AN ABSTRACT OF THE THESIS OF

Duanghathai Katwibun for the degree of Master of Science in Mathematics Education presented on March 9, 2000. Title: The Relationships between Thai Girls' and Boys' Attitudes and Beliefs about Mathematics and Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

Redacted for Privacy

Abstract Approved:_

Dianne K. Erickson

The intention of this study was to explore the relationships between Thai middle school girls' and boys' attitudes and beliefs about mathematics and mathematics achievement, future mathematics coursework intentions, and career interests. Participants in this study were 523 students who were enrolled in The Chiang Mai University Demonstration School during the first semester of the 1999 school year. In order to measure the students' attitudes and beliefs about mathematics, a questionnaire was developed from the Fennema-Sherman Attitudes Scale (Mulhern & Rae, 1998) and Indiana Mathematics Beliefs Scale (Kloosterman & Stage, 1992). Students' mathematics achievement was obtained from their final mathematics grades at the end of the semester. Students' future mathematics coursework intentions questionnaire was developed from Throndike-Christ's (1991) study. Finally, students' career interests questionnaire was rated according to Goldman and Hewitt's (1976) science/math continuum.

The findings revealed that Thai middle school students had positive attitudes and beliefs about mathematics. The students had good mathematics achievement and demonstrated a moderate likelihood to take optional future mathematics coursework. Many students were interested in careers related to mathematics and science fields.

Focusing on grade level, those students in higher grades expressed lower motivation, confidence in learning mathematics, and mathematics achievement. On the other hand, they showed stronger beliefs about mathematics as a male domain and the usefulness of mathematics and had stronger interests in careers related to mathematics and science fields than students in lower grades.

Overall, no gender differences in motivation and confidence in learning mathematics surfaced. However, gender differences favoring boys were found in students' beliefs about mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort. Boys also indicated more willingness to take optional mathematics coursework and displayed stronger interests in careers related to mathematics and science fields. The only gender difference favoring girls was mathematics achievement. The regression findings revealed that attitudes and beliefs about mathematics variables were predictive of students' mathematics achievement, future mathematics coursework intentions, and career interests.

The Relationships between Thai Girls' and Boys' Attitudes and Beliefs about Mathematics and Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

by
Duanghathai Katwibun

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirement for the degree of

Master of Science

Completed March 9, 2000
Commencement June 2000

Master of Science thesis of Duanghathai Katwibun presented on March 9, 2000

APPROVED:

Redacted for Privacy

Major Professor, representing Mathematics Education

Redacted for Privacy

Chair of Department of Science and Mathematics Education

Redacted for Privacy

Dean of Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to readers upon request.

Redacted for Privacy

Duanghathai Katwibun, Author

ACKNOWLEDGMENTS

First and foremost, I would like to express my thanks to the Thai Government, my employer and sponsor, for giving me the opportunity to work for the Masters Degree at Oregon State University. I am truly appreciate to all the officers in the Education Faculty of Chiang Mai University who made the decision to award me the scholarship that ultimately made all this possible.

I am grateful to The Chiang Mai University Demonstration School for allowing me to collect the data. Special thanks to Ms. Haruethai who helped me collected the data for this thesis.

I wish to express my sincere gratitude and appreciation to my advisor, Dr. Dianne K. Erickson for her encouragement, meaningful suggestions, warm support, improvement of the writing of the thesis and guidance throughout my years of graduate work and especially during the research process. Sincere thanks to the members of my Masters Committee, Dr. Thomas P. Dick, Dr. Margaret L. Niess and Dr. Barry F. Sherr, for their valuable professional directions as well as their suggestions in the completion of this thesis.

I am grateful to all of my best friends for their help, encouragement, thoughtful comments, and warm friendship during my study. Finally, my utmost thanks to my parents and my lovely sisters for their love, understanding, motivation, time and consulting to assist with and provide encouragement, which made everything possible.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

The Relationships between Thai Girls' and Boys' Attitudes and Beliefs about Mathematics and Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

CHAPTER I

THE PROBLEM

Introduction

Attitudes and beliefs about mathematics are important in education because they may affect students' academic performance and their future planning, which will ultimately impact their future lives. In this middle school study, relationships among these affective variables and girls' and boys' mathematics achievements, future coursework intentions, and career interests were explored.

Twenty-five years ago, most students did not take mathematics beyond their first or second year in high schools. Many students did not like the mathematics that they took and did not find it to be useful (Burrill, 1998). Burrill also noted that in recent years, some improvement in this regard has been evidenced. More students than ever before are taking more years of mathematics study. Their national test scores are gradually increasing (1998). However, students in some countries, such as Columbia, South Africa, and the United States scored lower than average on the Third International Mathematics and Science Study [TIMSS]. Thai students' scores were at the average on the TIMSS study. However, other countries such as Japan, Korea, and Netherlands scored above average (Beaton et al., 1997).

However, achievement in mathematics is becoming a prerequisite for many occupations such as engineering and science, an increasing number of students seem unable to succeed in mathematics (Borasi, 1990). Also, citizenship in the world requires higher mathematics literacy. Therefore, the discussion about developing students' mathematics achievement in K to 12 education has been given increased emphasis.

Since the emphasis on achievement has gained importance, affective issues such as attitudes and beliefs have earned an important focus in mathematics learning and instruction. Current efforts toward reform in mathematics education focus on the crucial role of affective domains (McLeod, 1992). The National Council of Teachers of Mathematics [NCTM] (1989) has reconfirmed the significance of affective issues in its publication of the Curriculum and Evaluation Standards for School Mathematics (1989), which is the framework for raising mathematics achievement. The NCTM standards stated, "[Students will]...build beliefs about what mathematics is, about what it means to know and do mathematics, and about children's views of themselves as mathematics learners. Thus, affective dimensions of learning play a significant role in, and must influence curriculum and instruction" (p.16). Silver, Strutchens, and Zawojewski (1997) reaffirmed that students' mathematics achievements can be affected by affective factors such as students' attitudes, beliefs, and emotions about mathematics and about themselves as mathematics learners. Furthermore, affective factors have also been shown to be significant determinants of students' decisions to take optional mathematics coursework and choose their occupations in the future (Silver et al., 1997; Thorndike-Christ, 1991). This realization is crucial because it opens up possibilities for how we might improve mathematics teaching and curriculum. Improvement of students' attitudes and beliefs may also help students to achieve in learning mathematics.

The classification of the general objectives of instruction in terms of school subject matter is not enough to explain the ultimate goals of education. One may gain more insight into educational outcomes by performing a psychological analysis of the objectives into the attainment of intellectual capabilities and social insights (cognitive development), the learning of practical active skills (psychomotor development), and the improvement of emotions, attitudes, and values (affective development) (Borich & Tombari, 1997).

During preschool years cognitive processes start with the acquisition of early language and numerical abilities, and continually develop to dominate education during the secondary and higher level. Regarding psychomotor development, teachers focus on the promotion of coordinated skills and their creative use. Teaching starts with the characteristic of earlier years of schooling including the act of handwriting, painting, workshop skills, and practical science. The development of affective learning throughout the whole process of schooling is not often obvious. Teachers may be self-conscious and self-critical about students' behaviors, which were affected from affective domains. The acquisition and application of values, attitudes, and beliefs are most marked by the time of adolescence and influence the general lives of the teenagers. The instruction of science and mathematics has the possibility of assisting in the development of a positive attitude toward cognitive outcomes (Clewell, Anderson, & Thorpe, 1992).

At the age of early adolescence, affective domains often influence the general lives and discussions of young individuals. In addition, the middle school years are filled with many issues for students. For instance, juvenile girls often become less self-assured at school (Clewell et al., 1992). Meanwhile, adolescent boys also form personal gender identification and their view of femininity and masculinity are reinforced (Whitney and Hoffman, 1998). Fennema (1996) noted that at the middle grade level girls' attitudes toward mathematics change, while girls in elementary school level describe themselves as confident in doing mathematics. As they go through middle school level, this confidence, and the degree to which girls consider mathematics a subject, which is appropriate for girls to fulfill declines. Furthermore, students at this level have to consider academic options and make decisions about course selections that will affect their future career choices. Therefore, the middle school years are an opportune time to explore the relationship of affective, cognitive, and gender issues.

Over the years, numerous research studies have examined the relationships between mathematics performance and various affective factors. For instance, students' attitudes toward mathematics and their beliefs about mathematics such as their confidence in their ability to learn mathematics, and their perception of the utility of mathematics all affect their performance (e.g., House, 1993; Ibe, 1994;

Kloosterman & Stage, 1995; Ma & Kishor, 1997; Signer, Bleasley, & Bauer, 1996; Telese, 1997; Vanayan, White, Yuen, & Teper, 1997; Wilson, 1995).

McLeod (1992) mentioned attitudes as the "affective responses that involve positive or negative feelings of moderate intensity and reasonable stability" (p.581). Furthermore, attitudes have also been considered as one of the affective domains. Why are attitudes an interesting area of study for many educators? Rajecki (1990) stated that "it is because so much of our personal and social lives are touched by psychological attitudes...there is a pervasive impression in the lay person and the scientist alike that our behavior is seen as the effect...[therefore] knowing a person's attitudes gives us confidences that we can predict or anticipate his or her actions in general" (p.3-6). However, while research on attitudes, especially the relationship between attitudes toward mathematics (ATM) and achievement in mathematics (AIM), has been studied since the 1970s, these have failed to provide consistent findings regarding this relationship.

Some researchers have demonstrated that the ATM-AIM correlation was quite low. Thus, they concluded that the relationship between ATM-AIM was weak (e.g., Ma & Kishor, 1997; Reynolds & Walberg, 1992). On the other hand, some studies have revealed that the attitudinal variables are strongly significant predictors of mathematics achievement. The correlation of the relationship was strong. Therefore, these conclusions showed the view of a strong relationship between ATM and AIM (e.g., Kloosterman, 1991; Loebl, 1993). The various findings of this relationship from different countries may be the result of many other factors. These may include: ethnicity; expectations of the society; and the examination system, which affect students attitudes and their mathematics performance in the school systems in which this relationship had been investigated. These factors may be created differently in school systems in other countries (Mahamad-Ali, 1995). Consequently, the research on the ATM-AIM relationship needs more investigation in order to find more evidence about the relationship.

Furthermore, a number of studies have identified some factors as having important affects on the relationship between ATM and AIM. Attitudes, beliefs, gender, grade, and ethnicity are the basic variables in the examination of this relationship (e.g., Ma & Kishor, 1997; Sayer, 1994; Singer et al., 1996). Research on beliefs in mathematics education has become a significant thread linking numerous studies of both teachers and students (McLead, 1992). Kloosterman (1996) noted that beliefs are a significant part of the motivational puzzle in mathematics. Many beliefs about mathematics account for motivation on both computational and problem solving-oriented mathematics tasks. The beliefs are categorized into two basic types: beliefs about mathematics as a discipline and beliefs about mathematics as a learner (Kloosterman, 1996).

Among many other authors, Garofalo (1989), Kloosterman (1996), McLeod (1992), and Schoenfeld (1989) have written about the meaningfulness of beliefs about mathematics as a discipline. For instance, Garafolo (1989) mentioned that at the secondary level students believe that nearly all of mathematics problems can be solved by the direct application of the facts, formulas, rules, and solutions given by the teacher or given in the textbook. These beliefs lead to the concept that mathematics consists of being able to remember, apply facts, rules, formulas, and procedures. Kloosterman (1996) mentioned that regarding a motivational perspective, students who believe that mathematics is rules and procedures are motivated to try to memorize those rules and procedures. They do not attempt to gain insight into concepts or make connections between mathematics topics.

Beliefs about mathematics as a learner are a broad perspective, but are very consequential factors in terms of motivation, which is a unique predictor of mathematics performance (Reynolds & Walberg, 1992). Students come to mathematics classes with expectations about what they and their teacher require for them to do in learning mathematics. When the students could not do what teachers expected, motivation was often affected (Nickson, 1992). Some beliefs about learning mathematics, such as that memorization is important in mathematics, and that anyone can learn mathematics, appear to be significant in the motivational patterns of students. However, the significance of these beliefs varies among different students. It could not be said that one is necessarily a greater motivational factor than any others are (Kloosterman, 1996).

As mentioned above, these beliefs related to students' motivation, which had an affect on their mathematics performance. Hence, it is important to explore what students' beliefs in mathematics are, especially in other countries, since most of the studies have been conducted in the United States.

Gender differences in mathematics achievement have been studied over the past three decades. Maccoby and Jacklin (1974) directed one of the first comprehensive reviews of research on gender differences in cognitive abilities. From an analysis of more than 100 studies, they found that boys surpassed girls in mathematics achievement. They also reported that there were few sex differences prior to age 12 or 13; after which, boys' improved mathematics performance increased faster than girls' did. In the same way, Halpern (1986) noted that reliable gender differences in mathematics achievement did not emerge until age 13 to 16.

In the 1970s, the Fennema-Sherman studies (Fennema & Sherman, 1977, 1978) reported that gender could be linked to differences in performance and participation in grades 6 to 12. They found differences in selection of advanced level mathematics courses by girls and boys. They noted that more boys participated in advanced mathematics courses than girls did. Affective factors were investigated in the Fennema-Sherman studies as well. Regarding beliefs about the usefulness of mathematics and confidence in learning mathematics, they found that boys provided evidence that they had more confidence in learning mathematics than girls. Boys also believed that mathematics was and would be more beneficial to them than girls did. It also became obvious that while boys did not strongly believe the stereotype of mathematics as a male domain, they did believe much more strongly than girls did that mathematics was more appropriate for males than females (Fennema, 1996). Silver et al. (1997) added that from interesting results of National Assessment of Educational Progress (NAEP) findings regarding race/ethnicity and gender overall of white, African American, and Hispanic students at grades 8 and 12 either disagreed or strongly disagreed with the statement that mathematics is more for boys than girls. However, there was no information about Asian students from the findings.

Interestingly, later research suggested that gender differences in mathematics achievement were declining, and in some cases were eliminated (e.g., Ethington ,1990; Hype, Fennema, & Lamon, 1990; Linn, 1991). For example, Ethington (1990) reported a study of the results in 8 of 24 countries including Thailand involved in The Second International Mathematics Study (SIMS). There were no substantial gender differences in any of the content areas, and when any slight effects were noted they favored girls more often than boys at the seventh and eighth grade levels.

The considerable research mostly has been conducted on the relationship between students' beliefs and attitudes toward mathematics and mathematics achievement with students in the United States. Moreover, little data is available about the relationship between students' beliefs and attitudes toward mathematics and mathematics achievement in Thailand (e.g., Tocci, 1991; Beaton et al., 1997). For instance, Beaton et al. (1997) reported findings from TIMSS. The findings revealed some interesting characteristics of Thai students at the middle school level; Thai girls and boys at seventh and eighth grade levels had approximately similar average mathematics achievement. Moreover, they also generally had positive attitudes toward mathematics, and that those students with more positive attitudes had higher mathematics performance. Thence, from the TIMSS findings, it seems that attitude toward mathematics effects Thai students' mathematics achievement at the middle school level. In order to confirm this, a further study in Thailand needs to be done.

Nowadays, a larger amount of women are in the paid labor force than ever before. Despite the significant increase of women participation in labor force, most women are employed in a narrow range of careers involving teaching, nursing, and other female-dominated occupations. They are still underrepresented in scientific, technical, and mathematical fields (National Science Foundation [NSF], 1990). Gender segregation in the labor force is related to women's course selections in high school and college (Meece, 1996). In addition, House (1993) noted that many career options such as engineering and business require higher mathematics skills. Lower mathematics achievement could restrict students' choices of college majors and impact their subsequent career paths. Therefore, the research on girls' and boys' achievement in mathematics, their future mathematics coursework, and their future career plans need to be examined.

In conclusion, the results of the previous research revealed that the relationship between ATM and AIM has inconclusive results. Girls' and boys' attitudes and beliefs might affect students' future mathematics coursework intentions and career paths. Furthermore, in Thailand, little research has been done in this area. Therefore, the relationship between girls' and boys' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework, and career plans need to be investigated.

Statement of the Problem

The purpose of this study was to examine the relationships between girls' and boys' attitudes and beliefs about mathematics and mathematics achievement, future mathematics coursework intentions, and career interests in Thailand at the middle school level at the Chiang Mai University Demonstration School. The research questions investigated for this study were as follows:

1. What are Thai middle school students' attitudes and beliefs about mathematics?

2. What are Thai middle school students' mathematics achievement, future mathematics coursework intentions, and career interests?

3. Do Thai middle school students' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework intentions, and career interests differ by grade level and gender?

4. What are the relationships between Thai middle school students' attitudes and beliefs about mathematics and mathematics achievement, future mathematics coursework intentions, and career interests?

