AN ABSTRACT OF THE THESIS OF

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Title: Attitudes toward and Basic Understanding of Mathematics of Prospective Elementary Teachers and the Factors Influencing Attitudes and Basic Understanding of Mathematics

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Dr. JoAnn Brewer

The purpose of this study is to investigate the attitudes toward mathematics of prospective elementary teachers and their basic understanding of mathematics.

Two hundred fourteen subjects, representing prospective teachers from Oregon State University and Western Oregon State College participated in this study. The responses of this total population to the 20 items on the Revised Mathematics Attitude Scale, 74 items on the Iowa Test of Basic Skills, and demographic information supplied by the participants provided the data for this study.

An Analysis of Variance statistical design was used to determine the significance of difference between the prospective teachers' attitudes toward mathematics, their

basic understanding of mathematics and the following factors: high school graduation class size, college class level, high school and college mathematics background. The significant difference between sex and attitudes toward mathematics was determined by a t-test, as were the differences between the two schools' prospective teachers with respect to attitude and basic understanding of mathematics. The Pearson Correlation coefficient was employed to determine the relationship of attitudes toward mathematics and basic understanding of mathematics.

Within the limitations of the study the following major conclusions were drawn:

1. Prospective teachers have relatively positive attitudes toward mathematics.
2. There is a significant relationship between attitudes toward mathematics and basic understanding of mathematics of prospective teachers.
3. There were no significant differences between prospective teachers at Oregon State University and Western Oregon State College with respect to attitudes toward mathematics and basic understanding of mathematics.
4. There was a significant difference in attitudes toward mathematics and high school and college mathematics background and sex of prospective teachers.

5. There were no significant differences in attitudes toward mathematics and students from various ages of high school graduation classes and college class levels.
6. There was a significant difference in basic understanding of mathematics and prospective teachers' high school mathematics background and their college class level.
7. There was no significant difference in basic understanding of mathematics and students from various sizes of high school graduation classes, college class levels and sex of the prospective teachers.

Attitudes toward and Basic Understanding of Mathematics of Prospective Elementary Teachers and the Factors Influencing Attitudes and Basic Understanding of Mathematics

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CHAPTER I

INTRODUCTION

In the past several years there has been growing concern about teacher education programs, particularly in the field of mathematics. This concern about the quality of teacher education has been increased due to our nation's commitment to science and technology. The need for persons educated in mathematics and science has escalated in the past 20 years. Relatively few jobs exist that are free of mathematics; one must be able to interpret quantitative data, read graphs and record information to be successful in many occupations. W. W. Sawyer (1978) spoke of this concern:

> The ability to think mathematically will have to become something taken for granted as much as the ability to read a newspaper is at present. Such a change will seem fantastic to some people. But so would universal literacy have seemed absurd a few centuries ago.

In order for elementary teachers to teach children to "think mathematically" more research is needed on the instruction of mathematics for teachers. Recent work (Tobias, 1978) suggests that math performance is influenced by affective as well as cognitive variables. An affective variable influencing the teaching and

learning of mathematics, which deserves investigation is the teacher's attitude toward mathematics. Thurstone (1928), a forerunner in the study of the measurement of attitudes, defined attitudes as:

> The sum total of a man's inclinations and feelings, prejudices or bias, preconceived notions, ideas, fears, threats, and convictions about any specified topic.

Mathematics teachers can have a positive or negative effect upon pupils' attitude and understanding of the subject. Positive attitudes of teachers toward mathematics tend to influence retenion, stimulate further study, and involve others in the study of mathematics. Haan (1961) writes ". . . dislike of mathematics is readily communicated to children either directly or unconsciously."

Since attitudes are so important in teaching, Dutton (1951) developed a scale to objectively measure attitudes toward mathematics. Recently others have continued to research attitudes toward mathematics. The findings indicate that further investigations of elementary mathematics teachers are needed in order to understand the possible influences teachers have on students (Aiken, 1972; Anttonen, 1969; McCallon and Brown, 1971).

Numerous educators and noneducators have suggestions concerning the mathematics preparation of elementary teachers. The number of courses, course content and type of instruction is frequently being investigated. In a 1962 study, 22% of teacher training institutions

responding required no mathematics courses of their elementary education majors. In the last ten years colleges and universities have significantly increased the number of mathematics courses required of prospective teachers. The Committee on the Undergraduate Program in Mathematics (CUPM) recommended the need for 18 quarter-hours of mathematics content and in 1976 Oregon Teacher Standards and Practices Commission (TSPC) mandated all teacher education programs in Oregon to include at least 12 quarter-hours of mathematics content and three quarter-hours of mathematics methods. Oregon State University elementary education majors are required to complete an additional three quarter-hours of mathematics projects, coordinated with the first nine hours of their mathematics instruction. The effects of the increase in mathematics requirements of the past ten years have yet to be determined.

Elementary teachers are specifically trained in theories and techniques designed to enhance students' learning of mathematics. The selection of materials and activities allows the elementary teacher a great deal of flexibility to meet the individual student's needs.

As the literature suggests there is more to the teaching of mathematics than material and activities. The development of students' concepts and understanding of mathematics is related to the educator and the attitudes of the educator (Suydam and Weaver, 1975; Lyda

and Morse, 1963). Because of a lack of attitudinal assessment critical information may go unnoticed. Prospective teachers with negative attitudes are continuing a cycle of animosity toward mathematics. Teachers cannot be expected to generate enthusiasm and excitement for mathematics when they have fear and anxiety about the subject. Teacher education programs' awareness of attitudinal assessment will be of benefit for the prospective teacher and for the children in elementary school. Clearly then, attitudinal assessment research is worthy of attention.

Statement of Problem

The problems addressed in this study are to answer the following questions: What are the attitudes of prospective teachers toward mathematics? What is the relationship of prospective teachers and basic understanding of mathematics? This study also attempts to ascertain whether or not certain factors relate to attitude and understanding of mathematics. The factors utilized in this study are: sex, size of high school graduation class, high school and college mathematics background.

Purpose of the Study

The purpose of the study is to investigate the attitudes toward mathematics of prospective elementary teachers. Understanding of mathematics will also be

teachers. Understanding of mathematics will also be investigated. The five factors that this study takes into consideration are:

a. sex of student
b. size of high school graduation class
c. high school mathematics background
d. college mathematics background
e. college level

The Revised Mathematics Attitude Scale and Iowa Test of Basic Skills are the instruments used to identify the attitudes and understanding of mathematics of prospective teachers. The attitude scale was designed so that educators can identify attitudes of students as well as analyze differences in attitudes.

The objectives of the study were:

1. To investigate prospective teachers' attitudes toward mathematics and understanding of mathematics.
2. To determine if prospective teachers' attitudes toward mathematics are significantly different with respect to the five variables.
3. To determine if prospective teachers' basic understanding of mathematics are significantly different with respect to the five variables
4. To determine if the prospective teachers at Oregon State University and Western Oregon State College are significantly different in

attitudes toward mathematics and basic understanding of mathematics

5. To determine the relationship of attitudes toward mathematics and understanding of mathematics of prospective teachers

Significance of the Study

The significance of attitude toward teaching, particularly attitudes toward mathematics, has been mentioned frequently in educational literature since the early 1950's.(Dutton, 1954; Johnson, 1957). It is held by many educators that teacher enjoyment of mathematics is significantly and positively related to their students' mathematics achievement, teachers who enjoy the subject and are good at mathematics will stimulate positive attitudes in their students that are essential for learning. Often the teaching of mathematics has left the pupil with a dislike for the subject rather than an appreciation of mathematics (Banks, 1964; Aiken, 1970; Phillips, 1973).

Teacher training programs play a vital role in preparing elementary teachers who possess a positive attitude and a basic understanding of mathematics. It was for this reason that the present investigation was initiated. The significance of this research is related to the following:

1. There is a need to investigate the attitudes toward

mathematics of prospective elementary teachers so appropriate program elements can be examined, maintained, or modified.

2. New approaches in the teaching of mathematics may result from the identification of basic understanding of mathematics of prospective teachers.

3. A study of attitudes toward mathematics can enhance educators' awareness of prospective elementary teachers' needs in teacher training programs.

As proposed by Tobias (1978), mathematics studies are significant in that they have impact on many levels of the educational program. Only with careful study of mathematics attitudes will we understand what it is to have a favorable or unfavorable attitude toward the subject and only then will we be able to deal with the teaching-learning process of mathematics. This study will have specific application to teacher-training programs by providing data which will aid in:

1. Gaining an understanding of attitudes present within teacher training institutions
2. Identify needed program adjustments
3. Developing new programs for prospective teachers in the field of mathematics

Research Hypotheses

This study was designed to investigate prospective elementary teachers' attitudes toward mathematics and

basic understanding of mathematics. The following hypotheses were constructed for research purposes:

1. Prospective elementary teachers have neutral attitudes toward mathematics.
2. There is no significant relationship between attitudes toward mathematics and basic understanding of mathematics of prospective elementary teachers.
3. There is no significant relationship between attitudes toward mathematics and basic understanding of mathematics of prospective elementary teachers at Oregon State University and Western Oregon State College.
4. There is no significant difference with respect to attitude toward mathematics of prospective elementary teachers and:
   a. high school graduation class size
   b. high school mathematics background
   c. college mathematics background
   d. college class level
   e. sex of student
5. There is no significant difference with respect to basic understanding of mathematics of prospective elementary teachers and:
   a. high school graduation class size
   b. high school mathematics background
   c. college mathematics background
   d. college class level
   e. sex of student

Assumptions of the Study

The following assumptions underlying this study are:

1. That attitudes can be measured through a sufficiently validated instrument.
2. That the Revised Mathematic Attitude Scale as validated will measure attitudes toward mathematics.
3. That the Iowa Test of Basic Skills as validated will measure basic mathematical understanding of mathematics.
4. That all students will respond appropriately regarding their feeling toward attitudinal statements during the data collection.

