers have not seen problem posing modeled in the classroom in the majority of their mathematics instruction. Problem posing as a method of teaching a mathematical concept is difficult for preservice elementary teachers.

Recommendations

Future research is needed in the area of problem posing and future studies consisting of a larger subject population would be recommended. A multiple regression analysis of background predicators would also be recommended with a greater number of subjects for predictability. Further study might include replication with problem posing of multiplication and division of fractions with more subjects. While in this study, the small number of subjects might be a reason for no significant correlation with mathematical background and problem posing.

According to the TIMSS and CGI research, the need for teachers to problem pose is addressed. Techniques to teach problem posing as a means of presenting mathematical problems must be addressed in future research. Generating a story for other mathematical lessons might reflect more variables affecting research.

A longitudinal study of preservice elementary teachers at the beginning of their teaching profession would also be recommended. A longitudinal study would possibly answer questions of (1) how is problem posing, as a means to teach a mathematical concept, implemented in the classroom and (2) if problem posing, as a means to teach a mathematical concept, is implemented in the classroom.

Preservice elementary teachers cannot be expected to teach differently than they are taught. Problem posing should be modeled and implemented in the university mathematics classroom as well in kindergarten through high school. In order for preservice elementary teachers to implement new ideas teacher preparation programs must model these strategies (Putney & Cass, 1998). The need for inclusion of problem posing, as a means to teach a mathematical concept, into the mathematics curriculum stems from this research study. The ultimate goal of mathematics education research is improving the teaching and learning of mathematics.

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APPENDIXES

APPENDIX A

STUDENT CONSENT FORM

Student Consent Form

I, ___________________________, hereby authorize or direct Dana S. Craig to complete a mathematical background check using college transcripts to document mathematics courses taken in college and a survey for high school mathematics courses.

I, ___________________________, understand as participants in this project we will complete a mathematics attitudes scale.

This is done as part of an investigation entitled "Preservice elementary teachers' problem posing and its' relationship to mathematical knowledge and attitudes."

I understand that participation is voluntary, there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time without penalty after notifying the project director. My participation and responses will be completely confidential. There is minimal risk or possible discomfort to me for participating. I understand that only aggregate data are to be used and that my individual responses will not be identified. I understand that the researchers will assign me an identification number to be used only for the purposes of this study and only the researchers will have access to that number. My responses will be kept confidential under lock and key in the researcher's office. All of my responses and my identification number will be destroyed upon completion of the study. I understand that this study may help educators and other professionals who work with preservice elementary teachers understand factors related to mathematics education.

I may contact Dana S. Craig at telephone number (405) 974-5252.

I may also contact Gay Clarkson, IRB Executive Secretary, 305 Whitehurst, Oklahoma State University, Stillwater, OK 74078; telephone number: (405) 744 – 5700.

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ___________________ Time: _______________(a.m./p.m.)

Signed: ____________________________
Subject

I certify that I have personally explained all elements of this form to the subject or his/her representative before requesting the subject or his/her representative to sign it.

Signed: ____________________________
Project Director

Signed: ____________________________
Dissertation Advisor

APPENDIX B

MATHEMATICS BACKGROUND

Mathematics Background I.D.#__________

1. List mathematics courses successfully completed in high school.

2. List mathematics courses successfully completed in college.

APPENDIX C

FINNEMA-SHERMAN MATHEMATICS ATTITUDE SCALES

Finnema-Sherman Mathematics Attitude Scales

Elizabeth Fennema – Julia A. Sherman, University of Wisconsin-Madison

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Four areas are chosen for this research study. The scales include (a) attitude toward success in mathematics [ATSMS]; (b) confidence in learning mathematics [CLMS]; (c) effectance motivation in mathematics [EFMS]; (d) usefulness of mathematics [UMS].

Each scale consists of 6 positively stated and six negatively stated items with five response alternatives: strongly agree, agree, undecided, disagree and strongly disagree. Each response is given a score from one to five and on each scale the weight of five is given to the response that is hypothesized to have a positive effect on learning of mathematics.

The person's total score on each of the scales is their cumulative total and the higher the score, the more positive their attitude.