Many factors affect students' mathematics achievement, future coursework intentions, and career plans. This study focused on two affective factors: attitudes toward mathematics and beliefs about mathematics. Regarding attitude variables, the effective motivation of mathematics was highlighted since this attitudinal factor appears to relate to mathematics achievement (Telese, 1997). Belief variables, such as mathematics as a male domain and the usefulness of mathematics also related to students'achievement (Kloosterman, 1991).

There is now widespread agreement among social psychologists that the term of attitudes should be mention to a general and enduring positive or negative feeling toward persons, objects, or issues (Mueller, 1986). The statements "I like mathematics" and "I hate rats" should be considered as attitudes because they express a general positive or negative feeling about something. There is no right or wrong to having those feelings (Ruggiero, 1998). On the other hand, the statements " Mathematics is useful" and "Rats love cheese" are both examples of beliefs. The term belief is reserved for the information that a person has about other people, objects, and issues. The information may be factual or only one person's ideas. The beliefs may have positive, negative, or no evaluative implications for the target of the beliefs (Petty & Cacioppo, 1996). Beliefs can be tested for reasonableness, unlike feelings and behaviors (Ruggiero, 1998). Both attitudes and beliefs are built from experiences and take time to construct. But attitudes and beliefs are not entirely stable; they can be changed when environment or conditions change (Ruggiero, 1998). The statements such as "studying hard in learning mathematics" or "throw cheese away" represent behavior. Behaviors may also have positive, negative, or no evaluative implication for the target of the behavior (Petty & Cacioppo, 1996).

Recently, there is a new attitude definition by Ruggiero (1998). He said " an attitude is an habitual emotional response driven by beliefs" (p. 12). Therefore, attitudes become the eminent concept because of the important psychological functions that attitudes were thought to serve and because of the presumed capabilities to direct or predict behaviors. Beliefs were thought to involve behaviors only because they contributed to the formation of attitudes (Petty & Cacioppo, 1996).

Beliefs and attitudes toward mathematics may be positively related to mathematics achievement, plans to take advanced level mathematics courses, and explicit interests in mathematical career fields, especially for students at the middle school age (Beaton et al., 1996; Throndike-Christ, 1991). Furthermore, belief and attitude scores may be able to predict mathematics achievement, future mathematics coursework intentions, and career interests (Thorndike-Christ, 1991). Regarding TIMSS study (Beaton et al., 1997), nowadays boys in Thailand may still have more positive attitudes toward mathematics. This may cause boys to show more initiative to take advanced level mathematics courses and to show more interest in mathematical career fields than girls. If this is the case, young Thai women may have fewer opportunities for future educational career choices.

Significance of the Study

Thailand, in Southeast Asia, is situated in the Indochina peninsula. It is bordered on the immediate east by Cambodia, on the northeast by Laos, on the northwest and west by Burma, on the south by Malaysia, and on the southeast and east by the South China Sea and the Gulf of Thailand. The country is 518,000 square kilometers (about 200,000 square miles) in area. Its widest part is 750 km, its longest 1,620 km.

Thailand has developed a fairly sophisticated system of education using systems of western nations as a model. The school system is organized into four levels: (a) pre-school education, (b) elementary education, (c) secondary education; and (d) higher education. The elementary levels are Prathom 1-6 (equal to grades 1-6). Secondary education is Mathayom 1-6 (equal to grades 7-12). Secondary levels are organized into two main parts: middle school (Mathayom 1-3; which is equal to grades 7-9) and high school (Mathayom 4-6; which is equal to grades 10-12).

There are various types of opportunities in the Thailand education system. The official classification includes: kindergarten, elementary school, secondary school, teacher education, demonstration school, private school, adult education, dramatic arts, and fine arts as a few examples. The Chiang Mai University Demonstration School is one unit in the Faculty of Education, Chiang Mai University. It was established in 1976 in order to be the laboratory school for the education faculty.

There are some requirements to continue further study in the high school levels (grades 10-12) at the Chiang Mai University Demonstration School. The ninth grade students have to gain cumulative grade point averages (GPA) of at least

1.50. The GPA is ranged from 0 to 4, which 0 means failure, 1 means inferior, 2 means average, 3 means good, and 4 means excellent.

Several educational opportunities are opened to high school students. The available educational programs are (a) science-mathematics program, (b) language-mathematics program, and (c) art-language program. Different criteria are required for different programs. The science-mathematics program links to careers in fields of science and mathematics such as engineering, medicine, and the sciences. Students must gain a GPA of at least 1.75 from science courses and a GPA of at least 1.75 from mathematics courses, which are taken at the middle school level. Language-mathematics programs are designed for anyone who wants to work in fields of social sciences such as business and economics. Students must gain a GPA from mathematics courses at the middle school level of at least 1.75. Art-language program study involves occupations in the field of human society such as mass communication and journal writing. Students must gain a GPA of at least 1.50 from English courses, which are taken at the middle school level. The high school classes are referred to as pre-university classes. By successfully completing the upper secondary grades and passing the entrance examinations, selected students may go into higher education or technical school. Thus, students' mathematics and English grades at the middle school levels are important for students because they play a key role for gaining entry to different program studies, which will lead them to different careers. If the students are successful in mathematics at the middle school levels, it will help them to chose and get into mathematics-science study programs. Then, they might be able to go further in careers involving the mathematics field, which will play a more important part in the future world.

In order to upgrade and develop the students' learning of mathematics in Thailand, especially at the Chiang Mai University Demonstration School, my study, during the 1999 school year, analyzing the relationship between Thai girls' and boys' attitudes and beliefs about mathematics and mathematics achievement, future mathematics coursework intentions, and career interests was proposed.

An understanding of the relationships among the variables in this study may help teachers and pre-service teachers to establish guidelines for teaching strategies, including planning teacher-student activities, and organizing learning situations, and thus help to make the teaching and learning processes profitable and rewarding experiences for both educators and students. In addition, when strategies to foster the participation and performance of the middle school students are considered, attention should be given to encourage positive beliefs and attitudes toward mathematics, and the expansion of their knowledge about career options in mathematics and science fields.

Moreover, the results of the present study will be helpful to counselors in providing better advice to and placement of students for planning their future education, as well as early counseling for appropriate career paths. The guidance in determining appropriate high school majors is crucial for the middle school students in order to pursue higher education and decide for their future careers. This finding will also provide information to assist counselors in working with middle school students as they determine their intentions to take advanced mathematics courses and prepare for those disciplines.

In addition, the relationship among the factors of this study will be important in curriculum development. For instance, if the finding shows that the students' believe that memorizing is most important in learning mathematics, then learning mathematics by understanding mathematics concepts and creating connections between mathematics topics needs to be further emphasized. Moreover, the factors linked to mathematics success can be used to redesign the secondary curriculum to increase more students who succeed in mathematics. The curriculum developers will also be able to use the results from this study to readjust the education programs according to students' future coursework and career interests.

Definition of Terms

The following definitions are relevant to this study. Some terms or phrases used in the report are deemed to be self-explanatory.

1.Attitudes: a positive or negative feeling about some person, object, or issue driven by beliefs (Ruggiero, 1998).

2.Attitudes toward mathematics: This means how an individual feels about mathematics, an emotional feeling for or against mathematics.

3.Achievement: This refers to an accomplishment or proficiency of performance in a given skill or body of knowledge.

4.Mathematics achievement: This expresses to knowledge attained or skills developed in mathematics. In this study, it is designated by test scores on teacher-made mid-term and final examinations for each term.

5. Beliefs: the information that a person has about other people, objects, and issues. The information may be factual or only one person's ideas. Beliefs may have positive, negative, or no evaluative implications for the target of the beliefs (Petty & Cacioppo, 1996).

6.Beliefs about mathematics: Any information that students have regarding as mathematics is a discipline and as a mathematics learner (Kloosterman, 1996).

CHAPTER II

REVIEW OF LITERATURE

Introduction

This study investigated the relationships between Thai middle school girls' and boys' attitudes and beliefs about mathematics and achievement in mathematics, future course-taking plans, as well as future career paths. Related literature was reviewed so that the relationships among the variables studied previously might be explored.

Recently, some researchers have focused on and adopted different approaches in studying the effect of these variables: girls' and boys' attitudes and beliefs about learning mathematics. Some have identified factors that affect students' performance in mathematics (e.g., Kaiser-Messmer, 1993; Koolsterman, 1991; Kloosterman & Cougan, 1994; Schoenfeld, 1989; Telese, 1997), students' future coursework intentions, and future career plans (Throndike-Chirst, 1991).

This review was divided into three main sections. In the first section, the relationships between students' attitudes toward mathematics and mathematics achievement, future mathematics coursework intentions, and career interests were presented. Second, students' beliefs about mathematics and their mathematical performances were featured. In the third section, gender differences in mathematics achievement were reviewed.

The Relationships between Students' Attitudes toward Mathematics and Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

This section consists of four studies on the relationship between attitudes toward mathematics and achievement in mathematics. The first three studies deal with students in elementary and/or secondary schools. The first study, conducted by Thorndike-Christ (1991), studied attitudes toward mathematics and relationships to mathematics achievement, gender, mathematics course-taking plans, and career plans. Ma and Kisher (1997) conducted a meta-analysis to explore the relationship between students' attitudes toward mathematics and their achievement in mathematics. In 1996, Simich-Dudgeon conducted a study about the relationship between attitudes toward mathematics and ethnicity. Finally, Telese (1997) conducted a study, which involved students at the high school level, to examine Hispanic students' attitudes toward mathematics and their classroom experiences.

In the first study, Thorndike-Christ (1991) investigated the relationship between attitudes toward mathematics and mathematics performance, gender, mathematics course-taking plans, and career plans. The purpose of this study was to seek the relationships among the various attitudinal and affective variables: the influence of parents and teachers, confidence in learning mathematics, mathematics self-efficacy, mathematics anxiety by gender, mathematics achievement, and students' mathematics course-taking and career plans. It was expected that attitudes toward mathematics would be positively related to mathematics performance, the intention of taking higher study courses, and those attitude scores would be predictive of mathematics performance, mathematics course-taking plans, and career interests. Males were expected to have positive attitudes toward mathematics, to show greater intention of taking higher level mathematics courses, and to manifest more interest in careers related to mathematics and science than females. Additionally, the effect of mathematics "tracks" was investigated with the prospect that students in a more advanced, accelerated "track" would display more positive mathematics attitudes, and be expected to take optional advance mathematics courses than students in regular or remedial "tracks."

In this study, 1,516 students (722 male, 794 female) were enrolled in public middle and high school mathematics courses. Of the 1,516 students whose responses to an attitude survey were analyzed, 952 students were attending one of three middle schools and 564 students were attending one high school. Of the 952 middle school students, 4 (1 male, 3 female) were in sixth grade; 441 students (219 male, 222 female) were in seventh grade; and 507 students (239 male, 268 female) were in eighth grade. Of the 564 high school students, 254 (125 male, 129 female) students were in ninth grade; 89 students (41 male, 48 female) were in 10th grade; 221 students (97 male, 124 female) were in 11th grade or 12th grade. The courses that these students were taking ranged from the regular "track" 10th grade mathematics to high school geometry (the most advanced course in which accelerated "track" 10th-grade students are enrolled during the semester the survey was administered). To collect the data, the authors used Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1986), which applied Likert

Scales. All nine of the Mathematics Attitude Scales include (a) Confidence in Learning Mathematics, (b) Father, (c) Mother and Teachers Scales measuring perceptions of attitudes toward one as a learner of mathematics, (d) Motivation in Mathematics, (e) Attitude toward Success in Mathematics, (f) Mathematics as a Male Domain, (g) Usefulness of Mathematics, and (h) Mathematics Anxiety. Each scale has 12 items that were scored on a 5-point Likert scale from 1 (strongly agree) to 5 (strongly disagree).

The authors designed a series of questions, which was included with the math attitude scales for gathering demographic information. This information was relative to students' expectations of successful in the course they were currently enrolled in, planning future enrollment in mathematics courses, and career plans including their expected college major if they planned to attend. To obtain a measure of math self-efficacy, students were asked to rate their confidence level on a 5-point scale from 1 (no confidence) to 5 (complete confidence). They were also asked to rate their plans to take optional mathematics courses on a 5-point scale from 1 (definitely will not continue to take mathematics) to 5 (definitely will continue to take optional mathematics courses). The anticipated college majors/careers were rated according to Goldman and Hewitt's (1976) Sciences/Math Continuum, from 1 (fine arts) to 5 (the physical sciences and mathematics). The survey was administered to all participants during their normal mathematics class time. In the sixth to eighth grade levels, surveys were administered in the individual classrooms. Most of the high school students were surveyed in large groups in an auditorium because of the school administration's requirement that the survey be completed in one day. Students' final mathematics grades were gathered at the end of the quarter (grades 6-8) or semester (grades 9-12).

The findings of this study supported the hypotheses regarding the relationships between attitudes toward mathematics and mathematics achievement, mathematics course-taking plans, and career interests for middle school and high school students. As predicted, some attitude variables like confidence and self-efficacy were significantly positively correlated with the intention to take optional mathematics courses. Students, who were interested in careers that were more mathematically involved, indicated they had more positive attitudes toward mathematics. Furthermore, all nine attitude variables, mathematics self-efficacy, and gender significantly contributed to the prediction of mathematics performance.

Support for hypotheses regarding the relationships between attitudes toward mathematics and gender surfaced. As expected, males reported more confidence in their ability to learn mathematics, had lower levels of mathematics anxiety, and explained performing mathematical tasks as more enjoyable than females did. However, females reported more positive attitudes toward success in mathematics and were less likely to view mathematics as a male domain. In addition, males and females perceived mathematics as equally useful to them in their future lives, and had similar positive attitudes from their mothers, fathers, and teachers toward them as learners of mathematics. The author did not analyze data by grade level.

These results suggested that the gender differences in attitudes toward mathematics among secondary school students might not be obvious. It was a positive finding that males and females in this study were equally likely to have plans to continue their mathematics education once course registration became available.

The results supported the hypotheses that students in more advanced mathematic "tracks" would have more positive attitudes toward mathematics, would be more likely to make plans to take mathematics, and would be interested in more mathematics-related careers. The findings also revealed that accelerated "track" students expressed more positive attitudes toward mathematics than regular "track" or remedial "track" students.

The author advised that an additional idea could be taken from the results of this study. Attitudes toward mathematics appeared at the secondary school level, and the relationship between attitudes, mathematics performance, taking future mathematics plans, and career interests did emerge.

Overall, the procedure of this research was effective. The author gave ample details about how the data were collected, and listed what kinds of scales or questionnaires were used. Its weakness was that the author did not give information about the validity and reliability of the questionnaires. The author did not give a reason why the sizes of the students of each group level were so different, such as four students form the entire sixth grade, 441 students form the seventh grade. The sample of each group should not be dramatically different because the samples are needed to be representative of each group to have comparable data. In addition, details about how the samples were selected were not provided.

In 1997, Ma and Kishor also investigated the relationship between the attitudes toward mathematics (ATM) and achievement in mathematics (AIM), but used a different method. The authors of this study identified meta-analysis as an effective way to apply a quantitative method using existing research and used it in this study to explore the relationship between ATM and AIM. Gender, grade, and ethnicity were the basic factors in the examination of this relationship, establishing the effect of gender on the ATM-AIM relationship. In addition to considering variables that might influence the ATM-AIM relationship, the authors attempted to investigate some basic issues about the research design on this relationship, with the objective of supplying pragmatic implications for further studies. The authors were interested in assessing effects of sample selection and sample size on the ATM-AIM relationship that had not been formerly tested. The research questions were (a) what was the magnitude of the general relationship between attitudes toward mathematics and mathematics achievement, using the common metric (correlation coefficient), (b) was this relationship consistent across gender, grade, ethnicity, sample selection, sample size, and the time period covered by the review, (c) what was the magnitude of the causal relationship between attitudes toward mathematics and achievement in mathematics.

The authors defined the method of their literature search using criteria for identifying studies. They created multiple descriptors (attitudes, beliefs, and achievement regarding mathematics) and searched three databases and also conducted a manual search of well-known journals in education for the years 1966 to 1993. This resulted in an example of 113 primary studies on the ATM-AIM relationship.

The primary studies were then coded according to the following independent variables for this meta-analysis: (a) author identification, (b) date of publication, (c) sample size, (d) sample selection (random or not), (e) causal direction (specified or not), (f) gender, (g) grade, and (h) ethnicity. The dependent factor was effect size, approximated with the Pearson product-moment r. "Instrument" was added as an independent variable because the instrument used to measure ATM-AIM varied greatly among the primary studies due to the long time span (1966 to 1993). A large sample, 82,941 students in 12th grade level, participated in these studies. Most studies were mixed for gender and ethnicity.