Limitations of the Study

This study was confined to a sample of prospective elementary teachers enrolled at Oregon State University and Western Oregon State College in the spring of 1985. It was limited by the use of the specific measuring instrument. Attitude scales are self-report measures and therefore the researcher can never be sure of the degree to which the responses of the subject reflect the participants' actual attitude (Borg and Gall, 1983).

Definition of Terms

Attitudes - Refers to "a predisposition to accept or reject, in a consistent manner, groups of individuals, social systems, or other social objects" (Chase, 1974).

Likert-type scale - a scale for measuring attitudes based on the research of Renis Likert. The individual checks one of five possible responses to each statement: strongly agree, agree, undecided, disagree, strongly disagree.

Mathematics Attitude Scale - a specially constructed scale containing statements relating to mathematics to determine the direction and intensity of attitude toward mathematics.

Mathematics Attitude Score - a numerical score that indicates the direction of an individual's attitudes toward mathematics.

Mathematics Concept Test - a test relating to quantitative processes (numeration, equations, integers, fractions, decimals, geometry, and measurement).

Mathematics Problem Solving Test - a test relating to realistic problems, presented in situations such as students experience in everyday life (students are asked to use addition, subtraction, multiplication, division, and multiple step problems).

Prospective teachers - students enrolled in a teacher training program, who have not received teacher certification.

CHAPTER 2

REVIEW OF THE RELATED LITERATURE

This review of the literature provides an overview of attitudes toward mathematics. The review is divided into three sections. The first section presents an historical perspective and rationale for attitude measurements. The second part focuses on attitudes toward mathematics specifically dealing with prospective teachers' attitudes. The concluding section examines related studies in attitudes toward mathematics and comprehension of basic mathematics.

In reviewing the literature, there were a vast number of studies in the 1950's and 1960's, but the research completed in recent years is limited and inconclusive. Prominent studies related to this study have been reviewed.

Attitudes

Gordon Allport wrote 50 years ago:

> Attitudes is the most distinctive concept in contemporary American social psychology. No other term appears more frequently in experimental and theoretical literature (Allport, 1935).

The words of Allport are as true today as in 1935. The number of attidudinal studies has been growing in the past ten years and will increase as new technology allows a more sophisticated approach to research analysis.

After the turn of the century, the study of attitudes was popular in many fields with little knowledge or agreement about its scope and sequence. Researchers in psychology and sociology investigated attitudes in terms of set, prejudice and suggestion. It was not until Allport's (1935) chapter in The Murchinson Handbook that attitude was clearly distinguished from other psychological concepts and then viewed as a study in social psychology. Before World War II social psychologists devoted a large part of their efforts to attitude measurement. Post war psychologists have dedicated their efforts to theoretical and empirical issues in attitude change. Blumer (1939) took the position that social psychology is the scientific study of attitudes. He believes that it is necessary to consider psychological variables in order to understand social change.

Historically, attitudes have been more easily measured than defined (Dawes, 1972). There is little consensus among the experts in the field to a definition of attitudes, but the literature suggests than an operational definition must be eclectic. Researchers have been known to choose a measurement procedure for their

study and operationally define the meaning of attitude. In 1972, Fishbein and Ajzen found more than 500 different devices to measure attitude. Social scientists for the past 50 years have recognized Thurstone's (1928) definition of attitude:

> Attitude is the sum total of man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats and convictions about any specified topic (Thurstone, 1928).

Allport (1935) refined Thurstone's (1928) definition of attitudes to include the concept of time:

> An attitude is a belief toward a referent that has strength is a predisposition for behavior or value changes and is normally consistent over time (Allport, 1935).

More recently another, commonly accepted, definition has been proposed by Katz (1960):

> Attitude is the predisposition of the individual to evaluate some symbol or object or aspect of his world in a favorable or unfavorable manner . . . Attitudes include the affective, or feeling core of liking or disliking, and the cognitive or belief, elements which describe the effect of attitude, its characteristics and its relations to other objects.

Borg and Gall (1983) updated the definition to include three components:

1. affective component - the individual's feelings about the attitude object
2. cognitive component - the individual's beliefs or knowledge about the attitude object
3. behavior component - the individual's predisposition to act toward the attitude object in a certain way.

There is really no necessity that social psychologists agree about the definition of attitudes in order

to measure attitudes. All that can be measured are specific properties. In order to understand attitudes, one must be able to measure attitudes. Attitude measurement scales have facilitated this process.

Attitude Measurement Scales

The use of attitude measurement scales first appeared with significant frequency in the 1920's when Allport and Hartman (1925) took the first step in a series of self-report measures that led to techniques for the quantification of attitude measurement. The psychophysical model by Thurstone (1928) was the first to measure attitude statements along the attitude continuum. Since that time, many researchers have used Thurstone's scale as a model for measuring attitudes toward specific behaviors, including Likert (1924), Guttman (1950), Osgood (1957) and Coombs (1964).

The Likert scale has received the greatest attention among researchers and psychologists who want to score attitudes directly from the attitude responses without a panel of judges that is needed in the Thurstone scale. The respondent in the Likert scale is asked to indicate the degree of agreement to items on a five point scale. The Guttman scale analysis is usually applied to dichotomous data. Only two values, yes-no, agree-disagree are given to the individuals involved in the study. Another contribution to measuring attitudes is from

Coombs (1964). This is the unfolding technique that derives information on the unidimensionality and relative spacing is used between the attitude items.

It was in the late sixties that attitude measurement scales were the focus of Tittle and Hall's (1967) study. They reported the Likert scale to be superior to all others. By far, the great majority of studies rely on Likert-type scales to measure attitudes toward a certain topic, behavior, or group.

Today, social scientists have stopped asking if attitudes can be measured and have accepted the standard measurement techniques, assumptions and all (Kiesler, Collins and Miller, 1969). Social scientists, using the various scales have measured attitudes, including measurement of attitudes toward mathematics.

Attitudes toward Mathematics

The importance of attitudes toward mathematics in teaching and learning has been mentioned in literature since the 1950's (Lee and Lee, 1950). But objective measurement of attitudes toward a certain subject was insufficient until Dutton (1954) prepared an objective evaluation instrument. His study showed that attitudes toward mathematics could be measured objectively and that the information obtained is helpful in the education of prospective teachers. Several Likert-type

(Aiken, 1974; Hunkler, 1972) and semantic-differential (Kane, 1968; McCallon-Brown, 1971) instruments have been used successfully with prospective teachers. Bottoroff (1974) designed a factor-analysis procedure to refine Dutton's attitude instrument, and Jackson's (1974) mathematics attitude scale was used with disadvantaged students. The attitude dimension assessed by these instruments frequently involved only one of the affective goals of mathematics instruction: the enjoyment of mathematics. Aiken (1974) developed an attitude scale to measure not only enjoyment of mathematics but also the importance and relevance of mathematics. Hosticka and Traugh (1980) used the Revised Mathematic Attitude Scale (Aiken, 1974) and found prospective teachers to have reasonably positive attitudes. This is in contrast to other studies of prospective teachers where their attitudes toward mathematics have been reported as negative on various scales (Aiken, 1972).

The information obtained from these objective scales has been of benefit to educators and students. During the 1960's Dutton and others (Reys and Delon, 1968) studied the attitudes of prospective teachers toward mathematics. Dutton (1962) found that 38% of 127 prospective teachers had unfavorable attitudes. In 1968 Reys and Delon indicated that 60% of the 355 University of Missouri prospective teachers had favorable attitudes.

In a study similar to Dutton's (1962) Smith (1964) found that too many prospective teachers had a negative attitude toward a subject they will be required to teach. In a study at Brigham Young University, Gee (1964) found that most students had ambivalent feelings toward mathematics. The students in these studies reported they began college mathematics classes with antagonistic attitudes and they remember mathematics as being taught in an atmosphere of tension due to the emphasis on correct answers and pressures of timed tests. The conclusion is that a substantial portion of elementary teachers will be teaching with a negative attitude (Reys and Delon, 1968).

It is generally held that teachers who like the subject and are good at it are likely to stimulate favorable attitudes in their pupils for learning, whereas elementary teachers who dislike the subject are likely to infect their pupils with negative feelings (Phillips, 1973).

There is little empirical evidence as yet to endorse the scientific validity, but it is widely assumed that teacher attitude toward mathematics plays a significant role in student learning (Stein, 1959). In the Peskin study (1965) the results showed that correlations between teacher's attitude and student understanding of mathematics were significantly positive.