APPENDIX D

ATTITUDE TOWARD SUCCESS IN MATHEMATICS

SCALE (ATSMS)

Attitude Toward Success in Mathematics Scale [ATSMS]

There are no correct answers for these statements. Answers permit you to indicate the extent to which you agree or disagree with the ideas expressed. Blacken the corresponding circle.

strongly agree	agree	undecided	disagree	strongly disagree
A	B	C	D	E

1. It would make me happy to be recognized as an excellent student in mathematics.

2. I'd be proud to be the outstanding student in math.

3. I'd be happy to get top grades in mathematics.

4. It would be really great to win a prize in mathematics.

5. Being first in a mathematics competition would make me pleased.

6. Being regarded as smart in mathematics would be a great thing.

7. Winning a prize in mathematics would make me feel unpleasantly conspicuous.

8. People would think I was some kind of a grind if I got A's in math.

9. If I had good grades in math, I would try to hide it.

10. If I got the highest grade in math I'd prefer no one knew.

11. It would make people like me less if I were a really good math student.

12. I don't like people to think I'm smart in math.

APPENDIX E

CONFIDENCE IN LEARNING MATHEMATICS

SCALE (CLMS)

Confidence in Learning Mathematics Scale[CLMS]

There are no correct answers for these statements. Answers permit you to indicate the extent to which you agree or disagree with the ideas expressed. Blacken the corresponding circle.

strongly agree	agree	undecided	disagree	strongly disagree
A	B	C	D	E

1. Generally I have felt secure about attempting mathematics.

2. I am sure I could do advanced work in mathematics.

3. I am sure that I can learn mathematics.

4. I think I could handle more difficult mathematics.

5. I can get good grades in mathematics.

6. I have a lot of self-confidence when it comes to math.

7. I'm no good in math.

8. I don't think I could do advanced mathematics.

9. I'm not the type to do well in math.

10. For some reason even though I study, math seems unusually hard for me.

11. Most subjects I can handle O.K., but I have a knack for flubbing up math.

12. Math has been my worst subject.

APPENDIX F

EFFECTANCE MOTIVATION IN MATHEMATICS SCALE (EFMS)

Effectance Motivation in Mathematics Scale[EFMS]

There are no correct answers for these statements. Answers permit you to indicate the extent to which you agree or disagree with the ideas expressed. Blacken the corresponding circle.

strongly agree	agree	undecided	disagree	strongly disagree
A	B	C	D	E

1. I like math puzzles.

2. Mathematics is enjoyable and stimulating to me.

3. When a math problem arises that I can't immediately solve, I stick with it until I have the solution.

4. Once I start trying to work on a math puzzle, I find it hard to stop.

5. When a question is left unanswered in math class. I continue to think about it afterward.

6. I am challenged by math problems I can't understand immediately.

7. Figuring out mathematical problems does not appeal to me.

8. The challenge of math problems does not appeal to me.

9. Math puzzles are boring.

10. I don't understand how some people can spend so much time on math and seem to enjoy it.

11. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.

12. I do as little work in math as possible.

APPENDIX G

USEFULNESS OF MATHEMATICS SCALE (UMS)

Usefulness of Mathematics Scale[UMS]

There are no correct answers for these statements. Answers permit you to indicate the extent to which you agree or disagree with the ideas expressed. Blacken the corresponding circle.

strongly agree	agree	undecided	disagree	strongly disagree
A	B	C	D	E

1. I'll need mathematics for my future work.

2. I study mathematics because I know how useful it is.

3. Knowing mathematics will help me earn a living.

4. Mathematics is a worthwhile and necessary subject.

5. I'll need a firm mastery of mathematics for my future work.

6. I will use mathematics in many ways as an adult.

7. Mathematics is of no relevance to my life.

8. Mathematics will not be important to me in my life's work.

9. I see mathematics as a subject I will rarely use in my daily life as an adult.

10. Taking mathematics is a waste of time.

11. In terms of my adult life it is not important for me to do well in mathematics in high school.

12. I expect to have little use for mathematics when I get out of school.

APPENDIX H

ESSAY QUESTIONS FOR PROBLEM POSING

OF MULTIPLICATION AND DIVISION

OF FRACTIONS

I.D.#________

What problem would you pose to your students to teach multiplication of fractions? Be as detailed as possible. Please respond in writing using as many pages as necessary.