There were 118 independent effect sizes produced for this meta-analysis. Each primary study reported their statistical results, which were transformed into a common effect size. Because nearly all studies employed the Pearson product (moment correlation coefficient to assess the relationship between ATM and AIM), the effect size used to describe the relationship was the Pearson r statistic.

The authors treated longitudinal data as separate studies according to grade levels because the authors intended to maintain a clear identity or an explainable background for each correlation at the primary study level, with the purpose of making statistics easy to interpret and comprehend. Some extra degrees of freedom can be produced through this approach, resulting in a possible uncertainty of the overall mean effect size.

The authors built the statistical comparison of group mean effect size to address the research questions. First, the authors computed a 95% confidence interval for each mean effect size to test the null hypothesis that the mean effect size was zero. Then, the authors tested, on the basis of whether or not their confidence intervals overlapped the null hypothesis, that two mean effect sizes were equal.

The authors found that the relationship between ATM and AIM was positive and reliable, but not strong. Then, the authors also found that gender did not have a significant effect on the ATM-AIM relationship. The relationship between ATM and AIM might not be significant for grades 1-6 but might be practically meaningful for grades 7-12.

The relationship between ATM and AIM did not seem significant for white students; however, for Asian students and African American students, there was evidence that a positive correlation existed between ATM and AIM. The research that was applied to non-random samples was less powerful in showing the ATM-AIM relationship. Sample size effects demonstrated that a sample of 300 was the most economical and large enough group to disclose the ATM-AIM relationship.

This meta-analysis was composed of studies that investigated the ATM-AIM relationship for 27 years (1966 to1993). Studies were divided according to their years of publication within five time groups. The ATM-AIM relationship did not seem obvious until 1975. In the time group 1966-1975, the strength of the relation was almost stable. The relationship was strengthened in the time groups 1971-1975 and 1976-1980, and then it was weakened in time group 1976-1980 and 1981-1985. Then, the strength of the relationship was almost constant again in the time groups 1981-1985 and 1986-1993. The authors also studied the interaction effects among gender, grade, and ethnicity on the ATM-AIM relationship through analysis of variance (ANOVA). They found that there was no reliable sign of interaction effects among gender, grade, and ethnicity on the ATM-AIM relationship.

In the discussion section, the authors pointed out that one major limitation of this meta-analysis is the lack of adequate information about the research method of the studies included. Since they did not set well-specified criteria for methodological sufficiency; the quality of the selected studies was inadequate. Consequently, it showed areas in need of further research. As a result of the authors' meta-analysis, they were able to separate analyses of the ATM-AIM relationship based on gender, groups, grade levels, and ethnic backgrounds. Researchers did not take into account the ability levels of students. The majority of the studies did not perform separate analyses for students' different mathematical abilities, nor did they show appreciable analyses of grade level and ethnic groups. The authors had stated that the ATM-AIM relationship needed to be examined at a multi level perspective, such as school level variables, and recommended the hierarchical linear modeling approach for further research.

The authors were concerned with doing a literature search to decrease serious bias in this study. It was interesting that this study was the first in trying to assess effects of sample selection and sample size on the ATM-AIM relationship as the authors claimed. Additionally, the author provided plenty of interesting ideas in the discussion section. For example, the meta-analysis findings (regarding the ATM-AIM relationship) lead the authors to believe that the junior high grades might be the most important period of schooling for students in understanding and shaping their attitudes in relation to their mathematics achievement. In general the design of this study was effective. The authors provided some criteria for the results of study selection. Moreover, the authors also tried to make sure that most of the ATM-AIM questionnaires used in the primary studies were developed psychometrically. Therefore, the authors justified the reliability and validity of the instruments used.

Another study, which also focused on ethnicity, gender, and attitudes regarding mathematics achievement, was conducted by Simich-Dudgeon (1996). Few investigations about the role of mathematics attitudes at school level by ethnicity exist. However, for nearly 10 years, the National Assessment of Educational Progress (NAEP) has studied the mathematics of Asian, Hispanic, and white students.

Simich-Dudgeon (1996) compared the mathematics performance of Asian and Hispanic students by their achievement in mathematics as assessed by their performance scores in the 1992 NAEP. They also explored the relationship between the attitudes toward mathematics of Hispanic and Asian students by gender and ethnicity. The records of the sample were gathered from the 1992 NAEP Trial State Assessment data set.

There were 32,000 fourth and eighth grades Hispanic and Asian students participating in this assessment. The sample consisted of the same percentage of males and females from both ethnic groups. The majority of the students in this study lived in bilingual environments. First, the author designed a background of the sample through a variety of variables, such as age, language, English expertise, and some school and home variables. Second, the author described the students' attitudes represented by their answers to eight NAEP survey questions: (a) I like math, (b) I am good at math, (c) I understand most of my math classes, (d) math is mostly memorizing facts, (e) math is used in jobs and for solving problems, (f) math is more important for boys than girls, and (g) I would not study more math. Third, the author focused on the average mathematics proficiency of Hispanic and Asian students, by gender and grade level. Fourth, the author investigated the relationship between ethnicity, gender, attitudes toward mathematics and their achievement in mathematics. Eventually, the author discussed the finding, and the educational and policy implications of the results.

The Hispanic and Asian students' data were analyzed by descriptive and inferential statistical procedures, which were designed for secondary data analysis with NAEP data sets. Descriptive statistics were useful in creating cross tabulations of students' background features, including their attitudes toward mathematics and their average mathematics performance scores. Inferential statistics on eight attitude variables by gender and ethnicity were tested with regressions on the NAEP mathematics achievement scores of the sample in this study.

The findings revealed that the profile of the target students that occurred from the descriptive analysis of selected background data variables in that the majority of Hispanic and Asian students were born in the United States, the District of Columbia and territories. A majority of the students were considered English proficient as tested by school personnel students in the schools that they attended, but their teachers identified 13% to be Limited English Proficient (LEP) students.

The results and evidence that most of the Hispanic and Asian students were found to be English proficient hinted that most of them had attained a level of bilingualism. However, The authors did not study the relationship between bilingualism and mathematics performance. The author found that Asian students were more likely to have more types or greater numbers of literacy-linked items in their home than Hispanic students were. Furthermore, the Asian students had higher mathematics achievement scores than their Hispanic peers. Interestingly, the author found that fourth and eighth-grade Hispanic students scores (both female and male) were below the lower areas for the basic achievement level, which placed them below the lowest standards of mathematics achievement established by the National Assessment Governing Board (NAGB). The findings noted that, by the fourth grade, male Hispanic students performed slightly below their female peers, and their mathematics level was a little bit higher than the national average mathematics proficiency. By the eighth grade girls and boys are at the same low level of mathematics performance.

Regarding Asian, Hispanic, and white students' mathematics achievement, the results confirmed that Asian students outperform Hispanic and white students in mathematics performance. In this study, the fourth and eighth-grade male Asian students' average mathematics performance levels were slightly higher than the national average for fourth and eighth-grade males. By the eighth grade, the male Asian students' average mathematics proficiency level was slightly lower than their female Asian peers.

The descriptive analyses of the attitudes of Hispanic and Asian students in this study noted that by a small percentage, fourth-grade Asian students more than Hispanic students believed "they [were] good at math" and "they [understood] math". By the eighth grade, a difference was found. By a moderate percentage, more Asian students believed that "they [were] good at math" and "they [understood] math." These two beliefs were correlated with higher mathematics performance at both grade levels. Moreover, by a smaller percentage than Hispanic students, Asian students agreed that they liked math. But "like[ing] math" was not a significant indicator of mathematics achievement for fourth-grade students of both ethnic groups, and for eighth-grade Asian males. The author found that "like[ing] math" is correlated with the lower mathematics performance of male and female Hispanic students, and eighth-grade Asian females.

Additionally, the author reported that there was a moderate increase in the amount of eighth-grade students who disagreed or strongly disagreed with the stereotypical beliefs that define mathematics as a male domain. Moreover, the agreement with the statement "math [was] more for boys than for girls" was linked to low mathematics performance for both ethnic groups and both grade levels, except eighth-grade males. The author commented that this attitudinal change over time might be because of the changing in socialization practiced both at home and at school.

In this study, there were three belief variables, which can be presented in the dimensions of mathematics usefulness. There were "math [is] mostly memorizing facts", "math [is] used in jobs", and "math [is] for solving problems". The author reported that the statement "math is mostly memorizing facts" was a significant indicator of low mathematics performance for both 8th-grade Hispanic and Asian students. But for fourth-grade Hispanic students of both gender groups, this factor was not significant. However, it was a consequential indicator of low mathematics performance in fourth-grade male and female Asian students. "Math [is] used in jobs'; this statement was a significant indicator of prediction of higher mathematics performance for fourth-grade Hispanic and Asian students of both gender groups. "Math [is] for solving problems" was a significant indicator for Hispanic students, but not for Asian students. For eighth- grade students of both ethnic and gender groups, these two variables were not significant. For Asian students, these two statements: "using math in jobs" and "no more math"were not significant for female eighth-grade students. Meanwhile, the other two variables, "like math" and "math more for boys" were not significant for male Asian students. This study confirms the significance of eight attitude factors of mathematics performance, and small to moderate variation regarding their importance for Hispanic and Asian students, by gender.

Finally, findings revealed that a majority of the attitudes factors were significant for both ethnic groups by grade and gender, but the difference in attitudes toward mathematics were small at the fourth grade level, and greater at the eighth grade level. At the eighth grade level, "using math in jobs" and "solving problems" were not significant for Hispanic males. However, the statement "no more math" was insignificant for female Hispanic students.

Additionally, the findings reported that the attitude variable "liking math" was related to lower mathematics performance. This might imply that students might have an affinity for mathematics, but this variable did not have to reflect students' self-assessment of how well they learned mathematics nor their judgement of understanding the teaching of mathematics.

The author also commented in the discussion section that the findings corroborate previous studies, especially, as linked to those attitudes related to confidence and perceived usefulness of mathematics. This survey did not find any obvious evidence of difference in the attitudes of both ethnic and gender groups; however, moderate differences were found at the 8th grade level. The author also gave a clear explanation about the procedure of this study by summarizing each step of the study briefly.

In 1997, Telese conducted a study to attain an understanding in more specificity of Hispanic students' attitudes towards mathematics, particularly toward Algebra I. Additionally, the mathematics teaching tradition as encountered by the students in particular reform efforts was explored. There were two main questions for this study:

1. What were the attitudes of Hispanic students and their beliefs toward mathematics (i.e., Algebra I). A related question was how did attitudes differ among mathematics classes.

2. What the predominant mathematics teaching traditions presented as perceived by the students were. Related questions were (a) how did male and female students differ in their perceptions of teaching, (b) what types of teaching traditions were experienced in various mathematics course categories.

The author conducted the study, which focused on the importance of examination of beliefs and attitudes. A survey was administered at a local high school with 99% Hispanic student attendance. This survey was one aspect of a broader study at the high school. The author randomly selected 13 teachers' classrooms in order to include Algebra I, Algebra I-4, Algebra II, Informal Geometry, Geometry, Pre-Calculus, and Calculus. A questionnaire adapted from an early study by Telese was administered. There were 226 students in this study. The questionnaire consisted of 25 items that examined two areas (a) student attitudes and beliefs toward mathematics by using a 5-point Likert scale from 1 (disagreed) to 5 (strongly agreed), and (b) the classroom activities experienced by the students, which were divided into traditional and non-traditional activities. The traditional activities were included to represent the school mathematics tradition and the non-traditional activities were included to represent the developing and changing mathematical views by using 5-point Likert scale from 1 (never experienced the stated activity) to 5 (a lot of experience of the stated activity).

Means were computed for attitudes and classroom activities. Three-way ANOVAS were conducted on the sub scales, attitudes, and classroom activities. Students' achievement data were collected from several sources: Texas Assessment of Academic Skills (TAAS) scores, final grades (the grade point average) in the high school mathematics courses, and the first and second semester grades of eighth grade. Moreover, studies on the variables gender, course, and grade level, were also conducted using the final grades (the grade average point) in the high school mathematics courses dependent variable.

The outcomes show that overall the students were not very enthusiastic about mathematics. Both genders held equally bad attitudes toward mathematics. Nevertheless, male and female students were different in the degree of negative attitudes toward mathematics. The male Hispanic students had less negative attitudes toward mathematics than female Hispanic students did. Surprisingly, female students sought to reach a high level of mathematics performance despite having negative attitudes toward the subject. This study not only showed that differences in students' attitudes toward mathematics were found among genders but also among courses. It showed that the students viewed their mathematics coursework as something that they had to do and did not enjoy, except for calculus students. The students in Algebra I and II had negative attitudes toward mathematics. However, the students in calculus courses had more positive attitudes toward mathematics than the students in other courses. Furthermore, it showed that the calculus students have been successful in a formalist course, they were more experienced with the frequency of traditional instruction and students were adept in learning mathematics by a traditional approach.

Various achievement indicators such as TASS scores, the final mathematics course grades, and first and second semester grades were correlated with the major subscales from the student survey, positive attitude, negative attitude, traditional activities, and nontraditional activities. This finding supports the idea that students who had more positive attitudes toward mathematics tended to have higher achievement levels. Concerning the types of classroom activities, an unexpected outcome was the nearly equal correlation coefficients related with both the traditional and non-traditional activities, and positive attitude factors. This suggested that regardless of what type of activities the students experienced, different types of classroom activities did not affect students' positive attitudes.

The interview summary revealed that students really enjoyed learning with their peers. Students used calculators quite often for computing rather than learning concepts. The author suggested that philosophy should be taught before students are allowed to use calculators; they should be proficient using the basic skills. The disturbingly bad attitudes toward mathematics indicated by the algebra and geometry students raises a warning signal. If algebra was considered as a gatekeeper to further mathematics, then it becomes imperative that teachers, parents, counselors, and other people in authority stress the significance of gaining algebraic knowledge and provide activities meant to increase motivation and improve attitudes. The results revealed that the students agreed that mathematics was useful and to know the correct answer was necessary in mathematics. However, while the students' attitudes about mathematics included the importance of usefulness of mathematics in daily life, they were not sure about whether or not they would like to work in mathematical careers.

The author also suggested further research on Hispanic students' attitudes including a process to probe further into their expectations, career aspirations and delineating some socio-cultural factors associated with success and failure to progress through the delineating of some socio-cultural variables concerned with accomplishment and failure to advance through the pipeline.

In this study, there was no detail about how many students were in this study, what the grade levels of the students were, and how the author selected the participants (randomly or not). The author should specify the grade level of the students instead of using the word "high school" to avoid misunderstanding the data.

Moreover, the author randomly selected the teachers who taught the experiment classes. This method is good for avoiding bias in selection. For collecting the data, the author did not note the validity and reliability of the instruments or questionnaires used. The author studied gender as one variable, but the author did not give the exact number of females and males who participated in the study. Giving the number of females and males would help the readers see the proportion of them in this study. Additionally, the author mentioned the limitations of the study. This study was conducted in merely one high school. Therefore, the results could not be generalized to other high school students.

In conclusion, this result was in contrast to the findings of Thorndike – Christ (1991), which reported that female students' attitudes toward mathematics were normally positive. Additionally, since some studies of the ATM-AIM relationship focused on the results in Hispanic and Asian students or only Hispanic students, it is necessary to conduct a study, which focuses only on Asian students in order to compare the results, broadly.

In summary, the studies of the relationship between students' attitudes toward mathematics and mathematical achievement revealed that at elementary school, middle school, and high school levels, there was evidence that attitudes toward mathematics related to mathematics achievement. This relationship did not emerge at the elementary levels. The relationship was stronger at the middle school and high school levels (e.g., Ma & Kishor,1997; Simich-Dudgeon, 1996; Telese, 1997). This relationship also was found to effect students' mathematics courses-making plans and future career interests (Throndike-Chirst, 1991).

Regarding the relationship between ATM-AIM by sample selection, random samples were more robust. In addition, the sample size, about 300 participants, was ample to detect the relationship. Moreover, in the last decade, the relationship of ATM-AIM seemed to be constant after it had been dynamic, increasing or decreasing before.

Regarding the relationship between ATM and AIM by ethnicity, the findings showed that, for the Asians and African American students, there were positive attitudes toward mathematics, which were strongly related to high mathematics achievement (Ma & Kishor,1997). For white students, this relationship was insignificant. However, Asian students outperformed Hispanic and white students in mathematics achievement (Simich-Dudgeo, 1996).

Focusing only on Hispanic students, the findings noted that students who held more positive attitudes toward mathematics tended to have higher mathematics performance (Telese, 1997). Moreover, males held more positive attitudes toward mathematics than females especially at older age levels. From the results of the studies, the future study of the relationship between Asian students and their mathematics achievement is indicated.