According to Neale (1969) the attitudes of teachers have little or no effect on achievement in subject areas, particularly in the classroom setting. Neale contends that the correlation between scores on attitude scales and achievement are typically low. This is something of a surprise to educators who frequently assume that a positive attitude increases the likelihood of high understanding (Aiken, 1970). In his study, Jackson (1968) concluded that only at the extremes, highly positive or highly negative, do attitudes have an influence on achievement.

Mihalko (1978) indicates that prospective teachers continue to experience strain, fear, insecurity and confusion when confronted with mathematics. Some admit they never really understood mathematics in elementary school and are convinced that no amount of drill or practice will help them. Others have memorized rules and procedures and performed satisfactorily but realize that they are not prepared for teaching mathematics. To assist prospective teachers with their negative attitudes, a variety of clinics, workshops and support groups have been developed on college campuses. Administered by interested persons, the mathematics help-groups were set up to enrich the students' basic understanding of mathematics and relieve their fear of mathematics. Tobias (1978) points out that it is important to know,

not only the student's history of mathematics but also as much as possible about aptitude, interests and goals, including the basic understanding of mathematics.

Comprehension of Basic Mathematics of Prospective Teachers

Teacher education programs are responding increasingly to the educational needs of prospective teachers. This effort becomes of great importance as students compete for a limited number of teaching positions. It should be the goal of teacher education programs to provide students a comprehensive course of training including mathematics content and method courses (Fey, 1974). In 1981, the Committee on the Undergraduate Programs in Mathematics (CUPM) discussed the mathematical competence of prospective teachers, and urged teacher educators to increase the number of mathematics courses in elementary education training programs in order to improve basic knowledge of mathematics.

> If children are to earn a living in this new world they must understand mathematics more deeply than any other generation had to (Dossey, 1981).

Clinical experiences, content and method courses have been recommended by the CUPM and the Commission on the Education of Teachers of Mathematics (CETM) to improve mathematics education. Mihalko (1978) claims if there is to be an improvement in students' mathematics performance in schools, it will be the result of changes made

in teacher education programs. If the teacher does not have the knowledge he/she will be unable to make an impact on children.

> It is essential for teachers to know more than they are expected to teach and to be able to learn more than they already know, for without such knowledge progress is essentially impossible (Mihalko, 1978).

It is important to note that in 1957 only 12 states required one course in mathematics for certification and in 1975 only 23% of teacher education programs responding to a Commission on the Education of Teachers of Mathematics study required nine hours of mathematics. Oregon State University requires students in elementary education to complete 18 hours of mathematics (nine hours of mathematics specifically designed for elementary school teachers, three hours of mathematics electives, three hours of projects classes and three hours of math methods that are coordinated with a school experience).

Studies completed in the 1960's indicated that teachers had insufficient knowledge of mathematics to teach the subject effectively (Fulkerson, 1960), but more recent studies, including Hosticka and Trough (1980) found an acceptable level of mathematics skills and could not describe the skills of prospective teachers as extremely weak in mathematics.

One of the most frequently mentioned topics in mathematics education is the question of math avoidance

among girls and young women. Female teachers constitute the majority in primary and elementary schools, yet they cannot be expected to generate enthusiasm and excitement for a subject for which they have fear and anxiety (Mihalko, 1978).

Tobias (1978) cites three general reasons why there is growing concern for females in relation to mathematics education:

- only 20% of girls in the United States continue taking math beyond geometry in high school
- only 15% of the majors in mathematics are women
- only 12% of the science and technology personnel are women.

Fennema (1977) further emphasizes the point by saying that there is a need to recognize different levels of preparation by students entering college, in order that comprehensive testing, math instruction and guidance can be designed to fit the students' background. It is crucial for teacher education programs to meet the needs of prospective teachers, both males and females, in order to break the cycle of math avoidance that is increasing in the United States today.

Young (1979) is concerned with the effect of additional courses for prospective teachers to improve attitudes and increase knowledge. She believes it is very important that teachers enjoy mathematics and highly

rigorous courses have proven detrimental. Dutton (1961) had similar feelings, he believed that mathematics instruction should be provided according to the teacher's individual needs. His study indicated the level of achievement doubled in an unstructured course rather than a fast paced structured course. In a similar study by Gee (1964), prospective teacher's knowledge of mathematics was positively increased during one term of mathematics. This was also found in the Ruddell, Arden and Brown study (1970) where direct contact with the professor was the most significant factor in achievement.

Summary

The need to investigate the attitudes toward mathematics of prospective teachers is becoming more apparent to educators. The primary cause of this awareness is the rapid growth of science and technology in our society. This, along with the prospective teachers' potential influence has encouraged educators to investigate varous courses of action for mathematics education.

The history, theory, and research studies in this chapter provide a foundation for the hypothesis investigated in this research project. Evidence is provided that attitude research in teacher education is appropriate and that attitudes toward mathematics are related to other significant variables in education.

CHAPTER 3

METHODOLOGY AND PROCEDURE

This chapter includes the instrument, the design of the study, population and sample, and procedure used in collecting and analyzing the data.

The Instrument

The prospective teachers participating in this study were given an attitudinal scale, a basic understanding of mathematics test and a demographic information sheet. The first was the Revised Mathematic Attitude Scale (Aiken, 1974). This test yielded two scores: a measure of the students' reported enjoyment of mathematics (E) and a measure of the students' reported value of mathematics (V). The original Mathematics Attitude Scale was developed by Aiken (1972); it measured the affective dimension of teaching mathematics and has been used in numerous investigations. The scale used in this study combines the enjoyment of mathematics (E) and the importance and relevance of mathematics (V). Ten of the items on the scale are written in the direction of a positive attitude and the remaining ten are written in the direction of a negative attitude toward mathematics. The 13 items that denote enoyment of math and the seven

items that rate value were arranged in a format of the Likert-type. The students were asked to respond to the 20 attitudinal statements by marking either: strongly-disagree, disagree, undecided, agree or strongly agree to each statement. The responses to each item were assigned points, zero through four:

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Positive items	0	1	2	3	4
Negative items	4	3	2	1	0

A maximum score of 80 indicates an extremely positive attitude, a minimum score of zero an extremely negative attitude, and a score of 40 denotes a neutral attitude toward mathematics.

The second instrument, Iowa Test of Basic Skills, Level 14, Form 7, Test M, Mathematics Skills was administered to the prospective teachers. The test yielded three measures: Mathematics Concepts score, Mathematics Problem Solving Score and a mathematics ability score derived from the two subtests. The test is an objective type test consisting of 74 multiple choice items, 43 items dealing with math concepts and 31 items with problem solving. The score of the test is the total number of correct responses made by the students. The Mathematics Concepts Test covers the following: numeration, equations, whole numbers, fractions, decimals, geometry

and measurement. The Mathematics Problem Solving Test includes single and multiple step problems using addition, subtraction, multiplication, and a combination of the basic operations.

Design of the Study

The intent of this study was to investigate prospective teachers' attitudes toward mathematics. The design of the study included students who represented (1) all levels in the Elementary Education programs at Oregon State University/Western Oregon State College, (2) various mathematics backgrounds in high school and college, (3) small and large high schools, and (4) both sexes.

The design consisted of utilizing a One-Way Analysis of Variance to determine whether three or more sample means are significantly different from each other and the Newman-Keuls procedure was used following a significant F ratio in analysis of variance. The t-test was used to determine if a significant difference existed among teachers' attitudes, their basic understanding of mathematics and their sex. The t-test was also used to determine whether prospective teachers at Oregon State University and Western Oregon State College differ significantly from each other with respect to attitude and basic understanding of mathematics. Pearson Correlation coefficient was utilized to determine the relationship of attitudes towards mathematics and basic understanding of mathematics.

Population and Sample

The students were undergraduates enrolled in the Elementary Education program at Oregon State University or Western Oregon State College. The 166 prospective teachers at Oregon State University were enrolled in the Junior Block program, Student Teaching, or in Education 199 M, N or O course (an education class required for all Oregon State University elementary education majors) taken concurrently with Math for Elementary Teachers. The 48 prospective teachers at Western Oregon State College were enrolled in the Junior Block program. All of the students had completed at least one three hour Math for Elementary Teachers course. None of the sample had received a teaching certificate. Forty-five of the student sample had completed their student teaching experience.

Collection of Data

The data in this study consisted of the results of the Revised Mathematics Attitude Scale, Iowa Basic Skills Test and demographic information supplied by the participants. Two hundred fourteen prospective teachers completed the three instruments. The data were collected in the following manner: propsective teachers enrolled in Junior Block, Student Teaching or Ed. 199 M, N or O at Oregon State University and Junior Block at Western

Oregon State College completed the three instruments during one class period of Spring term 1985. The data-gathering instruments were administered by the researcher and collected at the end of the 60 minute time period. It was later found that the 214 prospective teachers responded to all items on the Revised Mathematics Attitude Scale. Not all items were completed on the Iowa Basic Skills Test due to the time limit required by this instrument.

Analysis of Data

The major focus of this study was to investigate the attitudes toward mathematics of prospective teachers. Basic understanding of mathematics was also investigated.

This study utilized a One-Way Analysis of Variance (ANOVA) which is called the F-test or F-ratio. This analysis is used when there are three or more independent groups and one dependent variable. It determines if the significance of the difference among the means of these groups is a function of chance alone (Sharp, 1979).