I.D.#________

What problem would you pose to your students to teach division of fractions? Be as detailed as possible. Please respond in writing using as many pages as necessary.

APPENDIX I

INSTITUTIONAL REVIEW BOARD (IRB)

APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

DATE: 01-28-99 **IRB #: ED-99-076**

Proposal Title: PRESERVICE ELEMENTARY TEACHERS' PROBLEM POSING AND ITS RELATIONSHIP TO MATHEMATICAL KNOWLEDGE AND ATTITUDES

Principal Investigator(s): Kay Reinke, Dana S. Craig

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

Signature: Carol Olson Date: January 28, 1999

Carol Olson, Director of University Research Compliance
cc: Dana S. Craig

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.

2

VITA

Dana Sue Craig

Candidate for the Degree of

Doctor of Education

Thesis: PRESERVICE ELEMENTARY TEACHERS' PROBLEM POSING AND ITS RELATIONSHIP TO MATHEMATICAL KNOWLEDGE AND ATTITUDES

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born in Enid, Oklahoma on September 7, 1954, the daughter of Myron and Mary Robertson.

Education: Graduated from Putnam City High School, Oklahoma City, Oklahoma in May 1972; received Bachelor of Science degree in Mathematics from Southwestern Oklahoma State University, Weatherford, Oklahoma in 1975; received Master of Arts degree in Mathematics Education from University of Alabama at Birmingham in Birmingham, Alabama in 1989. Completed the requirements for the Doctor of Education degree at Oklahoma State University in December, 1999.

Professional Experience: 8/97- Present – Full-time Temporary Instructor, Department of Mathematics and Statistics, University of Central Oklahoma, Edmond, Oklahoma.

Professional Service: Advisory Committee for *National Science Foundation* Grant at Oklahoma State University titled "Rich Problem Solving Contexts: Integrating Mathematics and Reading Curricula for Preservice Teachers" (1998-1999); Designed and implemented mathematics tutoring program for preservice elementary teachers (1998-1999); Exeter Technology Conference (1997); Grant writer for Teachers Teaching with Technology (T^3) (1995); Instructional Development: Curriculum (1999); Judge of Oklahoma Math Week Poetry Contest (1999); National Council of Teachers of Mathematics Leadership Conference (1999); Oklahoma

Commission for Teacher Preparation (1998-1999); Participant in internet course on qualitative research using learning space with students located in Bangkok, Thailand (1998); Proposal reviewer for Dwight D. Eisenhower Program with Oklahoma State Regents for Higher Education (1999); Rocky Mountain Educational Research Conference (1998); Staff Development: Designing a College Course Curriculum (1999); Teacher Advisement Interviewer (1997-1999); Third International Mathematics and Science Study Conference (1998); Vice-President of Central Oklahoma Association of Teacher of Mathematics (1999-2000).

Presentations: Quantitative Biology: Oklahoma Teacher Education Collaborative Summer Institute for entry year mathematics and science teachers (June, 1999) – Presentation Topic: *Science and Math linked with the CBL and Graphing Calculator* – Presentation Topic: *TIMSS in the Science and Mathematics Curriculum*; Putnam City Schools Inservice (January, 1999) – Presentation Topic: *Graphing with the TI-83*; Rocky Mountain Educational Research Association (November, 1998) – Research Paper: *Preservice Teachers' Understanding of Problem Posing*; Oklahoma Teacher Education Collaborative Summer Institute for entry year mathematics and science teachers (June, 1998) – Presentation Topic: *Technology in the Schools* – Presentation Topic: *Third International Science and Mathematics Study (TIMSS)*; Student Education Association of University of Central Oklahoma (October, 1998) – Presentation Topic: *Third International Mathematics and Science Study (TIMSS)*; Oklahoma State University (March, 1998) – Presentation Topic: *Third International Mathematics and Science Study* (TIMSS); Resident Teacher Workshop (September, 1997) – Presentation Topic: *Training with the Graphing Calculator*.

Professional Memberships: American Education Research Association, Association of Mathematics Teacher Educators, Central Oklahoma Association of Teachers of Mathematics, Mathematical Association of America, National Council of Supervisors of Mathematics, National Council of Teachers of Mathematics, Research Council on Mathematics Learning, Rocky Mountain Research Association.