Regarding the ATM-AIM relationship by gender factors, some findings reported that males had more confidence, lower anxiety levels, and enjoyed learning mathematics more than females. In contrast, females had more positive mathematics attitudes and were found less likely to think that mathematics is a male domain. However, males and females in general realized the usefulness of mathematics. In addition, the findings revealed that confidence in learning mathematics had a strong effect on mathematics achievement and plans for taking math courses and career interests in the future (Throndike-Christ, 1991).

Students' Beliefs about Doing and Learning Mathematics

Students' beliefs about mathematics have been of increasing concern to researchers. Since 1985 the topic of beliefs have become a common area of research because they might explain gender differences in mathematics achievement (Ma & Koehler, 1990; McLeod, 1992), and because beliefs appear to have a substantial impact on learning behaviors of students (Kloosterman, 1995; Schoenfeld, 1989).

Five studies about students' beliefs about mathematics will be presented in this section. The first two studies focused on the elementary school level: a investigation of students' beliefs about learning mathematics by Kloosterman and Cougan (1994) and a three-year study exploring students' beliefs about mathematics by Kloosterman et al. (1996). One study at middle school level by Kloosterman (1991) was reviewed. The next two studies focused on the high school level explored aspects of the relationship between students' beliefs about mathematics and mathematics achievement (Schoenfeld, 1989) and a survey about students' beliefs about mathematics and science(Fleener, 1996).

Kloosterman and Cougan (1994) conducted their study to indicate beliefs about mathematics at 1st to 6th grade levels and to decide which beliefs vary with age. In this study the authors examined five categories: (a) beliefs about the magnitude to which students liked school, particularly mathematics; (b) beliefs about school and parental support in mathematics; (c) beliefs perceiving mathematical usefulness; (d) beliefs centering on self-confidence in learning mathematics; (e) personal beliefs about ability to learn mathematics.

The sample of this study involved 62 students in first to sixth grade levels from one school, where instructors were participating in a project to improve mathematical teaching. The teachers were requested to rank the students according to their mathematical abilities. The study included an equal proportion of boys and girls, nearly all of the participants were Caucasians. This study depended on an individual interview. The interview instrument consisted of eight categories with one or two principal questions, followed by sub-questions for each. Additionally, during the session a mathematics problem was presented, followed by an interview to discuss how the problem was solved. An alternating process of presenting a mathematics problem followed by an interview occurred through seven math problems. The students were asked to think aloud and explain their ideas to solve the problems as they solved them. The authors and one additional female graduate student conducted the interviews. The interviewers used the same questions in their interviewing for all of the students. The mathematics problems were harder depending on the grade level.

The last part of the interview involved questioning students to classify a set of ten story problems into categories of "mathematical" or "non-mathematical" in nature. In first and second grade levels, the interview lasted about 30 minutes. However, in third to sixth grade levels the interview lasted about 45 minutes due to a more itemized response to questions involving more time to solve the problems. To examine the five belief categories, 12 questions were used. The interviewers gave follow-up questions to get students to explain their answers. The interviews were conducted for two to four weeks during school hours in a quiet room far from regular classrooms. Audiotapes were used to record all interview sessions. Furthermore, achievement data were gathered from students taking the California Achievement Test (CAT) about eight weeks prior to the interview sessions. Students also completed three-item problem-solving "tests" during the last week that interviewing took place.

The interviewers wrote brief comments about general mathematical proficiency, confidence, and beliefs of each student immediately after each interview. Comments on mathematical proficiency were based on predominance and on the accuracy of finished mathematical problems during the interview. Comments on confidence were based on response to the confidence question and how sure of themselves students seemed to be while solving the mathematical problems.

In data analysis processes, the authors categorized each student as a high, medium, or low achiever based on the following criteria: (a) achievement test scores (CAT), (b) problem solving tests scores, and (c) mathematical proficiency comments. They then ignored them until rankings on the belief variables were done. The authors ranked students as high, moderate, or low in each of the categories of (a) liking school, (b) liking mathematics, (c) parental support for school generally, (d) parental support for learning mathematics, and (e) self-confidence in mathematics. The authors compared these data within grade levels and across grade levels. No statistical analyses were applied to the data. Finally, the authors matched achievement data for each student with the belief data in order to examine any positive correlation between belief in ability to do mathematics and actual achievement in mathematics. No analyses about gender differences were performed.

The results of the study were divided into six main sections: (a) self-confidence and grading, (b) liking school and liking mathematics, (c) usefulness of mathematics, (d) self-confidence, liking of mathematics, and achievement, (e) parental support and achievement, (f) existence of a "Math Mind."

A relationship between self-confidence and grades existed. The findings revealed that grades and teachers' feedback about the accuracy of the solution on homework or seatwork assignments instead of conceptual comprehension or mathematics power were the foundation of student's self-confidence in mathematics. The authors also noticed that confidence varied with the mathematical topic studied.

Regarding liking school and liking mathematics, the results showed that students were grouped as having a high, moderate, or low liking of school and of mathematics. Most of the students liked school and mathematics, but some liked school more than mathematics. Almost none of them really liked mathematics more than they liked school. Students perceived the usefulness of mathematics. The authors reported that students in the first and second grade levels expressed some comments about the usefulness of mathematics, such as " you need math to find how much money you have." This identified that students were answering the questions precisely but they were not confident that they really believed those answers. Nevertheless, the authors believed that higher-grade level students answer to these questions were really believable. The majority of the students expected to use mathematics in careers, sports and higher education. Only some of them mentioned the need of mathematics to pass to the next grade.

A relationship existed between confidence, liking of mathematics, and achievement in different levels. The findings indicated that first-grade students who liked mathematics were fairly confident in learning mathematics, whereas, students who disliked mathematics had very low confidence in learning mathematics. There was no evidence of the relationship between mathematics achievement and confidence in the first grade level. As a whole, first-grade students seemed to enjoy learning mathematics no matter how well they did in the subject.

In the second grade level, high-achievement students liked mathematics and had confidence in their ability to perform mathematics. There was no relationship between achievement and confidence in mathematics among low achievement students. From the third to sixth grade levels, moderately achieving students had as much self-confidence in mathematics as did high achievers. Meanwhile, the low achievers expressed low to moderate liking of mathematics.

Interestingly, concerning, parental support and achievement, there was not a constant relationship between students' reports of parental involvement in their education and their achievement in mathematics. Low achievers expressed that their parents sometimes helped them with their homework, participated with them in educational activities, and encouraged them to study hard at school. However, this study showed that high achievers had little help from parents concerning their education.

Students believed in the existence of a "Math Mind." The belief about the existence of a "Math Mind" is the belief that everyone can learn mathematics if they try. Nearly all students believed that it was crucial to learn mathematics and that learning mathematics could determine future in subjects involving this subject success. Some first-grade students said that some students could not learn mathematics because they do not try to learn mathematics. All of fifth and sixth-grade students believed that effort is an important component of being able to learn mathematics for everyone.

In addition, some of the first and second-grade students showed less ability than older students to verbalize specific beliefs. In younger student groups, the questions about parental support for education and the existence of a math mind were often coupled with confused looks. This was related to the fact that students were seldom asked such questions and they had not thought about these questions before.

In the discussion section, the authors linked to their study another issue concerning students feeling that anyone who tried could learn mathematics. In 1984, Nicholls reported that young children did not differentiate between ability and effort as causes for success in mathematics. Stipek (1984) noted that kindergarten and first-grade students were not able to decide who the highest achievers in the class were, noting work frequency instead of achievement when asked to rank their peers. The findings from this study corresponded to Nicholls and Stipek's studies. In this study, almost all of the first-grade students said that everyone could learn mathematics if they tried. A number of third and fourth-grade students obviously believed that some people were just too "dumb" to learn mathematics. Additionally, surprising evidence from this study was based on data stating that a number of students in this study expressed that grades and teachers feedback affected their self-confidence in mathematics.

The results hinted that most students believed that mathematics was useful, expressed that perceived usefulness of mathematics mediates students' efforts to learn mathematics and was a substantial variable in determining further continuation of mathematics enrollment when mathematics courses became available. The students seemed not to realize why mathematics was crucial for their life in the early grades. However, in later grade levels, this realization appeared and the students saw the reasons of the importance of learning mathematics.

The authors reported that student confidence relied on grades and the feedback of the teachers. Therefore, the teachers should not expect their students to evaluate themselves in view of intrinsic objectives and mathematical ability. The authors also reported some limitations of this study. There was no evidence of a relationship between parental support and achievement. Moreover, having a difficulty interpreting students' comments about parental support for education was troublesome. Students may under report the actual help in mathematics provided by their parents. The results on confidence noted that some students were confident on some types of mathematical work rather than on others. Hence, the authors suggested that some further studies should examine self-confidence in a variety of views in mathematics. Another limitation of this study was that this study was based on only 62 students from one school. The sample was too small. Therefore, these results would not generalize to other school populations.

The authors set some criteria of beliefs to focus on in this study and the authors gave enough details about the participants. However, they did not provide information about how the sample was selected, and how many boys and girls were in this study. This might be because they did not focus on gender differences in this study. The authors explained the processes of this study quite clearly, including interview process, the kinds of questions to be asked, and gathering data on the validity of the questions.

The limitations of this study include both some difficulties in getting the data about the parental support correctly and the results from this study could not draw a causal relationship to other students in general. Since this study was conducted in only one school with a small group of students, it could not be generalized.

Kloosterman et al. (1996) designed the next study in the same way as the previous study in 1994, but used a longer period of time. This study was a three-year longitudinal study. The authors investigated the issue of how beliefs affect students' motivation. There were two main research questions: (a) how stable were elementary students' beliefs about knowing and doing mathematics, and (b) were there developmental trends in certain beliefs about knowing and doing mathematics.

The subjects for this study were from first to sixth grade levels. There were 62 students from one school. The students were from lower-middle or low-income socioeconomic status. Classroom teachers were requested to identify students with a range of mathematical abilities. There were 23 classrooms at the school: two kindergarten classes, nine classes of primary grades, six classes of intermediate grades, and six special education classes. Three to five students from each of 15 first to sixth regular education classrooms were chosen based on teachers' suggestions.

The instructors at this school participated in a three-year project emphasizing developmental mathematics teaching by using a problem-solving orientation. Therefore, most of the students in this study had received instruction using mathematical manipulatives with highlights on problem solving. This study started at the end of the second year of the in-service project and proceeded one year after the project was done.

The primary data collection was an individual interview between a researcher and a student. The interview was conducted in a quiet room separate from the classroom. Two interviewers did the interviews. One was one of the authors, and the other one was a doctoral student in mathematics education. The interviewing took place once per year a month before school ended for the summer. The students were told at the introduction of each interview that their teachers and parents would not be told about what they said. Thus, seemingly, most students spoke openly to the interviewers. The interviewing took about 30 minutes at first and second grade levels and about 45 minutes at higher-grade levels. The interviewers audiotaped and wrote down students' answers to the questions. In the second year of the study, the teachers were interviewed about their students. They were asked about mathematical achievement and confidence of each of their students and students' social maturity and academic accomplishment in general. The researchers collected data on both beliefs and achievement for all students during the first year of the study, and they collected only belief data in the second and third year. Using standardized test scores, which came from the California Achievement Test (CAT), two short group tests and individual testing gathered achievement data. The CAT was administered about eight weeks prior to the first interview. Additionally, to get more data about students' problem solving skills, tests were administered during the last week of interviewing. In the interview, the students were asked to think aloud and explain their solutions to the problems as they solved them in order to get a better sense of students' abilities to solve mathematical problems. To collect students' belief data, the authors used an interview instrument containing questions about five categories of beliefs.

The first category was the extent to which students liked school and liked mathematics. The second category was concerned with beliefs about how important learning mathematics was. The third category was about beliefs of self-confidence in learning mathematics. The fourth category of beliefs was about whether anyone who tried in mathematics would be able to learn mathematics. The fifth category was students' views of group learning in mathematics, which was only asked during the first-and third-year interview.

The analyses of data were conducted over three years. At the end of each interview session, the interviewers critiqued the collected data and added a one-to-two-page summary of her or his general impressions of the students' beliefs. At the end of the first year of data collection, the students were classified as a high, medium, or low achiever in mathematics based on the first-year: (a) achievement test scores, (b) problem solving test scores, and (c) mathematics competence comments written by the interviewers.

Students were given a high, medium, or low achievement rating based on their computation and concept or application sub-tests. To rank students as high, medium, or low on problem solving achievement, scores on each of three process problems were converted to *z* scores based on the grade level at the school. At this point, standardized test scores, problem-solving ratings, and interviewer comments about mathematical ability were compared, and an overall ranking for mathematics performance was determined for students.

The authors also found that many first-and second grade students' beliefs varied, but as a whole, their beliefs seemed to be as stable as the beliefs of the older students. The findings showed that the students' beliefs about knowing and learning mathematics over the three-year study were relatively consistent. Four themes in these beliefs also appeared: (a) trends concerning students' views on mathematical usefulness, (b) students' perspectives on the value of group versus individual work in mathematics, (c) trends in the relationship between confidence and ability, and (d) students' tendency to like mathematics as it became harder.

Regarding the usefulness of mathematics, the first year study showed that most of the students felt mathematics was useful and important. The authors found that the reasons giving by the students for needing mathematics matured over the three years of the study. Those students who noted in the first year of the study that they needed mathematics to go further to the next grade or to get higher education gave similar responses for the next two years. As they got older, they stated more examples of mathematical applications in their real lives, such as shopping, cooking, sports, and so on.

Concerning group versus individual work, the authors found that there was significant variation in students' beliefs about group work. Some students preferred to work alone, some indicated that group work was necessary when they could not solve the problems by themselves. The authors thought that this result was due to the wide variety of teacher beliefs about the appropriateness and effectiveness of group learning and due to the kinds of group activity students had experienced.

There was some evidence of the relationship between confidence and achievement. In the first grade level, there was lack of any relationship between self-confidence and achievement, but there was a strong relationship between these factors when the students got older. In particular, for the third graders and above, average and above-average achievers enjoyed mathematics and had the same confidence in their abilities. However, low achievers had low self-confidence. Furthermore, most of the students' confidence was based on external feedback, for instance, homework, tests, and report card grades or teachers' comments.

Some students revealed that they liked mathematics as it became harder. Corresponding numbers for liking mathematics were 3, 2, and 1 (from "I like it" to "it's okay" to " I hate it"). No students claimed to dislike both school and mathematics. Perceiving no consistent relationship between liking mathematics and liking school, the authors commented that some students started to like mathematics more as they got older. In earlier grade levels mathematics was boring because of easiness by the students liked it more when it got more difficult because it was more challenging. The authors also noted that the students who liked mathematics when it became more difficult tended to have medium to high mathematics abilities and confidence.

In the discussion section, one of the noteworthy findings was that students believed that anyone could learn mathematics. The authors commented that since this study involved only elementary students, they were unable to conclude that the understanding of the usefulness of mathematics was enough to support students to continue taking mathematics courses in high school. The consequences of the study also indicated that low achievers had low self-confidence. Hence, teachers need to convince low achievers to believe that effort is worthwhile.

Surprisingly, the sample in this study, which consisted of 62 elementary students, had the same amount and level of the students in the Kloosterman & Cougan's (1994) study. The study designs were similar to each other. Therefore, Kloosterman et al.'s (1996) study might try to confirm the study of Kloosterman & Cougan (1994) by using a longitudinal study over time. Ample detail was provided about the sample of this study. Readers could follow why the participants changed from 62 in the first year of study to 29 in the third year of this study. But the authors did not explain clearly about how and why the sample selected three to five individuals from each of the 15 first to sixth grade regular education classrooms. The author did not mention about the validity and reliability of the questions and the tests.

The data analysis processes were clear about how students were ranked on the categories that the authors had set before: (a) achievement test scores, (b) problem-solving test scores, and (c) mathematical competence noted by the interviewers. The limitations of this study were similar to the study in 1994. The study was conducted only in one school. Thus, no causal relationships could generalize to other populations of elementary students. In addition, the authors found that only the usefulness of mathematics was enough to push students to continue taking mathematics courses in the future. Therefore, there is a need to study more about the effect of these beliefs on their mathematics courses (the usefulness of mathematics) for middle school and high school levels.

Kloosterman (1991) conducted a study at the middle school level to describe and explore the correlation between four beliefs about how mathematics is learned and mathematics achievement. The four beliefs were confidence in learning mathematics, attribution style in mathematics, effort as a mediator of mathematical ability, and failure as an acceptable phase in the learning of mathematics.