The statistical procedure is illustrated in the following explanation. The null hypothesis was analyzed by the One-Way Analysis of Variance (ANOVA) in order to test for significant differences of prospective teachers' attitudes toward mathematics and size of high school graduation class, mathematics background in high school and college and college class level. This method

is appropriate for testing for significant difference between the means of the groups. The variance of each group was tested for mean differences. The scores of all the subjects in the subgroups were then combined into one total group, and then the variance of the total group was computed. If the variance of the combined total group was approximately the same as the average variance of the separate groups, then there existed no significant difference between the means of the various groups. When the variance of the combined total group apparently was larger than the average variance of the individual groups, then a significant mean difference existed between two or more of the subgroups and the null hypothesis was not accepted.

If the null hypothesis was not accepted then a multiple comparisons test was conducted to determine where the specific differences existed between means for the individual groups. In this study, the Newman-Keuls procedure was used to analyze the results.

The t-test, a method used for testing significant difference between the means of only two groups, was utilized to determine whether Oregon State University and Western Oregon State College differ significantly from each other with respect to attitude and basic understanding of mathematics. The t-test was also used to determine significant difference of prospective teachers'

attitudes and basic understanding of mathematics and sex of student.

The Pearson Correlation coefficient was used to describe the strength of relationship between attitudes toward mathematics and basic understanding of mathematics.

CHAPTER 4

ANALYSIS OF DATA

This chapter presents the results of the data analysis relative to the investigation.

The demographic information supplied by the 214 participants in this study is shown in Table 1.

Sixty-five percent of the students were juniors and seniors in college and all were majors in elementary education at Oregon State University/Western Oregon State College. Thirty-seven percent of the students had graduated from a high school class size of 201-400 students. The percentage of males in this study (16%) was the same as the percentage of males that were enrolled in the School of Education at Oregon State University/Western Oregon State College in 1984-85 school year.

The mathematics background summary is shown in Table 2.

All of the students had taken at least one mathematics class in high school and one mathematics class in college. Twenty-nine percent of the students had taken four or more courses in high school and 28% of the students in the study had taken four or more courses in college. Of the 95 students who had taken general

Table 1

Summary of the Demographic Information in the Investigation

Student Information	Number of Students	Percent of Students
College class level:		
Freshman	28	13.1
Sophomore	46	21.5
Junior	69	32.2
Senior	71	33.2
Sex:		
Male	35	16.4
Female	179	83.6
Major:		
Elementary Education	214	100
Other	0	
High School Graduation Class Size:		
50 or less	23	10.7
51-200	75	35.0
201-400	79	36.9
401^{+}	37	17.3

Table 2

Mathematics Background of the 214 Prospective Teachers in the Study

High School Mathematics Background	Number of Students	Percent of Students
1 course	68	31.8
2 courses	28	13.1
3 courses	56	26.2
4+ courses	62	29.0

College Mathematics Background	Number of Students	Percent of Students
1 course	34	15.9
2 courses	73	34.1
3 courses	47	22.0
4+ courses	60	28.0

mathematics in high school, 28 had taken only the one general mathematics course. Sixty-nine percent of the students had taken first-year algebra and of these 147 students, 15 had taken only first year algebra. Thirty-seven percent of the students had completed first-year algebra, second-year algebra, and geometry while in high school.

There were 53 students who had taken a high school trigonometry course, 12 of these students had taken a high school calculus course.

The college mathematics background information revealed that 36% had taken Mathematics for Elementary Teachers and 18 students had taken college calculus, while 11 students had taken college trigonometry. There were 44 students (21%) who had only a college algebra course.

Summary

All of the students in the study were enrolled in the Oregon State University/Western Oregon State College School of Education, and all were working toward an elementary teaching certificate.

The high school mathematics background data showed that 69% had taken first-year algebra, 50% had taken second-year algebra and 37% had taken first and second-year algebra and geometry.

The college mathematics background data showed that 28% of the students had four or more courses in mathemmatics and 26% had only one college mathematics course.

Objective 1: Attitudes toward Mathematics

The primary objective of the study was to investigate the attitudes of prospective teachers toward mathematics.

The students involved in the study completed the Revised Mathematics Attitude Scale (Aiken, 1974), listed the elementary and secondary school subject liked most and least, the reasons for liking and disliking mathematics, and finally the students were asked to rate their general feeling toward mathematics on a scale of one to eleven.

A One-Way Analysis of Variance and Newman-Keuls Procedure were used in data analysis to establish the relationship of attitudes toward mathematics and five factors:

a. size of high school graduation class
b. high school mathematics background
c. college mathematics background
d. college class level

To determine the attitude of prospective elementary teachers towards mathematics the following hypothesis was tested.

Null Hypothesis H_o: There is no significant difference in the attitudes toward mathematics and:

a. size of high school graduation class

b. high school mathematics background

c. college mathematics background

d. college class level

e. sex of student

As reported in the Analysis of Variance tables the null hypothesis was rejected for high school mathematics background and college class level with respect to attitudes toward mathematics. Since there was a significant difference between groups, the Newman-Keuls Procedure was used to determine which group was significantly different. This determination is illustrated in the Newman-Keuls Procedure Tables where the means of the four groups are compared.

Attitudes and High School Mathematics Background

Table 3 indicates that there is a significant difference between the four groups for high school mathematics background on the Revised Attitude Mathematics Scale at the .05 level.

Table 3

Analysis of Variance for Attitudes toward Mathematics and High School Mathematics Background

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	2819.9899	939.9966	6.426*
Within Groups	210	30717.0194	146.2715	
Total	213	33537.0093		

F = .0003 at .05 level *significant at .05 level

Table 4 illustrates the differences in means between the four groups. Prospective teachers having four or more courses of math in high school have a more positive attitude than prospective teachers having only one or two courses of mathematics.

Table 4

Comparison of Differences in Mean Scores of Attitude and High School Mathematics Background using the Newman-Keuls Procedure

Group	Count	Mean
1 course	68	50.0735*
2 courses	28	50.0000*
3 courses	56	54.2500
4^{+} courses	62	58.6613
Total	214	53.6613

$\bar{X}^1 = \bar{X}^2$ $\bar{X}^2 = \bar{X}^3$ *significant at .05 level

$\bar{X}^1 = \bar{X}^3$ $\bar{X}^2 < \bar{X}^4$

$\bar{X}^1 < \bar{X}^4$ $\bar{X}^3 = \bar{X}^4$

Attitudes and College Mathematics Background

Table 5 shows the results of a comparison of attitude scores and college mathematics background. Significant difference was observed between the four groups at the .05 level of significance.

Table 5

Analysis of Variance for Attitudes toward Mathematics and College Mathematics Background

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	2417.3217	805.7739	5.437*
Within Groups	210	31119.6877	148.1890	
Total	213	33537.0093		

F = .0013 at .05 level *significant at .05 level

In discriminating differences between the four groups in Table 6, the analysis showed that prospective teachers having four or more courses of college mathematics are more positive than those having one to three courses of college mathematics.

Table 6

Comparison of Differences in Mean Scores of Attitudes toward Mathematics and College Mathematics Background using the Newman-Keuls Procedure

Group	Count	Mean
1 course	34	51.9412*
2 courses	73	51.1233*
3 courses	47	51.9574*
4 courses	60	59.0000
Total	214	53.6613

$\bar{X}^1 = \bar{X}^2$ $\quad \bar{X}^1 < \bar{X}^4$

$\bar{X}^2 = \bar{X}^3$ $\quad \bar{X}^2 < \bar{X}^4$

$\bar{X}^1 = \bar{X}^3$ $\quad \bar{X}^3 < \bar{X}^4$

*significant at .05 level

Attitudes toward Mathematics and Sex of Prospective Teachers

Table 7 reports the results of the comparison of attitudes toward mathematics and sex on the t-test. Significant difference was observed between the two groups. Males had significantly higher attitude scores than females.

Table 7

T-test - Attitude toward Mathematics and Sex

Group	Number of Cases	Mean	T Value	Degrees of Freedom	P-value
Female	179	52.8324	-2.16	212	.032
Male	35	57.800			

Attitudes toward Mathematics and High School Graduation Class Size

As reported in the Analysis of Variance tables there is no reason to reject the null hypotheses for attitudes toward mathematics and high school graduation class size. There are no differences among the levels of high school class size with respect to attitudes toward mathematics at the .05 level of significance. Table 8 reports the results of the comparison.

Table 8

Analysis of Variance for Attitudes toward Mathematics and High School Graduation Class Size

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	423.9615	141.3205	.896
Within Groups	210	33113.0479	157.6812	
Total	213	33537.0093		

Table 9

Comparison of differences in Mean Scores of Attitudes toward Mathematics and High School Graduation Class Size

Group	Count	Mean
50 or less	23	40.6522
51-200	75	53.1733
201-400	79	55.2025
401+	37	53.1351
Total	214	53.6449

No two groups are significantly different at .05 level.

Attitudes toward Mathematics and College Class Level

There were no differences among the levels of college classes with respect to attitudes toward mathematics. Table 10 reports the results of the comparison.

Table 10

Analysis of Variance for Attitudes toward Mathematics and College Class Level

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	245.6461	81.8820	.517
Within Groups	210	33291.3633	158.5303	
Total	213	33537.0093		

Table 11

Comparison of Differences in Mean Scores of Attitudes toward Mathematics and College Class Level

Group	Count	Mean
Freshman	28	51.9286
Sophomore	46	54.9783
Junior	69	52.7826
Senior	71	54.2985
Total	214	53.6449

*No two groups are significantly different at .05 level.

Revised Math Attitude Scale Scores

The findings indicate that 20% of the prospective teachers expressed an extremely positive attitude on the Revised Mathematics Attitude scale, 51% had a positive attitude, 26% indicated a neutral attitude and 3% had a negative attitude score. None of the students were found to have an extremely negative attitude. The mean score of 55.3 on the attitude scale portrays a positive attitude for the prospective teachers in the study. These findings are reported in Table 12.

Table 12

Distribution for Revised Mathematics Attitude Scale

Raw Score Interval	Frequency	Percentage
80-64	43	20
63-47	109	51
46-30	56	26
29-13	6	3
13-0	0	0

Responses to Attitude Statements on the Revised Mathematics Attitude Scale

The record of responses for 214 prospective teachers taking the attitude scale is shown in Table 13. The overall attitude of the sample tested is favorable toward mathematics.

Statements numbered 2, 4, 11, 14, and 17 all express a favorable attitude toward mathematics. More than 90% of the prospective teachers expressed agreement with statement 14, "Mathematics has contributed greatly to science and other fields of knowledge," while 87% agree with statement 17, "Mathematics helps develop a person's mind and teaches him/her to think." Over one-half of the students responded in a positive manner to Statement 2, "Mathematics is enjoyable and stimulating to me." Over 70%

of the students strongly agreed with statements 4 and 11, which express student interest in acquiring further knowledge and willingness to use mathematics outside of school.

Statements numbered 3, 5, and 10 express a negative feeling toward mathematics. Thirty-three percent of the students agreed or strongly agreed to statement 3, "Mathematics makes me feel uneasy and confused," while 16% responded that they had never liked mathematics and it was their most dreaded subject. Statement 10, "My mind goes blank and I am unable to think clearly when working mathematics," was felt by 17% of the prospective teachers.

Statements 1 through 13 deal with the enjoyment of mathematics while statements 14-20 express the value one places on mathematics. The prospective teachers indicated a profound respect for the subject, real enjoyment of working problems and they found the challenge of mathematics a pleasurable experience.

Table 13
Revised Mathematics Attitude Scale

Statement	Percentage of Students' Responses				
	SA	D	U	A	SA
1. I enjoy going beyond the assigned work and trying to solve new problems in mathematics.	8	31	21	33	7
2. Mathematics is enjoyable and stimulating to me.	8	20	20	67	8
3. Mathematics makes me feel uneasy and confused.	12	40	14	25	8
4. I am interested and willing to use mathematics outside school and on the job.	1	1	19	54	25
5. I have never liked mathematics, and it's my most dreaded subject.	41	36	7	12	4
6. I have always enjoyed studying mathematics in school.	10	42	12	29	7
7. I would like to develop my mathematical skills and study this subject more.	2	19	22	40	17
8. Mathematics makes me feel uncomfortable and nervous.	15	43	14	21	7
9. I approach mathematics with a feeling of hesitation resulting from fear of not being able to do math.	16	44	7	23	9
10. My mind goes blank and I am unable to think clearly when working mathematics.	20	50	13	14	3
11. I am interested and willing to acquire further knowledge of mathematics.	1	9	17	56	17
12. Mathematics is dull and boring because it leaves no room for personal opinion.	17	52	16	11	4
13. Mathematics is very interesting, and I usually enjoy courses in this subject.	4	21	27	37	11
14. Mathematics has contributed greatly to science and other fields of knowledge.	1	1	5	40	52
15. Mathematics is less important to people than art and literature.	21	48	20	10	2
16. Mathematics is not important for the advance of civilization and society.	43	50	4	1	1
17. Mathematics helps develop a person's mind and teaches him/her to think.	0.9	3	7	58	29
18. An understanding of mathematics is needed by artists and writers as well.	0	2	15	62	21
19. Mathematics is not important in everyday life.	47	48	2	1	1
20. There is nothing creative about mathematics; it's just memorizing formulas and rules.	26	52	12	10	0.4

Student Responses to Like/Dislike of Subjects

One hundred ninety-four students responded to the subjects liked most and least in elementary and secondary school. In elementary school, mathematics was the subject liked most by 25% and liked least by 31%. In secondary school 18% of the prospective teachers chose mathematics as the most liked subject and 39% listed mathematics as their least liked subject. Table 14 reveals the summary of the prospective teachers.

Table 14

Summary of the Number of Prospective Teachers that Expressed a Like or Dislike for Mathematics in Elementary/Secondary School

	Liked Mathematics the Most		Liked Mathematics the Least	
	Number	Percent	Number	Percent
Elementary School	50	25	60	31
Secondary School	34	18	75	39

Reasons for Liking and Disliking Mathematics

Students' statements relating to their feelings toward mathematics are listed in Table 15. One hundred twenty-one favorable statements were noted, while 113 unfavorable statements were listed by prospective

teachers. The responses were not grouped under large headings, in order to clearly show the types of feelings expressed and the range of responses.

When Tables 15 and 16 are combined, the number is larger than the number of participants in the study, because many of the prospective teachers listed responses for liking and disliking mathematics.

Twenty-four percent of the students responding expressed that the reason they enjoyed mathematics was because it is systematic and logical, 22% found mathematics challenging, and 17% listed mathematics as "fun." These students viewed mathematical problems as a game that they enjoyed solving. Only one person indicated good teachers as a reason for liking mathematics while 13% attributed poor teachers as the reason they disliked mathematics. Another 13% of the students thought mathematics was "too abstract" and they felt they did not "think or reason logically." Of the 113 prospective teachers responding, 13 felt mathematics was confusing and eight thought it was not useful in everyday life. Favorable statements of prospective teachers indicate the reasons for liking mathematics. A few of the sample statements are quoted:

> "My family is interested in math, we have always spent time working out problems."
>
> "I enjoy working with and applying math. I enjoy learning new things about it."

> "I like mathematics because I do it well, it is systematic and I can see definite results."
>
> "It is logical, it has well defined rules which build on one another. You can do interesting things with numbers."
>
> "It is logical, either you have it or you don't and I seem to have it. Math does not require subjective grading."

Quotations from prospective teachers show the quality of feelings expressed concerning dislike of mathematics.

> "I didn't like the math class, because the teacher was terrible, although I liked the subject."
>
> "It's frustrating at times when I can't find a solution becuase I refuse to give up."
>
> "The approaches we are forced to participate in while taking math in school. The pressures of math "tests."

Table 15

Reasons for Liking Mathematics

Statement	Number of Students Reporting
Systematic and logical	29
Challenging	27
Fun	20
Useful (practical)	20
I'm successful at it	11
I enjoy working with numerals	4
Math promotes thought	4
It is interesting	4
Good teacher	1
Total	121

Table 16

Reasons for Disliking Mathematics

Statement	Number of Students Reporting
Too abstract	15
Poor teachers	15
It is confusing	13
Lack of understanding	13
Frustrating	11
It is not useful in everyday life	8
Geometry	6
Fear of failure	5
Boring	5
Time consuming	5
Story problems	4
No creativity	4
Pressure	3
Algebra	2
Afraid to ask dumb questions	2
Too much memorizing	2
Total	113

Responses of Self-rating Scale of General Feelings toward Mathematics

The 214 students were asked to place a check above the number that indicated their general feelings toward mathematics on a scale of one to eleven. A check above 6 indicated a neutral feeling, a check above 1 a strongly

unfavorable feeling and an 11 indicated a strongly favorable feeling toward mathematics.

1	2	3	4	5	6	7	8	9	10	11
strongly against					neutral				strongly favor	

Table 17 shows the number of prospective teachers having positive, neutral, and negative feelings on the self-rating scale. One hundred and five students, representing 49% of the study sample declared themselves to be on the positive side. A neutral rating was indicated by 72 students or 34% of the students. Thirty-six prospective teachers (17%) rated themselves on the negative side of the attitude scale. This table indicates that prospective teachers in the study generally have favorable feelings toward mathematics.

Table 17

Responses to Self-rating Scale of General Feelings toward Mathematics

Scale Value	Frequency	Percent
1 (strongly against)	3	1.4
2	0	0
3	4	1.9
4	12	5.6
5	17	7.9
6 (neutral)	72	34.0
7	16	7.4
8	31	14.4
9	21	9.8
10	16	7.4
11 (strongly favor)	22	10.2

Summary

The significant aspects of prospective teachers' attitudes toward mathematics are indicated in the following statements:

1. Prospective teachers completing four or more courses of high school mathematics had a more positive attitude toward mathematics than students completing only one or two courses.
2. Prospective teachers completing four or more courses of college mathematics had a more

positive attitude toward mathematics than those having one, two, or three courses.