The participants in this study were 429 seventh-grade students (233 female, 196 male) from three lower-middle to upper-middle class schools in small cities in south-central Indiana. The seventh grade level was chosen in this study since they were old enough to develop their beliefs about mathematics and had all been taught similar mathematics content.

Instruments for measuring confidence and attributional style in this study were chosen from the available instruments, whereas, the instruments for measuring effort as mediator of mathematical ability and failure as an acceptable phase in learning mathematics were constructed, piloted and revised. There were two standardized mathematics achievement tests, which were from F sections of the Stanford Mathematics Achievement Test (SMAT). The first test was Concept of Mathematics (CONCEPTS). This test contains 34 multiple-choice items covering the topics of (a) whole numbers and place value, (b) rational numbers, and (c) operations and properties. Another test was Applications of Mathematics (APPLIED). This consists of 40 multiple-choice items covering the topics of (a) problem solving, (b) geometry and measurement, and (c) tables, graphs, and charts. The authors of the study reported a reliability (KR 20) of .88 and .91, respectively, for these two achievement tests when used at the seventh grade level.

University research assistants administered all instruments during regular mathematics classes. The attribution scale and the mathematical concepts test were administered in one class period. The other belief scales and the mathematical applications test were administered one week later.

To analyze the data, the author applied LISREL, an acronym for the analysis of linear structural relationships by the maximum likelihood method, which is a technique to estimate the strength of linear relationships among specified variables. For using this technique, two models have to be identified. The first model is the measurement model. This model indicates which measured variables are to be used to define latent variables. Since this study focused on the relationship between students' beliefs and performance, the two latent variables defined for this study were beliefs about how mathematics is learned and mathematics achievement. The second model was a structural model, which identified the relationship between the latent variables. The structural model includes specifications about which variables in the structural model are causes of other variables in the model.

Regarding instrument use, attributional style in mathematics (AS) was measured with the Fennema Peterson Autonomous Learning Behavior (ALB) mathematics attributional scale (Fennema & Peterson, 1984). This scale consists of six Likert-type subscales of five items each. The six subscales are (a) success due to ability (SA), (b) success due to effort (SE), (c) success due to ease of the task (ST), (d) success due to help from others (SO), (e) failure due to lack of ability (FA), and (f) failure due to lack of effort (FE). The participants were asked to choose strong yes, weak yes, undecided, weak no, or strong no for each item.

An attributional style score was computed for each student by combining his or her standard (z) score on each of the subscales. Three subscales, SA, SE, and FE were positively weighted due to mastery-oriented students, whereas FA, ST, and SO were negatively weighted. Therefore, positive attributional style scores indicate master orientation and negative attributional style scores indicates learned the degree failure. The reliabilities (Cronbach's α) of the scales were .77 for SA, .80 for SE, .75 for ST, .71 for SO, and .73 for FA and FE.

The author used the Fennema-Sherman confidence scale (Fennema & Sherman, 1976) to measure self-confidence in learning mathematics (SELFCON). The participants were asked to respond using a 5-point Likert scale (strongly agree,

agree, uncertain, strongly disagree) to a twelve item Likert scales. The reliability (Cornbach's α) was .89 for this scale.

Scores on effort as a mediator of mathematical ability (EFFORT) and failure as an acceptable phase in the learning of mathematics (FAILURE) can vary from 6 to 30 with a high score on the EFFORT scale indicating an incremental view of intelligence. A high score on the FAILURE scale indicating a strong belief about mistakes is an acceptable part of the learning process. The reliabilities were .83 for EFFORT and .59 for FAILURE.

Means, standard deviations, and correlations for the measured variables were analyzed by gender. All correlations except those between EFFORT and CONCEPTS and between EFFORT and APPLIED were significantly greater than zero ($p < .001$). There were no statistically significant gender differences ($p > .01$) in the means of any of the measured factors. The only statistically significant gender difference ($p < .01$) in the correlation was the correlations between SELFCON and FAILURE. This gender difference favored males rather than females. The total coefficient of determination for all x-variables, which provided by the LISREL program revealed that most of the variance in the latent variables was accounted for by the measured variables.

Consequently, the author concluded that correlations between the belief variables were considered individually and the achievement variables were of the magnitude expected from previous studies. The LISREL computed correlations coefficients that indicated the latent construct of beliefs about how mathematics is learned is significantly and positively correlated with mathematics achievement. The findings supported the hypothesis that beliefs about how mathematics was learned account for a considerable part of the variance in mathematics performance scores. When beliefs about how mathematics is learned were treated as a single construct, there was a stronger relation between beliefs and achievement than when beliefs about mathematics were considered independently.

The author reported a potential limitation of this study. The instruments used had a somewhat low reliability in measuring " failure as an acceptable phase in learning of mathematics." The author suggested that the low reliability of this scale might result from the fact that many students have never been asked to think about making mistakes in mathematics as being acceptable. Each student, without clear views about this issue, would probably not have answered consistently to questions about it. Another possible problem with the scale was that three of the items implied that making mistakes was associated with low ability, whereas the other items did not involve such implications.

In general this study provided ample data for readers, especially in the detail of the data analysis, collecting data, procedure, and the instruments used. The authors clearly provided information about statistical methods used in this study. Furthermore, the reliabilities of the instruments were reported for each scale. However, the author did not provide details about how the participants were selected for this study.

At the high school level, Schoenfeld (1989) conducted a study exploring students' mathematics beliefs and behaviors. The purposes of this study were to explore the directions of students' conceptions of mathematics and the ways that they engaged in mathematical activities. The relationship between students' comprehension about the nature of deductive proof in plane geometry and other geometric attempts was also focused on. There were 230 students (112 female, 118 male) who participated in this study, and were enrolled in high school mathematics courses. There were 125 (60 female, 65 male) of the 230 who were enrolled in six 10th grade New York State Regents' Geometry courses taught by four teachers; 57 (29 female, 28 male) were enrolled in three 11th grade algebra-trigonometry pre-calculus courses taught by three teachers; and 48 (28 female, 25 male) were enrolled in three 12th grade calculus or problem solving courses taught by two teachers. No information was provided about how the sample was selected.

For this study, a questionnaire consisting of 70 closed and 11 open questions was developed. The questionnaire contained multiple-choice questions which involved attributions of success and failure; students' perceptions of mathematics and school practice; their views of school mathematics, English, and social studies; the nature of geometric proofs, reasoning, and constructions; motivation; and personal and scholastic performance and motivation. The open-ended questions gave students the opportunity to present slightly more extended answers to issues of interest. The study was conducted only during the last two weeks of the year. The teachers who participated in this study were given the copies of the questionnaires, which were distributed to their students. By this time the students had completed the year's academic work and were beginning to review for their final exams or for the New York Regent's Examinations. The questionnaires took 20 to 25 minutes to be completed. The teachers collected them, and then returned them to the author.

The author did not give information about the data analysis as one part of the article. The author only included this detail in the result and discussion session. In the results and discussion part, the author discussed these following five topics: (a) attributions of success or failure, (b) students' perceptions of mathematics (mathematics attitude), including geometry, (c) classroom practice, (d) students' views of school mathematics, English, and social studies, and (e) motivational and personal data.

Regarding attributions of success or failure, the data was analyzed for gender differences using the standard error of a difference between uncorrelated means. Insignificant gender differences in attribution occurred from the data; in fact, differences in the means were small. It is worth noting that gender differences were consistently insignificant in all statistical analyses. Considering the population as a whole, the students believed mathematics to be an objective, and objectively graded, discipline that can be conquered. They believed that it was not good luck that accounted for good grades, and they placed much more focus on work than on inherent ability. If they did poorly, they believe that it was their fault.

The findings reported students' perceptions of mathematics, including geometry. The majority of the students thought that the mathematics in school was mostly composed of facts and procedures that have to be memorized. They believed the best way to succeed in learning mathematics was by memorizing the formulas. They also agreed that they must know some rules to be able to solve mathematics problems. For the responses to geometry, the students also noted that memorization was very important in learning mathematics because they had to remember the rules when they worked on proofs. The students also believed that they had to memorize including constructing a geometric proof.

Concerning classroom practice, the teachers were sophisticated at classroom interactions, giving students the chance to find their answers without narrow constraints. The teachers refrained from giving the answers to students, gave individual students enough chance to deal with the questions, and seldom moved rapidly on other students. On the other hand, the questions were generally pointed and were emphasized more at evoking recall than at stimulating deep thought.

A repeated measure ANOVA with post hoc comparisons revealed that the mathematics scores were significantly different from the English and social studies scores. The students believed that solving mathematics problems relied on knowing the rules, and mathematics was assumed to be more rules-bound than English or social studies. They also believed that good instructional practice in mathematics included making sure that students know how to use the rules to solve mathematics problems. Interestingly, the findings showed that the students believed that a proof or the answer to a problem in mathematics was either right or wrong. In contrast, there was enough area for interpretation and disagreement in the humanities and social sciences. The most likely reasons for these results were that the students interpreted the item in a direction that was different from what had been intended, responding about grading policies and school practice instead of about the disciplines themselves.

Regarding motivational and personal data, both the students and their parents believed that it was important for the students to do well in mathematics; the students mostly worked at mathematics in large part because they wanted to succeed in mathematics courses required in their programs. During the same period of time, they found the material interesting, and they also studied mathematics for intrinsically valuable reasons, such as to think clearly, instead of for extrinsic reasons, such as to impress teachers.

Relationships of academic performance and perceived ability to other variables appeared. The students' overall academic achievement, their expected mathematical achievement, and their perception of mathematical ability were correlated strongly with each other. Additionally, motivation to do well in mathematics was correlated with academic performance.

The author noted the limitations of this study and commented that perhaps the most troubling aspect of this study was the suggestion that the students have come to separate school mathematics (the mathematics they learned and experienced from the classrooms) from abstract mathematics, the discipline of creativity, problem solving, and discovery.

Some good points of this study were that the author provided open-ended questions in the questionnaire. Thus, the students could show their ideas in different ways and they were not limited to comment on any related issue. Furthermore, the author interpreted the data quite clearly by classifying some categories to explain the results. This helped readers to follow the author easily. However, there were also some weaknesses in this study. The author did not report the sample selection nor mention the validity or reliability of the questionnaires. In addition, not much information about the data analyses was provided.

The last reviewed study in this section, which was conducted at the high school level, was the investigation of high school students' beliefs about mathematics and science. Fleener (1996) conducted this study to explore beliefs about mathematical and scientific truths; the value and significance of mathematics and science inquiry; gender equity and ability with regard to search of mathematical and science careers; the relationship between mathematics and technology; and the role of science in society. The questions for investigation of this study were (a) what beliefs did high school students have about scientific and mathematical knowledge-building and practice, and (b) what were the world views of students as suggested by their beliefs about scientific and mathematics knowledge-building.

The sample for this study was 20 high school students (12 female, 8 male) from a variety of schools and academic backgrounds in the summer between their sophomore and junior years. Their recommending teachers or counselors considered all students to be strong mathematics and science students. They participated in a four-week residential program designed to display ideas and concepts not normally considered in the traditional high school mathematics and science curricula.

The students completed a mathematics and science beliefs instrument upon arriving on campus. The 46-item questionnaire was made up of a variety of science and mathematics attitude scales. A mathematics education researcher and a science education researcher determined the validity of the questionnaire. The findings of the belief inventory were put in sequence by deciding items upon which there was agreement, disagreement, mixed, and unstable responses. Regarding the first question, students strongly agreed that there were some things, which were known by science to be absolutely true, and that science and mathematics were gradually showing truths about reality. They also noted that mathematical innovations resulted from scientific inquiry and practical applications. Most of the students agreed that knowing mathematics and science profited all of them. Moreover, they believed mathematics and science improved their reasoning ability. They were not confident about whether the value of mathematics and science inquiry was for solving practical problems. They believed that females were just as good at mathematics and sciences as males and they agreed that mathematical and scientific inquiries were evenly available to individuals of either gender. The students also believed that having a good memory did not seem important for mathematical achievement.

In conclusion, the students had definitions of the principle of beliefs about the nature of mathematics and discovery of mathematical and scientific truths, the value and importance of mathematical and scientific inquiry, and equity of gender and background for working in the fields of mathematics and science.

For the second question, the result of this study revealed that the students felt that there might be multiple and individual methods to gain meaning and knowledge in mathematics and science. Based on student's believes about scientific and mathematics knowledge, nearly all of the students believed that there were mathematical and scientific truths and the aim of scientific inquiry was discovering those facts.

The author did not give any limitation or further research in the discussion section. However, the author suggested that changes in the organization of schooling in the 21st century for well prepared students in a new and complicated world was necessary. The author mentioned the validity of the questionnaires used, and gave enough information about the data analyses. However, this study contained some weaknesses. First, little information was provided about how the participants were selected. The exact number of the students in each level was not provided. And information was not supplied on who collected the data, and what the procedures for data collection were.

One result of this study was contrasted with another study, which was reviewed previously. The finding at the secondary level, which showed that students believed that having a good memory did not seem significant for mathematics was opposite with the results found from Schoenfeld's (1989) study. Therefore, it is necessary to investigate more about this contradiction.

In summary, the four studies involving beliefs about doing and learning about mathematics reported some noteworthy findings. At the elementary level, self-confidence in mathematics was related to grades and teacher feedback and comments. The students could be grouped according to the ratings of how much they liked school and mathematics. The relationship between liking mathematics and liking school was not consistent. Additionally, the students, when they got older, started to like mathematics more because increasing the difficulty of mathematics problems at upper-grade levels was challenging for them (Kloosterman & Cougan, 1994). At the middle school level, there were four beliefs about how mathematics should be studied: (a) confidence in learning mathematics, (b) attributional style in mathematics, (c) effort as a mediator of mathematical ability, and (d) failure as an acceptable phase in the learning of mathematics as it is related to mathematics performance. The results indicated that when beliefs about how mathematics is learned were treated as a single construct, there was a stronger relation between beliefs and achievement than when beliefs about mathematics were considered independently. Additionally, there was no significant gender difference in the correlation between the beliefs about mathematics and mathematics performance (Kloosterman, 1991).

Furthermore, the students realized the usefulness of mathematics. Nearly all of the students believed that mathematics was a crucial subject for them, to be the basis of their higher education and future lives. Especially, older students realized that mathematics would be involved in their future careers (Fleener, 1996; Kloosterman & Cougan, 1994; Kloosterman et al., 1996; Schoenfeld; 1989). However, at the beginning elementary level, the students could identify the usefulness of mathematics in their real lives, but not broadly when compared to the upper elementary level. Additionally, younger students did not really believe in the usefulness of mathematics until they got older (Kloosterman & Cougan; 1994).

The relationship between liking mathematics and confidence in learning mathematics was not apparent at the beginning elementary level, but it became evident at the upper-elementary level as students' enjoyment of learning mathematics did not relate to their performance in mathematics. Moreover, there was no evidence of the relationship of parental support in learning and doing mathematics, and mathematical achievement (Kloosterman & Cougan, 1994). No gender differences were discovered in the study regarding the attribution of success or failure. Some believed that success or failure was dependent upon themselves (Kloosterman et al., 1996), and believed anyone could learn mathematics if they tried (Kloosterman & Cougan, 1994). In addition, to successfully learn mathematics, some students believed that memorizing the formulas, the rules, and the process of doing mathematics were crucial for them. This would be effective if the students were taught to practice mathematics using their rules (Schoenfeld, 1989). However, another study found different results, students believed that memorization was not important in doing mathematics (Fleener, 1996). Fleener added that students also believed that mathematics and science improved their reasoning skills. The students at the elementary level believed that the answer to a mathematics problem was either right or wrong (1996). Schoenfeld (1989) indicated that the expected mathematical achievements and the perception of mathematical ability were strongly correlated. Moreover, the motivation to success in mathematics was correlated with performance with mathematical grades, and the sense of their own mathematics ability.

At the high school level, the students agreed that science and mathematics showed truths about reality, and mathematics innovations resulted from scientific inquiry and practical applications. Surprisingly, Fleener (1996) noted that students' believed that females were just as good at mathematics and science as males instead of "math is more for males.

Gender Differences in Mathematics

Over the last three decades gender differences in mathematics learning continued to attract much research attention. Particularly, within the field of psychology and education, gender differences in mathematics achievement have been studied intensively. And there has been consensus on the pattern of differences.

Five of these studies are presented in this section. The first study, conducted by Hyde, Fennema, and Lamon (1990) studied at the elementary and middle school levels with a meta-analysis about the relationship between gender and mathematics achievement. The next study, focused on the middle school level, was the TIMSS study conducted by Beaton et al. (1996). The last three studies were at the secondary level. Hanna, Kundiger, and Larouche (1990) conducted a study to explore gender differences in mathematics performances in 15 countries. In 1993, Kaiser-Messmer conducted a study to investigate gender differences in mathematics in Germany. The last study was designed by Singer, Beasley, and Bauer (1996) to study the interaction of ethnicity, mathematics performance, socioeconomic status, and gender on attitude toward mathematics.