3. Males had a more positive attitude toward mathematics than females.
4. There were no significant differences among the students from various levels of high school graduation class sizes with respect to attitudes toward mathematics.
5. There were no significant differences among the students in various college levels (Freshman, Sophomore, Junior, Senior) with respect to attitudes toward mathematics.
6. Students' overall attitude on the Revised Mathematics Attitude Scale was favorable toward mathematics.
7. Mathematics was the least liked subject in elementary school by 31% of the students.
8. Mathematics was the least liked subject in secondary school by 39% of the students.
9. On the self-rating scale of attitudes toward mathematics, 49% of the students had a positive attitude.

Objective 2: Basic Understanding of Mathematics

The second objective of the study was to investigate the basic understanding of mathematics of prospective teachers.

There are no clear cut standards for acceptable mathematical understanding for prospective teachers but the Iowa Test of Basic Skills mean score at 57.97 indicates an acceptable level of skill. The sample group of prospective teachers can not be reported as extremely weak in mathematics. One hundred thirty-one students answered 80% or more items correctly while only six of the students scored less than 50% on the Iowa Test of Basic Skills.

Table 18

Distribution for Iowa Test of Basic Skills

Raw Score Interval	Frequency	Percent
70-74	31	14
69-65	37	17
64-60	31	14
59-55	32	15
54-50	37	13
49-45	17	8
44-40	17	8
39-35	16	7
34-20	6	3

A One-Way Analysis of Variance and the Newman-Keuls Procedure were used in data analysis to establish the

relationship of basic understanding of mathematics and the following factors:

a. size of high school graduation class

b. high school mathematics background

c. college mathematics background

d. college class level

The following hypothesis was tested:

Null Hypothesis H_o: There is no significant difference in the basic understanding of mathematics and:

a. size of high school graduation class

b. high school mathematics background

d. college class level

e. sex of student

As indicated in the Analysis of Variance tables the null hypothesis was rejected for high school mathematics background and college class level with respect to basic understanding of mathematics. Since there was a significant difference between groups, the Newman-Keuls Procedure was used to determine which groups was significantly different. This determination is illustrated in the Newman-Keuls Procedure tables where the means of the four groups are compared.

Basic Understanding of Mathematics and High School Mathematics Background

Table 19 indicates that there is a significant difference between the four groups for high school

mathematics background on the Iowa Test of Basic Skills at the .05 level.

Table 19

Analysis of Variance for Basic Understanding of Mathematics and High School Mathematics Background

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	2936.4984	978.8328	7.454*
Within Groups	210	27577.4455	131.3212	
Total	213	30513.9439		

F = .0001 at .05 level *significant at .05 level

Table 20 illustrates the difference in means between the four groups. Prospective teachers having four or more courses of mathematics in high school scored significantly higher on The Iowa Test of Basic Skills than prospective teachers having less than four courses. Students completing three mathematics courses scored higher than students completing two courses.

Table 20

Comparison of Differences in Mean Scores of Basic Understanding of Mathematics and High School Background using the Newman-Keuls Procedure

Group	Count	Mean
1 course	68	54.2353*
2 courses	28	51.0000*
3 courses	56	57.4464*
4^+ courses	62	61.7581
Total	214	56.8318

$\bar{X}^1 < \bar{X}^4$ $\bar{X}^2 < \bar{X}^3$ *significant at .05 level

$\bar{X}^2 < \bar{X}^4$ $\bar{X}^1 = \bar{X}^3$

$\bar{X}^3 < \bar{X}^4$

Basic Understanding of Mathematics and College Level

The college class level and basic understanding of mathematics results are described in Table 21. Significant difference was noted between the four groups at the .05 level of significance.

Table 21

Analysis of Variance for Basic Understanding of Mathematics and College Class Level

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	1182.8022	394.264	2.823*
Within Groups	210	29331.1417	139.6721	
Total	213	30513.9439		

F = .0328 *significant at .05 level

In discriminating the differences between the four groups in Table 22, the analysis showed that the freshman group was significantly different from the senior group. This difference is significant at the .05 level of significance. The scores of sophomores and juniors were not significantly different.

Table 22

Comparison of Differences in Mean Scores of Basic Understanding Mathematics and College Class Level using the Newman-Keuls Procedure

Group	Count	Mean
Freshman	28	61.1429
Sophomore	46	57.4565
Junior	69	57.6522
Senior	71	53.9296*
Total	214	56.8318

$\bar{X}^1 = \bar{X}^2$ $\bar{X}^2 = \bar{X}^3$
$\bar{X}^1 = \bar{X}^3$ $\bar{X}^2 = \bar{X}^4$
$\bar{X}^1 > \bar{X}^4$ $\bar{X}^3 = \bar{X}^4$

*significant at .05 level

Basic Understanding of Mathematics and High School Graduation Class Size

As the Analysis of Variance Table 23 describes there is no reason to reject the null hypothesis for basic understanding of mathematics and high school graduation class size. There are no differences among the students from various levels of high school graduation class size and the scores on the Iowa Test of Basic Skills at the .05 level of significance.

Table 23

Analysis of Variance for Basic Understanding of Mathematics and High School Graduation Class Size

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	149.8191	49.9397	.345
Within Groups	210	30364.1249	144.5911	
Total	213	30513.9439		

Table 24

Comparison of Differences in Mean Scores of Basic Understanding of Mathematics and High School Graduation Class Size*

Group	Count	Mean
50 or less	23	56.3043
51-200	75	56.1867
201-400	79	57.9241
401^{+} students	37	56.1351
Total	214	56.8318

*No two groups are significantly different at .05 level

Basic Understanding of Mathematics and College Mathematics Background

Table 25 indicates there is no reason to reject the null hypotheses for basic understanding of mathematics

with respect to college mathematics background. No significant difference at the .05 level was observed between the four groups. Therefore, the null hypothesis was accepted.

Table 25

Analysis of Variance for Basic Understanding of Mathematics and College Mathematics Background

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Between Groups	3	123.5917	41.1972	.285
Within Groups	210	30390.3522	144.7160	
Total	213	30513.9439		

Table 26

Comparison of Differences in Mean Scores of Basic Understanding of Mathematics and College Mathematics Background*

Group	Count	Mean
one course	34	55.1176
two courses	73	56.9589
three courses	47	57.3191
4^+ courses	60	57.2667
Total	214	56.8318

*No two groups are significantly different at the .05 level

Basic Understanding of Mathematics and Sex of Students

Table 27 presents the results of the comparison between basic understanding of mathematics and sex of the prospective teachers on the t-test. No significant difference was observed at the .05 level, so the null hypothesis is accepted.

Table 27

Comparison of Differences in Mean Scores of Basic Understanding of Mathematics and Sex of Students using T-test

Group	Count	Mean	T Value	Degrees of Freedom	P-Value
Female	179	56.2737	-1.55	212	.123
Male	35	59.6857			

Summary

The significant aspects of basic understanding of mathematics are indicated in the following statements:

1. Prospective teachers completing four or more courses in high school scored significantly higher on the Iowa Test of Basic Skills than students completing less than four courses
2. Freshmen scored significantly higher on the Iowa Test of Basic Skills than seniors

3. There were no significant differences among the students from the four levels of high school graduation class size with respect to Iowa Test of Basic Skills scores
4. There were no significant differences among the students of college mathematics background with respect to Iowa Test of Basic Skills scores
5. The basic understanding of mathematics was not significantly different for males and females

Objective 3: Compariosn of Oregon State University/Western Oregon State College Prospective Teachers

The third objective of the study was to investigate the attitudes and basic understanding of prospective teachers on the Oregon State University campus in Corvallis and Western Oregon State College campus in Monmouth.

As noted on Table 28, there is no significant difference between the two schools at the .05 level of significance on the t-tests.

Null Hypotheses H_o: There is no significant difference between attitudes toward mathematics of prospective teachers of Oregon State University and Western Oregon State College.

Null Hypothesis H_o: There is no significant difference between basic understanding of mathematics of prospective teachers at Oregon State University and Western Oregon State College.

Table 28

Oregon State University and Western Oregon State College Prospective Teachers - Attitudes toward Mathematics

Group	Number of Cases	Mean	T Value	Degrees of Freedom	P-value
OSU	166	53.6687	.05	212	.959
WOSC	48	53.5625			

Table 29

Oregon State University and western Oregon State College Prospective Teachers - Basic Understanding of Mathematics

Group	Number of Cases	Mean	T Value	Degrees of Freedom	P-value
OSU	166	57.1566	.74	212	.462
WOSC	48	55.7083			

Objective 4: Relationship of Attitudes toward Mathematics and Basic Understanding of Mathematics

The final objective of the study was to investigate the relationship of attitudes toward mathematics and basic understanding of prospective teachers.

Null Hypothesis H_o: There is no significant relationship between attitudes toward mathematics and basic understanding of mathematics of prospective teachers at Oregon State University and Western Oregon State College.

The Pearson Correlation Coefficient was utilized to describe in mathematical terms the strength of the relationship between attitudes toward mathematics and basic understanding of mathematics. The level of significance was reported at .001, therefore the null hypothesis was rejected. There is a positive correlation between attitudes and basic understanding of mathematics. Table 30 describes the correlational statistics.

Table 30

Pearson Correlation Coefficient - Attitudes toward Mathematics and Basic Understanding of Mathematics

Coefficient	.3955
Cases	214
Significance	P = .001

The relationship between attitudes toward mathematics is described in Tables 31 and 32. Of the 23 students who had extremely positive scores on the Revised Mathematics Attitude Scale (71-80 points) all 23 of the students scored 64% or higher on the Iowa Test of Basic Skills. Eleven of these prospective teachers scored 95% or higher.

On the negative side of the attitude scale the 24 students who scored the lowest on the Revised Mathematics Attitude Scale (23-38 points) only two students scored 95% on the Iowa Test of Basic Skills and 11 of the prospective teachers scored less than 64% on the test of basic understanding of mathematics.

Table 31

Relationship of Attitudes toward Mathematics and Basic Understanding of Mathematics of Students who had Extremely Positive Scores on Attitude Scale

Revised Mathematics Attitude Scale Score (80 items)	Iowa Test of Basic Skills (74 items)	Percentage Correct on ITBS
80	47	64
79	72	97
78	51	69
78	74	100
78	73	99
77	59	80
76	74	100
76	61	82
76	72	97
75	51	69
75	62	84
75	58	78
74	73	99
74	74	100
74	73	99
73	49	66
73	72	97
72	73	99
72	66	89
71	65	88
71	70	95
71	56	76

Table 32

Relationship of Attitudes toward Mathematics and Basic Understanding of Mathematics of Students who had Negative Scores on Attitude Scale

Revised Mathematics Attitude Scale Score (80 items)	Iowa Test of Basic Skills (74 items)	Percentage Correct on ITBS
38	52	70
38	56	76
38	41	55
37	61	82
36	45	61
36	57	77
35	68	92
35	43	58
35	46	62
34	80	95
34	38	51
33	53	72
33	67	91
32	73	99
31	45	61
31	52	70
31	36	49
30	59	89
28	62	84
27	61	82
26	37	50
25	21	28
24	35	47
23	20	27

Summary

The following information was found in analyzing the data:

1. The majority of prospective teachers at Oregon State University/Western Oregon State College have positive attitudes toward mathematics.
2. There is a positive significant relationship between attitudes toward mathematics and basic understanding of mathematics.
3. Prospective teachers who have had four or more courses of high school/college mathematics have a more positive attitude toward mathematics than did students having fewer courses.
4. Males have a more positive attitude toward mathematics than females.
5. There were no significant differences among students from various levels of high school graduation class size or college class level with respect to attitudes toward mathematics.
6. Prospective teachers who had completed four or more courses in high school scored significantly higher on the Iowa Test of Basic Skills than students completing less than four courses.
7. Freshmen scored significantly higher on the Iowa Test of Basic Skills than seniors.

8. There were no significant differences among high school graduation class size, of students, sex and college mathematics background with respect to basic understanding of mathematics.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter consists of four sections. First, the purpose of the study and research procedures are reviewed. Second, the findings are summarized based on the data presented in Chapter 4. Third, conclusions are formulated and presented on the basis of the findings. And fourth, recommendations are made based on the conclusions.

Summary

This study was initiated by an interest in investigating attitudes toward mathematics of prospective teachers. The literature review indicated that information gathered on this topic has been one of interest for the past 40 years and the research has been increasing. The literature also pointed out that prospective teachers generally have negative attitudes and they are frequently below average in understanding mathematics.

The two-fold purpose of this study was to investigate prospective teachers' differences in 1) attitudes

toward mathematics and 2) basic understanding of mathematics with respect to the following factors:

a. high school graduation class size
b. high school mathematics background
c. college mathematics background
d. college class level
e. sex of student

The participants provided additional information about their previous mathematics experiences and other demographic data.

Procedures

The purpose of this study was to investigate prospective teachers' attitudes toward mathematics and basic understanding of mathematics.

The instruments used in the investigation were the Revised Mathematics Attitude Scale and the Iowa Test of Basic Skills. The attitude scale analyzed the enjoyment and value of mathematics and the basic understanding of mathematics included math concepts and problem solving.

Prospective teachers at Oregon State University and Western Oregon State College made up the sample groups for the investigation. The prospective teachers consisted of 214 students, 166 at Oregon State University and 48 at Western Oregon State College. All of the

participants were in the elementary education teacher training program.

Analysis of Variance tested for significance differences among the mean scores for the four factors. All differences were tested at the .05 level of significance. T-tests were used to determine significant difference between sex and attitudes toward mathematics, and also to determine the differences between the prospective teachers at Oregon State University and Oregon State College with respect to attitudes and basic understanding of mathematics.

Findings

Null Hypothesis H_o: Prospective elementary teachers will have neutral attitudes toward mathematics

The results from the Revised Mathematics Attitude Scale and self-rating scale indicate that prospective teachers have relatively positive attitudes toward mathematics. Seventy-one percent of the students revealed a positive attitude on the Revised Mathematics Attitude Scale, the mean score of 53.6 portrays a positive attitude toward mathematics. On the self-rating scale 49% of the prospective teachers declared themselves as having a positive attitude.

Null Hypothesis H_o: There is no significant relationship between attitudes toward mathematics and basic understanding of mathematics of prospective elementary teachers.

There is a significant relationship between attitudes toward mathematics and basic understanding of mathematics. Therefore the null hypothesis was rejected. Using Pearson Correlation Coefficients it was noted that as attitudes toward mathematics scores increased the scores on tests of understanding increased.

Null Hypothesis H_o: There is no significant relationship between attitudes toward mathematics and basic understanding of mathematics of prospective elementary teachers at Oregon State University and Western Oregon State College.

The students on the two campuses are not significantly different with respect to attitudes and basic understanding of mathematics. The mean scores on the Revised Mathematic Attitude Scale were very similar on the two campuses:

Oregon State University = 53.6687

Western Oregon State College = 53.5625

The prospective teachers' mean scores on the Iowa Test of Basic Skills were slightly different, but not significantly different at the .05 level of difference.

Oregon State University = 57.1566

Western Oregon State College = 55.7083

Null Hypothesis H_o: There is no significant difference with respect to attitudes toward mathematics and:

a. high school graduation class size
b. high school mathematics background
c. college mathematics background
d. college class level
e. sex of student

The results from the Analysis of Variance technique indicated significant difference in attitudes toward mathematics and the following factors.

high school mathematics background
college mathematics background
sex of student

Therefore, the null hypothesis was rejected for these three factors and the Newman-Keuls procedure provided a comparison of mean scores on the Revised Mathematics Attitude Scale. Students having four or more mathematics courses in college had more positive attitudes than students completing, one, two, or three courses. Males had a more positive attitude toward mathematics than females. This significant difference occurred at the .05 level of significance.

No statistically significant difference developed in mean comparison of subjects from high school graduation class size and college class level. Prospective teachers graduating from schools of 40 or less students had slightly lower mean scores than the students in the other three groups.

Null Hypothesis H_o: There is no significant difference with respect to basic understanding of mathematics and:

a. high school graduation class size
b. high school mathematics background
c. college background
d. college class level
e. sex of student

Significant differences were found in basic understanding of mathematics and the following factors: high school mathematics background and college class level. Since the null hypothesis was rejected for these two factors, the Newman-Keuls Procedure provided a comparison of mean scores which indicated prospective teachers having four or more courses in high school are significantly different than the other three groups, and freshmen were significantly different from seniors. This significant difference occurred at the .05 level of significance.

No statistically significant differences developed in mean comparisons of:

high school graduation class size
college mathematics background
sex of student

For these three factors, the only factor that indicated a noticeable spread in mean scores was sex of students,

it showed males having slightly higher mean score on Iowa Test of Basic Skills than females.

Conclusion

The following conclusions were drawn from the results of the study and must be considered in view of the limitations indicated.

1. Prospective teachers have relatively positive attitude toward mathematics
2. There is a significant relationship between attitudes toward mathematics and basic understanding of prospective teachers.
3. There is no significant difference between Oregon State University and Western Oregon State College prospective teachers with respect to attitudes toward mathematics and basic understanding of mathematics.
4. There is a significant difference in attitudes toward mathematics and prospective teachers' high school and college mathematics background and sex of student.
5. There is no significant difference in attitudes toward mathematics and students' various graduation class size and college class level.

6. There is a significant difference in basic understanding of mathematics and prospective teachers high school mathematics background and college class level.
7. There is no significant difference in basic understanding of mathematics and students' various graduation class size and college class level.

Discussion

Teacher-education programs consist of prospective teachers with a variety of attitudes toward teaching, in particular attitudes toward mathematics. One effective way of understanding this diversity is to investigate the various factors that are significant, including basic understanding of mathematics.

Any discussion of the results from a study of this type must be considered within any researcher's ability to measure attitudes. The issue of measuring attitudes is subject to debate and discussion in the literature. Attitude scales are direct self-report measures and therefore have a disadvantage; the main disadvantage is that one cannot be sure of the degree to which the students' responses reflect his/her true attitude (Borg and Gall, 1983). Neale (1969) for example, argues that attitudes are difficult to measure and have little effect

on achievement in the subject area. Fishbein and Ajzen (1977) suggest that specific behavior can be predicted from measures of attitudes toward the specific behavior. Aiken (1970) agrees and states that rather than dismissing attitudes as not worth concern, what is needed is research covering the entire domain of affective and cognitive variables in the learning of mathematics. Thus, the literature, although not conclusive, tends to support the assumptions of this study that attitudes toward mathematics can be measured.