Hyde, Fennema, and Lamon (1990) performed a meta-analysis of studies of gender differences in mathematics performance. Their goal was to provide answers to the following questions: (a) what was the magnitude of gender differences in mathematics performance, (b) did the magnitude or direction of the gender differences vary as a function of the cognitive level of the task, (c) did the magnitude or direction of the gender differences vary as a function of the mathematics content of the test, (d) at what ages did gender differences appear, (e) were there variations across ethnic groups in the magnitude or direction of the gender difference, (f) did the magnitude of the gender difference vary depending on the selectivity of the sample, (g) had the magnitude of gender differences in mathematics performance increased or declined over the years.

The sample of the study came from seven sources: (a) a computerized data base search of PsycINFO for the years 1967 to 1987, (b) a computerized data base search of ERIC, (c) inspection of all articles in Journal for Research in Mathematics Education and Educational Studies in Mathematics, (d) the bibliography of Maccoby and Jacklin (1974), (e) the bibliography of Fennema (1974), (f) norming data from widely used standardized tests, and (g) state assessments of mathematics performance. The results were 100 usable studies yielding 259 independent effect sizes. This represents the testing of 3,985,682 students (1,968,846 males and 2,016,836 females).

For each study, the following information was recorded: (a) all statistics on gender differences in mathematics performance measurement, including means and standard deviations or *t*, *f* and *df*, (b) the number of females and males in the sample, (c) the cognitive level of the measure (computation, concept, problem solving, and general-mixed), (d) the mathematics content of the test (arithmetic, algebra, geometry, calculus, and mixed-unreported), (e) the ages of the students in the sample, (f) the ethnicity of the sample groups (African American, Hispanic, Asian American, American Indian, Australian, Canadian, or mixed-unreported), (g) the selectivity of the sample such as national samples, classrooms, or level of the students, (h) the years of publication.

According to interrater reliability, interrater agreement was computed for ratings of ethnicity, samples selectivity, cognitive level of the test, and mathematics content of the test. The formula used Scott's pi coefficient (1955). Nearly all of the four variables' pi coefficients either get close to one or equal one, so, these categories were coded with high reliability.

Homogeneity analyses using procedures specified by Hedges and Becker (1986) showed that the set of 254 effect sizes was significantly non-homogeneous, thus, it can be concluded that the set of effect size is heterogeneous. The authors sought to partition the set of studies intò more demonstrated regression analyses to determine which are the best predictors. Since the first homogeneity analysis indicated that overall, the set of effect sizes was non-homogeneous, and multiple regression analysis was applied to construct a model of the sources of variation in effect sizes.

The effect size computed was *d*, defined as the mean for males minus the mean for females, divided by the mean within-sexes standard deviation. The positive values of *d* represent superior male performance and negative values represent superior female performance. Depending on the statistics available for this study, formulas provided by Hedges and Backer (1986) were used for the computation of *d* and the homogeneity statistics. All effect sizes were computed independently.

The results of the analysis of effect sizes were arranged according to the cognitive level of the test. As in the overall analysis, the effect sizes were small.

There was a slight female superiority in computation, no gender difference in understanding of concepts, and a slight male superiority in problem solving. The analysis according to the mathematics content of the tests was less successful because many studies failed to report the mathematics content of tests as a mixture of content. The results of the analysis reported that there was no gender difference in arithmetic or algebra performance. The male superiority in geometry was small. The tests with mixed content showed the largest gender difference. Homogeneity analyzed indicated that it was a significant difference between the effect sizes for the different types of mathematics content. There was slight female superiority or no gender differences in the elementary and middle school levels; however, a moderate gender difference favoring males appeared in the high school or higher levels. Homogeneity analysis indicated significant differences in the magnitude of the gender difference as a function of age group. The age effect was strong.

The results for analysis of gender differences as a function of ethnicity showed that there was essentially no gender difference in mathematics performance for African Americans, Hispanics, and Asian Americans. However, the slight differences for Americans favored males. For Asian Americans, there was evidence of slight superior female performance, and the difference was small. Homogeneity revealed that there were significant differences between ethnic groups in the magnitude of the gender difference.

The analysis of the magnitude of the gender difference as a function of the selectivity of the sample revealed that the gender difference was close to zero for general samples. A large gender difference favoring males was found in each successive level of selection for higher ability: moderately selective, highly selective, precocious, and selected for low performance. Homogeneity analyses indicated that there were significant differences in effect size depending on how selective the sample was. Studies were divided into two subgroups depending on the year of publication (those published in 1973 or earlier and those published after 1973). The data from both groups showed that an increasing trend in the research on gender and mathematics in more recent studies. It was important to recognize that the set of effect sizes was not homogeneous. It was, therefore, essential to consider variations in the magnitude of the gender differences as a function of the three variables that were important predictors in the multiple regression analyses: age, selectivity of the sample, and cognitive level of the test.

The authors commented that one frustration that occurred in the process of conducting this meta-analysis was the difficulty of analyzing the results according to the mathematics content of the test. Hyde et al. (1990) found that few authors specified the content clearly, probably because the content was mixed. Additionally, the gender differences in mathematics performance were moderate. Therefore, in explaining the lesser presence of women in college-level mathematics courses and in careers related to mathematics, the authors suggested other factors should be looked at, such as internalized beliefs systems about mathematics, external factors such as sex discrimination in education, and mathematics curriculum at the pre-college levels.

This study involved a large number of the students. The author provided the number of males and females. The authors referred to the reliability of this study. They also provided enough information about the data analysis. Statistical methods were explained.

However, there were many results from a large number of studies in this meta-analysis. The authors provided only five categories of results. Seemingly, there were not enough to classify all results. The author might provide more categories to group the findings.

An interesting study about mathematics achievement at the middle school level was the part of the study of the Third International Mathematics and Science Study (TIMSS), which was conducted by Beaton et al., (1996) and supported by the International Association for the Evaluation of Educational Achievement (IEA). TIMSS was a series of international comparative studies designed to provide policy makers, educators, researchers, and predictioners with information about educational achievement and learning contexts. The main object of the TIMSS study was to focus on educational policies, practices, and outcomes in order to improve mathematics and science learning within and across systems of education in different countries.

The data of TIMSS were collected from 45 countries in more than 30 different languages, and tested more than half a million students from five grade levels around the world. TIMSS gathered the data about students' academic achievement, and their background factors: the home, school, and national contexts within which education took place. These national contexts could play keys roles in how students learned mathematics. The students who participated in the study completed questionnaires about home and school experiences involved in mathematics learning. Teachers and school administrators completed questionnaires about instructional practices. Each participating country provided system-level information.

Regarding attention to quality, the study was conducted carefully at every step of the way. Rigorous procedures were planned to translate the tests, and a number of regional training sessions was held in gathering the data and scoring procedures. Quality control monitors observed testing sessions, and reported back to the TIMSS international Study Center at Boston College. Moreover, students who participated in this study were scrutinized following rigorous standards designed to prevent bias and confirm comparability. The quality of the tests was considered a crucial factor as well. During the entire procedure, developing the TIMSS tests was a cooperative venture concerning the National Research Coordinator (NRC). In order to ensure that the designed mathematics topics were covered in enough contexts, the countries submitted items that were reviewed by mathematics subject-matter specialists, and additional items were added.

Six content areas were covered in the mathematics tests taken by seventh and eighth grades. The areas of the test items included: fractions and number sense, measurement, proportionality, data representation and analysis, probability, geometry, and algebra. The expected performance included knowing how to solve the problems, and solving problems.

Approximately, one-fourth of the questions in the questionnaires were open-ended. Some of those questions required extended responses. The TIMSS tests were translated into 30 additional languages from English. A series of verification checks were conducted to make sure that the translations were comparable.

The students who participated in this study were not tested on all of the items. The test was assembled in eight booklets. Each booklet required 90 minutes to complete. Each student took only one of those booklets. Items were related through the booklets so that each booklet was answered by a representation of the participants.

In addition, the countries in this study were grouped for reporting of achievement regarding their compliance with the sampling guidelines and the level of their participation rates. The results of this study revealed students' mathematics achievement at seventh and eighth grade levels. In most of TIMSS countries, two of the grades tested were at the middle school level.

Four main findings from the TIMSS study at the middle school level were students' mathematics achievement, students' attitudes toward mathematics, home environment, instructional contexts and practices. Regarding students' mathematics achievement, Singapore had the highest mathematics performance in both seventh and eighth grades, whereas, Columbia, Kuwait, and South Africa had the lowest performance. Interestingly, there was a huge difference in average achievement between the highest and the lowest countries. For example, at both grade levels, average achievement in mathematics in top-performing Singapore was comparable to or exceeded performance for 95% of the students in the lowest-performing countries. However, at both grade levels, the results revealed that most countries had an average achievement level similar to a cluster of other countries.

The gender differences in mathematics achievement of most countries were small or non-existent. Nevertheless, the orientation of the sex differences that did occur favored boys more than girls. In the same way, there were few differences in achievement between boys and girls within the various content areas of mathematics except in algebra. These small differences favored boys except in Thailand, Australia, Belgium, Canada, Cyprus, Singapore, Russian Federation, and Lithuania, which favored girls rather than boys at the eighth grade level.

Most of the countries did relatively better in several content areas than they did in others. Because of consistency with the idea of countries having various areas of focus in their curriculum, those that performed relatively better in fractions and number sense tended to differ from those that performed relatively better in geometry and algebra. Additionally, in most countries both seventh and eighth-grade students had difficulty with multi-step problem solving, application items, and the proportionality items.

Regarding students' attitudes toward mathematics, a positive relationship was observed between a stronger liking of mathematics and higher academic performance within almost every country. Interestingly, the results from TIMSS study indicated that in some countries, such as Japan, students had a greater disliking of mathematics than students in other countries but they had higher mathematics performance than students in those other countries. Although most of the eighth grade students noted that they liked mathematics to some degree, not all students had positive attitudes toward the subject. In some countries such as Austria, Japan, and Korea, nearly half of the students noted that they disliked mathematics. Boys reported liking mathematics more than girls did in many countries such as Austria, Hong Kong, Japan, and Thailand. Furthermore, except in Hong Kong, Japan, Korea, and Lithuania, most of the students agreed or strongly agreed that they did well in mathematics, whereas students in Hong Kong, Japan, and Korea were in the highest mathematics performance group. Interestingly, in most countries, the most frequent motivation given for students to do well in mathematics was to instill in the students to pursue secondary school or university.

Regarding the home environment, the students in eighth grade in every country who had higher mathematics performance noted that they had educational resources in their homes. There was a strong relationship in most countries between mathematics performance and having study aids in the homes such as a computer or a dictionary. There was a significant positive relationship between the books students had and their higher mathematics performance. The majority of the eighth-grade students noted that they spent as much time in non-academic activities as they did in academic activities.

Regarding instructional context and practices, the qualifications required for a teaching certificate were relatively uniform across countries. Nearly all countries noted that practice teaching was a requirement. In most countries, teachers noted that mathematics classes basically met for at least two hours a week, but not more than three and one-half hours. In addition, in many countries, most students were in classes of fewer than 30 students. For instructional approaches, small-group work was used less often than other methods, whereas having students work individually with assistance from teachers was the most favorite instructional method.

Furthermore, teachers in most countries used a textbook in teaching mathematics. Teachers in a number of countries reported that most of the eighth-grade students used calculators almost every day in their classrooms. They often used it for checking answers, routine calculations, and solving complex problems. In addition, the students at the eighth grade level from about half of the countries reported that they spent about two or three hours per day doing mathematics homework. Moreover, the eighth-grade students from most countries reported considerable variation in the frequency of testing in mathematics classrooms. In some countries, they had quizzes and tests only once in a while or never, whereas one-third of the students reported that they always had quizzes or tests.

The data from the TIMSS study seemed difficult to interpret from the tables because of the intricate details represented in each table. Furthermore, the process and instruments used in this study were based on strong reliability and validity criteria. Nearly all of the procedures were scrutinized to reduce bias or any bias or lack of problem comparability. Therefore, this study could serve as an international data guideline for mathematics teachers, researchers, educators, and principals in nearly all countries around the world.

Hanna, Kundiger, and Larouche (1990) performed the study to investigate sex differences in mathematics achievement in 12th-grade students in 15 countries (North American, Europe, and East Asian countries). The investigation made use of the data of the Secondary International Mathematics Study (SIMS) conducted by the International Association for the Evaluation of Educational Achievement (IEA). The last grade of secondary school was selected because internationally this represented the population for university entrance. The study used a very large random sample stratified by region and school type in each of the fifteen participating countries.

The IEA survey sought detailed information from each of the participating countries on three interrelated aspects of mathematics teaching: the intended curriculum, the implemented curriculum and the attained curriculum. In addition to an investigation of classroom practices, the SIMS study included a survey of student attitudes toward a number of issues related to the study of mathematics. The seven sets of attitude questions addressed the following topics: mathematics in school, mathematics as a process, parental support for mathematics, mathematics and myself, mathematics and society, mathematics and gender, and computers and calculators.

The SIMS test was administered to over 40,000 12th-grade students in 15 different countries under comparable conditions. There were 136 test items, which were presented in multiple-choice format. They were divided into seven main content categories: Sets, Relations and Functions, Number Systems, Algebra, Geometry, Analysis, Probability and Statistics, and Finite mathematics. The student responses were gathered at the end of the course or the school year. The percentage of correct response (p-value) was computed separately for each item for boys and girls in each one of the fifteen countries. The mean percentage value for each content category was gained by averaging the percentage values for the individual items in the category. The multivariate analyses of variance and paired t-tests were used to analyze sex differences within and between countries.

Focusing on each content category separately, the findings revealed that for all topics except Sets, there were significant and consistent differences favoring boys. The results showed that mathematics achievement means for girls were significantly lower than the means for boys except for Thailand, British Columbia, and England in which the data showed high levels of home support for both genders. The authors found that strong parental support for participation in mathematics by both boys and girls was the only variable linked to mathematics achievement. Moreover, since the results of gender differences vary from country to country, while biological factors do not, their findings do not support the biological theory that attempts to explain boys' superiority in mathematics.

The authors suggested that the ratio of female to male mathematics teachers might be a key factor in explaining gender differences in attitudes toward mathematics because it most likely affected the degree to which girls subscribed to the idea that mathematics was more for men. Thus, countries with negligible gender differences in achievement would be expected to have higher proportions of female mathematics teachers than their counterparts. The author noted that boys are traditionally reinforced for their participation in masculine activities like sports by society at large. Thus, the degree of home support might be more important for girls than boys in predicting their achievement. Therefore, gender differences should be less pronounced in countries whose mean level of parental support was relatively higher than in countries in which home support was less evident. The authors reported that the data of this study supports this idea. The countries where gender differences were negligible showed high levels of home support for both genders, in contrast to the countries in which important gender differences were observed revealed lower levels of home support.

This study might be able to be called a cross-national study because it was conducted within 15 countries. The authors selected the sample randomly, and gave the reason why they selected 12th graders as their sample. Moreover, more details about the questionnaire were also provided.

Kaiser-Messmer (1993) conducted a gender difference study in Germany. The author noted that the outcomes that were gathered from studies in English-speaking countries could not be readily transferred to the situation in German-speaking countries because there were large differences between the systems of schools and their underlying educational philosophies. Therefore, the author aimed to study the possible variables affecting gender differences in mathematics achievement but focused on variables concerning attitudes towards mathematics and concerning the school population at the end of the 1980's in the Federal Republic of Germany (FRG). The author was also interested in whether the attitude of girls and boys towards mathematics had changed during the last twenty years and whether the research from the English-speaking countries could be applied to German-speaking countries.

The inquiry was based on a standardized, anonymous questionnaire consisting of 23 questions for the lower secondary level and 21 questions for the upper secondary level, with the majority of the questions being open-ended. The study was conducted from 1988 to 1989 in Kassel and its vicinity at seven schools consisting of four upper-type secondary level schools. In total, 748 students were questioned. The author then provided three main results of the study:

1. Gender differences determined the fundamental attitude toward mathematics.

2. Gender differences affected the manner of approaching mathematics.

3. Gender differences were focused on the mathematical ability of women.

With regard to gender, the first finding revealed some interest in mathematics by pupils. At the lower secondary level or middle school, there were significantly fewer girls than boys who had an interest in mathematics. At the upper secondary level or high school, responses comparing students on the basic and advanced level courses indicated that there were differences between boys' and girls' interests in mathematics. Two variables, gender and interest in mathematics, were significant for the basic course. Moreover, there was a gender-based influence on the interest in mathematics shown by boys and girls. At the lower secondary level, high attainment in mathematics was more significant for boys than girls. The upper secondary level had the same results as the lower secondary level.