The results of this study can be of value to educators, particularly in the area of teacher education. Most of the prospective teachers in this study will be in elementary classrooms in the next one to three years and will be making an impact on elementary children each year. As Fennema (1977) states, "Teachers are the most important educational influences on students' learning of mathematics." The results of this study indicate that, for the most part, prospective teachers have a favorable attitude toward mathematics, and view mathematics as challenging, useful, and appreciate its systematic and logical constructs. One explanation for this positive attitude could be attributed to the increased number of mathematics courses required of high school and college students. More students understand mathematics and therefore have a more favorable attitude

than prospective teachers have had in the past. Another explanation for the positive attitude toward mathematics is that mathematics instruction has changed in the past ten years and the students in this sample were in elementary and high school during this time period. Since 1975, inservice training, workshops, and mathematics classes for teachers have emphasized student participation with a manipulative and problem solving approach to learning rather than teacher directed, directed, workbook approach to learning that was popular in the past. Regardless of the explanation, there is no doubt that the higher attitude ratings are noteworthy. Further information is needed to address the concerns of the language used and the measurement on the attitude scale. One of the limitations is the difficulty to measure attitudes with language that has a number of definitions and meanings. Another limitation is the scoring of a negative-positive scale. Additional study is recommended to address the problem.

There are several arguments presented as to why male students have a more positive attitude toward mathematics than females. The entire idea of mathematics attitudes with respect to gender is receiving increased attention in research, but the question remains if differences in genetics, heredity, environment or instructor treatment is the cause of male attitudes toward mathematics. This does not mean mathematics anxiety is a feminist issue,

as Tobias (1978) stated, "Some men as well as the majority of women have been denied the pleasure and power that competence in mathematics and science can provide."

The prospective teachers in this study also showed a reasonable skill level in mathematics understanding. The freshmen participating in this study scored significantly higher on the Iowa Test of Basic Skills than seniors. It appears that an investigation of the relationship of the content of college mathematics courses and the knowledge measured on the Iowa Test of Basic Skills is needed. Today, with the emphasis on science and technology, an adequate knowledge of mathematics is essential. Properly prepared teachers are likely to provide the stimulus which will inspire their students to gain knowledge and will excite them to continue to study mathematics. There are a variety of occupations opened to those who approach mathematics with a positive feeling instead of fear and anxiety. Evidence exists that knowing algebra and geometry will make the difference between passing and failing tests such as civil service and federal service examinations (Tobias, 1978). The occupations students choose should not be based on a fear of mathematics but instead be based on the knowledge and confidence mathematics provides.

Teachers with basic understanding in mathematics and a positive attitude will frequently instill in their students an enthusiasm for learning and provide them with

the knowledge they need to survive in this age of science and technology.

Fortunately, teacher education programs at Oregon State University/West ern Oregon State College are beginning to understand the needs of prospective teachers. The study indicates that students on the two campuses have a reasonable skill level in understanding mathematics concepts and problem solving and their attitude toward mathematics is relatively positive. The Oregon State University/Western Oregon State College elementary teacher-education program offers a comprehensive mathematics preparation for prospective teachers including mathematics method courses, projects and elective courses and practical school experience. Teh field experiences introduce the student to a variety of teaching techniques and methods in the public school setting. Prospective teachers who successfully complete the mathematics component at Oregon State University/Western Oregon State College should be prepared to teach mathematics and make impact on future mathematics curriculum.

Recommendations

The following recommendations are suggested for further investigation:

1. Continued measurement and refinement of attitude scales is necessary so that the instrument measures what it purports to measure. Additional

investigation of the language used and the scoring process of the attitude toward mathematics scale is needed.

2. Investigation of the relationship of the content of college mathematics courses and the knowledge measured on the Iowa Test of Basic Skills.
3. A study, similar to the present study, should be made with certified teachers. A comparison of prospective teachers and certified teachers would give further insight as to the attitudes toward mathematics and basic understanding of mathematics.
4. A study similar to the present study should be made with prospective secondary teachers. A comparison of the two gorups would give additional information as to attitudes and basic understanding of mathematics at the college level.
5. A control and experimental group of prospective teachers should be studied in relation to the effect of the Mathematics Projects courses - Ed. 199 M, N, and O, required of all Oregon State University elementary education majors.
6. There is a need for a longitudinal study to assess whether the attitudes and understanding of mathematics change after completion of the teacher education program.

7. An attitudes toward mathematics survey should be used at the beginning of the teacher training program to determine the students' attitude toward mathematics. The student and instructor would be aware of the students' attitudes and could work together to maintain a positive attitude or promote a more positive attitude toward mathematics.
8. There is a need for the elementary education and mathematics departments to jointly address the issue of attitudes and basic understanding of mathematics.

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APPENDICES

APPENDIX A

Demographic Information

Instructions: The purpose of the information requested is to obtain personal data about students currently taking Education courses at Oregon State University and Western Oregon State College. Please check ( ) those items which are true in your case.

1. Last 6 digits of your Social Security number _____

2. Sex

   _____Male

   _____Female

3. Class level

   _____Freshman

   _____Sophomore

   _____Junior

   _____Senior

   _____Graduate

   _____Other (identify_____)

4. Major

   _____Elementary Education

   _____Other (identify_____)

5. High School Mathematics background

   _____None

   _____General mathematics

   _____First-year algebra

   _____Second-year algebra

   _____Geometry

   _____Trigonometry

   _____Calculus

   _____Other (identify_____)

6. College Mathematics background

_____None

_____College algebra

_____Other(s) (identify_____)

7. Size of graduation class

_____50 or less _____201-400

_____51-200 _____401+

8. Elementary school subject liked most _____

Elementary school subject liked least _____

9. High School subject liked most _____

High School subject liked least _____

10. Place a check above the number that indicates your general feeling toward mathematics

1	2	3	4	5	6	7	8	9	10	11
strongly against					neutral					strongly favor

11. List your reasons for liking mathematics:

List your reasons for disliking mathematics:

APPENDIX B

Revised Mathematics Attitude Scale

DIRECTIONS: Draw a circle around the letter(s) that show(s) how closely you agree or disagree with each statement. SD (Strongly Disagree), D (Disagree), U (Undecided), A (Agree), SA (Strongly Agree).

1.	I enjoy going beyond the assigned work and trying to solve new problems in mathematics.	SD	D	U	A	SA
2.	Mathematics is enjoyable and stimulating to me.	SD	D	U	A	SA
3.	Mathematics makes me feel uneasy and confused.	SD	D	U	A	SA
4.	I am interested and willing to use mathematics outside school and on the job.	SD	D	U	A	SA
5.	I have never liked mathematics, and it is my most dreaded subject.	SD	D	U	A	SA
6.	I have always enjoyed studying mathematics in shcool.	SD	D	U	A	SA
7.	I would like to develop my mathematical skills and study this subject more.	SD	D	U	A	SA
8.	Mathematics makes me feel uncomfortable and nervous.	SD	D	U	A	SA
9.	I appraoch mathematics with a feeling of hesitation resulting from fear of not being able to do math.	SD	D	U	A	SA
10.	My mind goes blank and I am unable to think clearly when working mathematics.	SD	D	U	A	SA
11.	I am interested and willing to acquire further knowledge of mathematics.	SD	D	U	A	SA
12.	Mathematics is dull and boring because it leaves no room for personal opinion.	SD	D	U	A	SA
13.	Mathematics is very interesting, and I usually enjoy courses in this subject.	SD	D	U	A	SA
14.	Mathematics has contributed greatly to science and other fields of knowledge.	SD	D	U	A	SA

15.	Mathematics is less important to people than art and literature.	SD D U A SA
16.	Mathematics is not important for the advance of civilization and society.	SD D U A SA
17.	Mathematics helps develop a person's mind and teaches him/her to think.	SD D U A SA
18.	An understanding of mathematics is needed by artists and writers as well.	SD D U A SA
19.	Mathematics is not important in everyday life.	SD D U A SA
20.	There is nothing creative about mathematics; it's just memorizing formulas and rules.	SD D U A SA

APPENDIX C

Facsimile of Cover Letter for Prospective Teachers

Thank you for participating in this study. The results of the test and attitude scale are strictly confidential. You will be asked to use the last six digits of your Social Security number only so the researcher can match the test and attitude scale. The results will not be used in any way connected with the grading of this or any other course.

I appreciate you giving your time and effort for this study.

Patricia J. Wall

APPENDIX D

Demographic Information for Oregon State University/Western Oregon State College Prospective Teachers

Sex of Student

	Female	Male
OSU	138	28
WOSC	41	7
Percentage	83.6	16.4

College Level

	Freshman	Sophomore	Junior	Senior
OSU	28	46	39	53
WOSC	0	0	30	18
Percentage	13	22	32	33

High School Mathematics Background

	1 course	2 courses	3 courses	4+ courses
OSU	43	25	44	54
WOSC	25	3	12	8
Percentage	32	13	26	29

College Mathematics Background

	1 course	2 courses	3 courses	4+ courses
OSU	17	59	38	52
WOSC	17	14	9	8
Percentage	16	34	22	28

High School Graduation Class Size

	-50	51-200	201-400	401+
OSU	14	60	61	31
WOSC	9	15	18	6
Percentage	11	35	37	17