There was some willingness to consider entering a career involving mathematics. At the lower secondary level, a smaller percentage of girls than boys tended to select a career involving mathematics. At the upper secondary level, obvious differences between basic and advanced level course data were reported. At the basic course level, the willingness to work in a career, which involved mathematics, was higher in boys than girls. In contrast, in advanced mathematics courses, gender differences in willingness to work in mathematics-related careers favored girls more than boys. The author noted that this contradiction might be caused from a small sample size in this study and indicated that there were different grades in mathematics. At the lower secondary level, there was no gender difference in comparing the mean of grades in mathematics. At the upper secondary level, the girls had significantly lower grades than boys.

With regard to the second finding, there were certain mathematical activities that interested the pupils. At the lower secondary level, girls followed an interest in geometrical activities and were mainly interested in arithmetic problems.

The findings showed that for the boys, the order was reversed. At the upper level, girls, focused on arithmetic and real-word problems followed by standard method problems and geometrical activities. Boys were interested in geometrical activities and real-world problems. However, boys were not interested in theoretical problems, but they appealed to boys more than girls.

There were themes from the real world that interested pupils in mathematics teaching. At the lower secondary level, the girls' favorite topic of study was ecology, followed by sports, biology/medicine and every-day life. For the boys, they strongly favored sports, technology, the economy and physics with significant gender differences in technology and physics. At the upper secondary level, there were significant differences between the basic course and the advanced course. The girls expressed a high interest in social science followed by ecology, every-day life, technology, and sports. The boy's interests slightly changed in order. More boys selected society and technology as favorites. More males than females preferred the topic of economy.

With regard to the third finding, minor gender differences can be found regarding their view on women's mathematical talents at the secondary level. At the lower secondary level, same academic level demonstrated views that women were less talented in mathematics than men. Mostly, boys held this view, whereas girls seldom considered this idea. The majority of the boys and girls believed that women had the same talent in mathematics as men. At the upper secondary level, the view that women are equally talented in mathematics as men was held by most of the boys and girls at both course levels, but more girls than boys believed this strongly.

There were some expectations of gender roles. At the lower secondary level, more girls than boys found that it was agreeable to work in gender atypical career plans, and to obtain insights into expectations of gender roles. It was observed that more boys were undecided and did not give any explanations. This confirmed that boys, much more than girls, preserve traditional gender role expectations. Most of the girls and boys from the upper secondary level were open-minded about gender atypical career plans.

In conclusion, the author did not clearly provide many details about the limitations of this study or other further research, but the author did give some information about the development of German schools. For example, inviting women who worked in mathematics–related professions to participate in discussions about their jobs provided role models for girls with which to identify.

This study was interested in another country rather than in the USA to find the results from different groups and gave the reasons to conduct the study in Germany. The author grouped the results to several parts, and then followed by subgroups. This organization helped readers gain insight into the findings of this study more easily. Nevertheless, the author did not provide enough information about the data analysis. The author did not focus on the limitations and suggestions for further research.

Singer et al. (1996) conducted a study of the interaction of ethnicity, math achievement, socioeconomic status, and gender on math attitudes of high school students. The goal of this study was to interview high school students in-depth to investigate the interactions between ethnicity, socioeconomic status (SES), math achievement/level, and gender on student beliefs about themselves as learners of mathematics.

Specifically, this exploratory research study questioned students regarding constructs that are acknowledged as influencing mathematics learning. They have achievement motivation, career expectations, influence from teachers and parents, parental education and occupational backgrounds, enjoyment of mathematics, self-esteem as a mathematics students, math stereotypes, mathematics utility/relevance, teacher expectations, and locus of control. The final objective was to generate hypotheses about the interaction of the student variables with the constructs that influence attitudes towards mathematics.

The authors used individual standardized open-ended interviews to collect appropriate information from African-American students, and white students in low- socioeconomic status (SES) and high-SES school communities in the New York City area. The interviews consisted of 23 questions and lasted 45 minutes. Students enrolled in either a masters program in education or a doctoral program in psychology conducted the interviews. The interviewers were instructed on how to ask probing follow-up questions at appropriate places by university professors. All students were asked the same questions in order to minimize bias and interviewer effects.

In this study, 100 secondary students were interviewed. They were either (a) African-American or white, (b) female or male, (c) high-math or low-math achievement/level, and (d) residing in a high-SES or low-SES school community. The SES determination was made by the percent of students in the school community who participated in the federally funded free or reduced lunch program. It was necessary to include the elementary and junior high school students only in this determination because those who qualify for the federal lunch program in high school would not participate because they were embarrassed to do so or they did not eat lunch at school.

Mathematics achievement/level referred to the type of mathematics courses the students were enrolled in during high school. High achievement/level referred to regents' courses. The regents diploma level mathematics course reflects a more rigorous, academic, college preparatory curriculum. The profile of a student enrolled in a non-regents level mathematics course included students who have (a) previously shown difficulty in understanding mathematical principles and concepts, (b) not been successful in passing a New York State Regents Examination, and (c) poor academic self-esteem and attitudes toward school.

An educational aspiration variable was constructed based on the students' responses to the question, " How far in school do you think you will get?" Academic aspirations were classified as either "less than college" or " college or beyond." Another dichotomous dependent variable was based on yes/no responses to " If given the opportunity, would you take more advanced math courses?" This factor was supposed to represent the students' academic aspirations in mathematics. A mathematics self-concept variable was based on the students' responses to " What do you think is the reason for your math grades?" This variable was dichotomized based on concepts related to their locus of control or expectations of their personal control regarding mathematics performance.

Several dichotomous demographic variables (i.e., gender, ethnicity) were considered. Because the sample included only African-American and white students, a dichotomous variable was appropriate. Socioeconomic status (SES) was based on the SES of the school community and classified as "High" or "Low." The students' Math Achievement was also classified as high or low based on what mathematics classes the students attended. Job utility was based on yes/no responses to "Is it important to know math to get a good job?" It was believed that these career perceptions might influence the dependent variables, especially those concerning academic aspirations.

Because the variables were dichotomous, loglinear modeling and logistic regression were used to determine which independent variables were most strongly related to the dependent variables of interest. In cases where statistically significant interactions were present, Odd Ratio (OR) was produced for descriptive purposes. In cases where no statistically significant results were found, a logistic repressive model was expressed.

A significant Math Achievement by Ethnicity interaction was shown for educational aspirations. All other two-way and higher-order interactions failed to reach statistical significance at the .05 levels. Furthermore, the main effect of job utility, and its interactions with other independent variables were not statistically significant. The OR for these results indicated that low achievement whites were the group least likely to have educational aspirations to attend college. Low-achievement African-Americans were three time more likely to expect to attend college than low-achievement whites; however, it revealed that high-achievement whites were about twice as likely to envision themselves attending college than high-achievement African-Americans. Significant three-way (Ethnicity by math achievement by SES) interactions were shown for the economic aspirations in mathematics variables. All other three-way and higher-order interactions were not statistically significant.

Gender by mathematics performance interactions was also indicated. None of the two-way interactions were statistically significant. High female achievers were the least likely to desire more advanced mathematics coursework. Surprisingly, low-achievers in mathematics, regardless of their gender, were equally likely to desire more advanced mathematics courses. Nevertheless, high male achievers were more than 19 times more likely to desire more advanced mathematics courses than female achievers.

In conclusion, the results revealed that there were interactions between mathematics achievement by ethnicity, ethnicity by math achievement by SES, and gender by math achievement. Math coursework and achievement/level was not commonly studied when reporting gender, ethnicity, and socioeconomic differences of math attitudes. While the study verified previous findings that males were more likely than females to attribute intrinsic constructs as reasons for their math grades, this study also reported interesting findings not previously explored. Especially that (a) African-American high school students in low level mathematics courses were three times more likely to indicate an interest in attending college than white counterparts, and (b) African-American students enrolled in low mathematics course levels in low–SES high schools were most likely to desire registration in more advanced mathematics courses. Lastly, the study confirmed previous findings concerning the fact that female students registered in high level mathematics courses were the least likely to request further registration in these courses. The authors did not comment on any limitations of this study or other related research.

The authors provided information about the procedure of this study quite clearly; however, they did not provide data about validity or reliability of this study. They did not give information about the grade level of the participants. The authors should specify the grade level in the sample instead of using the term "secondary students."

The authors also gave enough details about data analysis and reported the findings quite clearly. It would be better if the authors provided the limitations of this study or suggested related research. This will enable readers to better comprehend the researchers' objectives.

In summary, the results of gender differences were varied in different countries. The TIMSS study, Beaton et al. (1996) found that at the middle school level gender differences in mathematics achievement of most countries were not significant. However, the direction of gender differences that did appear favored boys more than girls except for Thailand, Australia, Belgium, Canada, Cyprus, Singapore, Russian Federation and Lithuania.

Other researchers who focused their studies at the high school level indicated that mathematics achievement means for boys were significantly higher than the means for girls except for Thailand, British Columbia, and England in which the data showed high level of home support to students in those countries (Henna et al., 1990). In Germany, Kaiser-Messmer (1993) indicated that there was no gender difference at the middle school level, but at the high school level there were significant gender differences favoring boys more than girls. In the United States, Hyde et al. (1990) conducted a meta-analysis study involving gender differences in mathematics achievement. They found there was slight female superiority or no gender differences at the elementary and middle school level. However, a moderate gender difference favoring males appeared at the high school or higher levels. Moreover, there was essentially no gender difference in mathematics performance for African Americans, Hispanics, and Asian Americans. However, the slight differences for white Americans favored males. For Asian

Americans, there was evidence of slight superior female performance, and the difference was small (Hyde et al., 1990).

In addition, Singer et al. (1996) noted that high female achievers were the least likely to desire more advanced mathematics coursework. Surprisingly, low achievers in mathematics, regardless of their gender, were equally likely to desire more advanced mathematics courses. Nevertheless, high male achievers were more than 19 times more likely to desire more advanced mathematics courses than female achievers. Additionally, female students registered in high level mathematics courses were the least likely to request further registration in advanced mathematics courses.

Several studies revealed interesting findings about students' attitudes toward mathematics (e.g., Beaton et al., 1996;). For instance, Beaton et al. (1996) found that a positive relationship of attitudes toward mathematics was related to higher mathematics achievement within nearly all countries. In addition, boys reported liking mathematics more than girls did in many countries such as Austria, Hong Kong, Japan and Thailand.

Other interesting findings were also were revealed by these gender differences studies (e.g. Hyde et al., 1990; Kaiser-Messmer, 1993; Singer et al., 1996). For instance, Kaiser-Messmer (1993) reported gender differences in willingness to consider entering a mathematics-related career. At the middle school level, boys more than girls tended to enter to a mathematics-related career. Kaiser-Messmer also found the same result at the high school level in basic mathematics courses. Singer et al. (1996) indicated that African-American students enrolled in low mathematics course levels in low–SES high schools were most likely to desire registration in more advanced mathematics courses. And female students registered in high-level mathematics courses were the least likely to request further registration in advanced mathematics courses.

Conclusion

During the past three decades, researchers have sought to identify by gender various affective variables such as students' attitudes and beliefs, which can be related to students' achievement in mathematics. Many researchers found a significant relationship between students' beliefs and attitudes toward mathematics and their mathematics performance (e.g., Kloosterman, 1991; Kloosterman et al., 1996; Ma & Kishor, 1997; Telese, 1997), their future coursework and their career interests (Kaiser-Messmer, 1993; Throndike-Christ, 1991), and their achievement in mathematics.

Some evidence indicated that the relationships between attitudes toward mathematics and achievement in mathematics was slightly significant at first to sixth grade levels, but there were significant correlations in higher grade levels between positive attitudes toward mathematics and high mathematical achievement could be noted (Ma & Kishor, 1997; Telese, 1997; Throndike-Christ, 1991). Beaton et al. (1996) added that at the seventh and eighth grade levels, attitudes toward mathematics in some countries such as Japan and Korea was not related to higher mathematics achievement, where as this relationship appeared in many other countries such as Denmark and England.

The relationship between students' beliefs in mathematics and achievement in mathematics also revealed similar results. There was evidence that the relationship between these factors was strongly significant for higher-grade level (Kloosterman et al., 1996). The research also revealed that students' beliefs about knowing and doing math were stable. Students believed that learning mathematics was useful (Fleener, 1996; Kloosterman & Cougan, 1994; Kloosterman et al., 1996; Schoenfeld; 1989). Schoenfeld (1989) confirmed beliefs about mathematics related to achievement in mathematics, especially students' beliefs in expected mathematical performance and their expectation in mathematical ability. Schoenfeld (1989) also noted that at the high school level students believed that memorizing was important in doing mathematics. However, Fleener (1996) found that this belief did not hold in higher-grade levels.

Among the studies, which investigated gender issues, several reported there were significant gender differences in mathematics performance. Some researchers found that males performed better than females (Kasier-Messmer, 1993; Throndike-chirst, 1991). A slight female superiority or gender difference was formed in elementary school and middle school levels; however, moderate gender differences favoring boys were detected in the higher levels (Hyde et al., 1990). Beaton et al. (1996) confirmed that at the middle school level gender differences in mathematics were small, but the direction of gender differences favored boys more than girls except in some countries in which the small differences favored girls more than boys such as Thailand, Australia, and Singapore.

Hanna et al. (1990) conducted their study in 15 different countries. They found that in many countries, there were significant gender differences in mathematics performance, but some countries showed different results. The authors reported that mathematics achievement means for girls were significantly lower than the means for boys except for Thailand, British Columbia, and England in which there were no gender differences, and the data showed high level of home support to both genders in those countries. The authors found that strong parental support for participation in mathematics by both boys and girls was the only variable linked to their mathematics achievement.

Since most of the studies of the relationships between students' beliefs and attitudes toward mathematics and mathematics performances and gender differences in mathematics were conducted in the 1990s or earlier; a new look at the predictive factors in the 21st century is essential. Moreover, in responding to the results of reviewed articles that were not conclusive, additional research is needed to determine whether students' beliefs and attitudes toward mathematics and gender affect their achievement in mathematics. In addition, possible different results among other races and ethnicities as well as in different countries need further research.

CHAPTER III

METHOD

Introduction

The study of the relationship between girls' and boys' attitudes and beliefs and their mathematics achievement, future mathematics coursework, and career choices was designed to focus on Thai students at the middle school level. This study was conducted in order to (a) describe Thai middle school students' attitudes and beliefs about mathematics, (b) describe Thai middle school students' mathematics achievement, future mathematics coursework intentions, and career interests, (c) explore the grade level differences and gender differences in the categories listed above, and (d) investigate the relationships among these factors.

Although research on the affective domain has remained on the edge of the field, it is still considered an active factor in mathematics classroom research. Koehler and Grouws (1992) explained several levels of mathematics classroom research and recognized the complex role of the affective domain. One important aspect is that children's affective characteristics, as well as research in these characteristics, should be broadened to encompass attitudes, beliefs, and performance. Other aspects of the study of the affective domain involve factors such as student gender, race, age, and ethnicity that can affect teacher practice and student behavior. McLeod (1992) noted that students' beliefs developed gradually over time and are influenced by classroom experiences and the cultural backgrounds of both teachers and students. Additionally, attitudes and beliefs toward mathematics play a crucial role in future career choices (Throndike-Christ, 1991). The classroom is a complex system. Teachers and students bring with them beliefs and meanings to the teaching and learning processes, which must be identified before a response can be made to meet the needs of students (Nickson, 1992).

Consequently, the affective domain acts as an important role in either encouraging or discouraging students to continue with advanced mathematics classes. Particular attitudes and beliefs develop and are influenced by variables such as repeated experiences in mathematics classroom, the cultural background and the social context of the mathematics classroom. In this chapter the researcher (a) describes the participants and variables of this study, (b) explains the development of the instrument used to gather the data, (c) describes the method used to collect the data, and (e) explains the analysis that will be carried out.

Participants

Participants in this study were 523 Thai students (179 male, 344 female) at the middle school levels (seventh through ninth grades) who were enrolled in the Chiang Mai University Demonstration School during the first semester of the 1999 school year. The study included 176 students (57male, 119 female) in seventh grade level, 161 (53 male, 108 female) in eighth grade level, and 186 (69male, 117 female) in ninth grade level. Students who were absent the day the questionnaire was administered or did not wish to participate in this study were deleted from the study. Most of them were 13 to 15 years old.

Variables

The affective variables consisted of one attitude toward mathematics, which was effective motivation. Six beliefs about mathematics were also included in this study: (a) motivation in mathematics, (b) confidence in learning mathematics, (c) mathematics as a male domain, (d) the usefulness of mathematics in daily life, (e) time-consuming mathematics problems, (f) the importance of understanding concepts in mathematics, (g) increase of mathematical ability by effort. The outcome variables included students' mathematics achievement, future mathematics coursework intentions, and their career interests.

Instrument

In order to measure the students' attitudes and beliefs about mathematics, a questionnaire was developed (see Appendix A). The attitudes and beliefs questionnaire was developed from the Fennema-Sherman Attitudes Scale (Mulhern & Rae, 1998) and Indiana Mathematics Beliefs Scale (Kloosterman & Stage, 1992).

Students' Attitudes and Beliefs Questionnaire

Students were asked to respond to the statements in the questionnaire on a 5-point Likert-type scale. Each response to a 'positive" statement was given a score of five for " strongly agree", four for "agree", three for "uncertain", two for "disagree", and one for "strongly disagree." The score was reversed for negative statements.

The statements in the scales consisting of effective motivation, confidence in mathematics, and mathematics as a male domain were taken from the Fennema-Sherman Attitudes Scale (Muhern & Rae, 1998). Statements for each scale were randomly selected. Three were selected from six positive statements and three from six negative statements. The statements in the scales consisting of the usefulness of mathematics, solving time-consuming mathematics problems, the importance of understanding concepts in mathematics, increasing mathematics ability by effort were taken from the Indiana Mathematics Beliefs Scale (Kloosterman & Stage, 1992). These attitudes and beliefs scales had been developed, used, and revised by previous studies (e.g., Muhern & Rae, 1998; Kloosterman & Stage, 1992) at the middle school, high school, and college levels, and were adapted especially for this study.

For the validity of the questionnaire, two mathematics educators from Oregon State University read through items before the questionnaire was translated by the researcher into Thai language. Then, two mathematics educators from Chiang Mai University read through items for readability to make sure that the items related to the intended construct. After that, the researcher had two or three middle school students volunteers from other schools in Thailand check the questionnaire for readability and time. Additionally, reliabilities (Cronbach's α) were computed for each scale used in the study.

Students' Attitudes and Beliefs Questionnaire Reliability

A reliability analysis was carried out using SAS institute's statistics program. The SAS system was used to determine internal consistency of the responses for each scale. Because some of the statements in the scales were chosen by the author from other scales, it was necessary to find the reliability coefficient of these scales to determine whether the different statements, when combined, gave consistent results. This was done by computing a reliability coefficient (Cronbach's α) for each scale, based on the responses by students to the statement in the questionnaire of this study. Cronbach's alpha gives a measure of the internal consistencies of the various statements in each scale. The score would be ranked from 1.0, which means that the responses to all statements in a particular scale are perfectly correlated to 0.0, which means the scale is totally useless and the different statements in the scale do not measure the same attitudes or beliefs. Normally, a reliability coefficient of .70 or higher is considered respectable; however, sometimes lower coefficients are tolerated (Henerson, Morris, & Fitz-Gibbon, 1978). In this study, coefficient of .70 and higher were considered very reliable, while caution should be used in interpreting the results when the coefficients between .50 and .70. Those lower than .50 were not considered as reliable scale.

The result of the reliability analysis of the scale solving time-consuming mathematics problems scale has a reliability coefficient of .39. The values of reliability coefficient (Cronbach's α) for all other scales range from .70 to .53. The reliability coefficient for the usefulness of mathematics scale is .70, confidence in learning mathematics scale is .70, increasing mathematical ability by effort is .69, motivation in learning mathematics scale is .67, mathematics as a male domain is .61, and the importance of understanding concepts in mathematics scale is .54. Therefore, all attitudes and beliefs scales from the questionnaire in this study except solving time-consuming mathematics problem scale were used because the reliability of that scale is lower than .50.

Students' Future Plans Questionnaire

According to Throndike-Christ's (1991) study a series of questions were added to the attitudes and beliefs scales in order to gather information relative to students' plans regarding their future mathematics coursework intentions and career interests. First, the students were asked to rate on a 5-point scale from 1 (definitely will not continue to take mathematics) to 5 (definitely will continue to take mathematics) to indicate the likelihood that they would continue to enroll in optional mathematics coursework. The anticipated careers were rated according to Goldman and Hewitt's (1976) science/math continuum, from 1 (fine arts) to 5 (the physical sciences and mathematics). In the demographic part, four questions were asked to gather students' background data: (a) gender, (b) grade level, (c) age, and (d) students' career interests.

The questionnaire, as presented to the participants, consisted of a cover sheet asking for student identification number providing information about confidentiality, and explained how to answer the items. The second part of the questionnaire included the attitudes and beliefs scales and a future mathematics coursework intentions question. The items from all seven of the attitudes and beliefs scales were randomly ordered. Positively and negatively worded items were likewise randomly ordered. Several questions about demographic information and their future career interests were added.

Students' Mathematics Achievement

Student's final mathematics grade or mathematics achievement was obtained from the mathematics teachers by using only students' identification number at the end of the semester. The teachers were asked to enter each student's final grade in the space provided on the appropriate class list and to remove the portion of the sheet, which contained students' names to assure confidentiality. The teachers computed students' final grade by using t-scores. The Chiang Mai University Demonstration School requires a computer program for the teachers to use in calculating final mathematics grades.

Procedure

The questionnaire was administered to all participants in 15 classes (five classes for each level) within one week. The students answered the questionnaire during one guidance class period. The questionnaire was designed to take 30 minutes.

One volunteer teacher from the Chiang Mai University Demonstration School administered, collected and returned the questionnaire to the researcher. Instructions for completing the questionnaire were read aloud to all students. The procedure for Likert scoring was described and directions for filling out the answer sheets were given. Students were asked to fill in their students' identification numbers, grade level, gender and age. Students were told that their identification numbers were required only as a means to match their questionnaire responses with their final mathematics grades. They were reassured that personal answers would be kept confidential and neither their mathematics teachers nor their parents would not have access to their personal answers.

Data Analysis

First, the data was gathered in spreadsheets. This part presents information about how the gathered data was analyzed by the SAS system based on the four main research questions:

1. What are Thai middle school students' attitudes and beliefs about mathematics? The results were reported by statistical and descriptive methods. The data from the attitudes and beliefs scales were used to compute means and standard deviations for each scale. These statistical methods were applied to the sample by focusing on all students.

2. What are Thai middle school students' mathematics achievement, future mathematics coursework intentions, and career interests? The results were reported by using statistical and descriptive methods. Mean scores and standard deviations were computed focusing on the same reiterate phase, which were designed to answer the first question. Frequencies and percentages for five career categories were also reported.

3. Do Thai middle school students' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework intentions, and career interests differ by grade level and gender? The answer to the third research question was first determined by searching mean scores on each measure of seventh, eighth, and ninth graders. Then, grade level differences were tested for statistical significance using analysis of variance (ANOVA). Next, each girls' and boys' mean scores overall on each measure were conducted. Gender differences overall were set for statistical significance using two sample t-tests. Then, girls' and boys' mean scores in each grade level were focused on. Finally, gender differences in each grade level were determined by two sample t-tests.

4. What are the relationships among Thai middle school students' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework intentions, and career interests? First, the correlations between attitude and belief scales and mathematics achievement, future mathematics coursework intentions, and career interests were reported. Then the data from the questionnaire were analyzed using multiple linear regression analysis in order to find whether students' attitudes and beliefs can predict their mathematics achievement, future mathematics coursework intentions, and career interests.

CHAPTER IV

RESULTS

Introduction

The main focus of this study was to obtain an inventory of attitudes toward mathematics and beliefs about mathematics of middle school girls and boys in Thailand. In addition, this research seeks to explore the relationships between students' attitudes and beliefs and mathematics achievement, future mathematics coursework intentions, and career interests. The results of the data analysis are reported in this chapter. Each research question is stated, followed by a presentation of the results concerning that question.

Question 1: Students' Attitudes and Beliefs about Mathematics

What are Thai middle school students' attitudes and beliefs about mathematics? In order to answer this question, Thai middle school students at the Chiang Mai University Demonstration School responded to a questionnaire. Six scales of attitudes and beliefs were administered to the students: motivation in mathematics, confidence in learning mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort.

Means and standard deviations for the attitude and belief scales are presented in Table 1. The highest mean score on the six attitude and belief scales was 3.99 (rated from 1 to 5) for the usefulness of mathematics. The mean indicated that students surveyed agreed or strongly agreed to the positive items in the scale and disagreed or strongly disagreed with the negative items in the scale. The mean score for mathematics as a male domain scale was high at 3.70. This result may be interpreted that the students had a very strong belief about gender stereotyping in mathematics. The students also had high mean scores on the importance of understanding concepts in mathematics scale and increasing mathematical ability by effort scale with the mean scores of 3.55 and 3.49 respectively. Interestingly, the students had the lowest equal mean score of 3.41 on motivation in mathematics and confidence in learning mathematics, which is still above a neutral average of 3.00. Thus, all average scores on the attitude and beliefs scales were relatively high for these Thai students.

Table 1. Means and standard deviations for attitude and belief variables of Thai middle school students

Variables	M	SD
1. Motivation in mathematics	3.41	0.73
2. Confidence in learning mathematics	3.41	0.72
3. Mathematics as a male domain	3.70	0.50
4. The usefulness of mathematics	3.99	0.48
5. The importance of understanding concepts in mathematics	3.55	0.49
6. Increasing mathematical ability by effort	3.49	0.49

Note. Measures based on n = 523.

Question 2: Students' Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

What are Thai middle school students' mathematics achievement, future mathematics coursework intentions, and career interests? Students' mean mathematics achievement as represented by their final mathematics grades was 3.04 (rated from (0) failure to (4) excellent). This mean indicated that the students' mean mathematics achievement was a bit above average expectations (see Table 2).

Table 2. Means and standard deviations for mathematics achievement, future mathematics coursework intentions and career interests of Thai middle school students

Variables	M	SD
1. Mathematics achievement (0 to 4 with 4 high)	3.04	0.82
2. Future mathematics coursework intentions (1 to 5 with 5 high)	2.93	1.10
3. Career interests (1 to 5 with 5 representing more mathematical careers)	3.78	1.10

Note. Measures based on n = 523.

Additionally, the mean score for future mathematics coursework intentions was 2.93, which may be interpreted that the average for students was neutral about the statement "I definitely will continue to take mathematics once participation becomes available." Further mathematics coursework intentions of 3.00 means students were uncertain about taking mathematics once participation becomes available.

Moreover, students expressed a high mean score on their career interests with 3.78 (rated from (1) fine arts, which involved less mathematics and science to (5) physical sciences and mathematics, which involved more mathematics and sciences). Thus, it may be interpreted that the students were interested in working in the mathematics and sciences fields. It may be illuminating to view the data on career interests by percentages (see Table 3). Of all 523 students, 48.57% of the students were interested in biological sciences, which means approximately half of the students hope to work in a field of biological sciences (e.g. doctors, nurses, dentists). Additionally, 25.05 % of the students were interested in physical sciences and mathematics career fields. This finding means one-fourth of the students aspired to a profession involved with mechanics and technology (e.g., engineers, programmers, and architects). Interestingly, the students expressed the lowest percentage of 6.12% for fine arts.

Table 3. Frequencies and percentages for five career categories

Career Categories	**Amount**	**Percent (%)**
1.Fine arts	32	6.12
2.Humanities	44	8.41
3.Social sciences	62	11.85
4.Biological sciences	254	48.57
5.Physical sciences and mathematics	131	25.05
Total	523	100

Question 3: Grade Level and Gender Differences among Attitude and Belief Scales, Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

Do Thai middle school students' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework intentions, and career interests differ by grade level and gender? Analysis of Variance (ANOVA) and two sample t-tests were used. Additionally, the following two main sections were focused on in order to answer the question.

Differences between Grade Level and Attitude and Belief Scales, Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

First, the attribution of the attitude and belief scales, mathematics achievement, future mathematics coursework intentions, and career interests in each grade level are reported. Second, the differences of these variables by grade level are discussed. Additionally, findings about five career categories by grade level are again presented by percentages.

Grade level means. For seventh, eighth, and ninth grades, students' attitudes and beliefs about mathematics were all average above neutral with a few notable exceptions. Seventh graders had the highest mean score of 3.72 on motivation in mathematics and lowest mean score was mathematics as a male domain with 3.36 mean score. Other attitude and belief scales ranged positively between 3.48 and 3.68. In addition, seventh-grade students had a high average mathematics achievement with 3.20 (see Table 4).

Table 4. Means and standard deviations for attitude and belief variables, mathematics achievement, future mathematics coursework intentions, and career interests in each grade level including analysis of variance (ANOVA) for attitudinal variables as a function of grade level

Variables	**Grade 7** n=176		**Grade 8** n=161		**Grade 9** n=186		df	F	p
	M	SD	M	SD	M	SD			
1. Motivation in mathematics	3.72	.62	3.38	.67	3.13	.76	2	34.01	<0.0001
2. Confidence in learning mathematics	3.55	.61	3.49	.70	3.21	.80	2	11.13	<0.0001
3. Mathematics as a male domain	3.36	.39	3.68	.44	4.03	.43	2	111.80	<0.0001
4. The usefulness of mathematics	3.68	.37	3.99	.42	4.29	.43	2	100.87	<0.0001
5. The importance of understanding concepts in mathematics	3.58	.44	3.56	.49	3.52	.53	2	.59	N.S.
6. Increasing mathematical ability by effort	3.48	.45	3.49	.51	3.49	.52	2	.02	N.S.
7. Mathematics achievement	3.20	1.02	3.17	1.10	2.77	1.15	2	8.70	=.0002
8. Future mathematics coursework	3.03	.76	2.86	.90	2.88	.82	2	2.30	N.S.
9. Career interests	3.95	.99	3.68	1.20	3.70	1.09	2	3.16	=.0431

Note. N.S. is an abbreviation for not significant.

Their average future mathematics coursework intentions and career interests were 3.03 and 3.95, respectively. This result suggested seventh-grade students were uncertain about taking future mathematics courses when courses are available, and students had career interests in careers related to mathematics and science fields.

For eighth graders, the highest mean score on attitude and belief scales was 3.99 for the usefulness of mathematics, whereas the lowest mean score was 3.38 on the motivation in mathematics scale. The other scales were also positive (ranged from 3.49 to 3.68). Students' mean mathematics achievement or final mathematics grade was also high with 3.17. The mean scores for their future mathematics coursework intentions and career interests were 2.86 and 3.68, in order.

For ninth graders, the highest mean score and lowest mean score on the attitude and belief scales were 4.29 for the usefulness of mathematics and 3.13 for motivation in mathematics scales, respectively. They had positive attitudes or strong beliefs on the other scales as well. They were rated from 3.21 (confidence in learning mathematics) to 4.03 (mathematics as a male domain). Students' average mathematics achievement was 2.77. Additionally, their mean score for future mathematics coursework intentions was 2.88 and their mean score for career interests was 3.70. These scores may be interpreted that students disagreed or were uncertain about whether they will take mathematics courses once participation is available. Ninth-grade students were also interested in career related to mathematics and science fields.

Grade level differences. In order to explore the grade level differences among attitude and belief scales, mathematics achievement, future mathematics coursework intentions, career interests and grade level, a series of analyses of variance (ANOVA) was conducted. The Fisher's LSD tests were performed when differences warranted in order to determine where the differences were found.

At 95% confidence interval, of six attitude and belief scales, significant differences in grade level were found in four scales: motivation in mathematics, confidence in learning mathematics, mathematics as a male domain, and the usefulness of mathematics. Students in lower grade levels had higher mean scores for motivation in mathematics and confidence in learning mathematics scales. They also had higher mathematics achievement and had a higher interest in careers related to mathematics and science fields, whereas students in higher-grade levels have stronger beliefs about mathematics as a male domain and about the usefulness of mathematics. There were no grade level differences in the beliefs about the importance of understanding concepts in mathematics or increasing mathematical ability by effort. Additionally, there was no significant grade level difference in future mathematics coursework intentions.

Interestingly, focusing on five career categories presented as percentages, seventh graders had 56.25% of the students choosing biological sciences and 26.70% of the students choosing physical sciences and mathematics category, respectively (see Table 5).

Table 5. Frequencies and percentages for five career categories in each grade level

Career Categories	**Grade 7** n=176		**Grade 8** n=161		**Grade 9** n=186	
	Amount	**Percent (%)**	**Amount**	**Percent (%)**	**Amount**	**Percent (%)**
1. Fine arts	9	5.11	15	9.32	8	4.30
2. Humanities	8	4.55	13	8.08	23	12.37
3. Social sciences	13	7.39	20	12.42	29	15.59
4. Biological sciences	99	56.25	73	45.34	82	44.09
5. Physical sciences and mathematics	47	26.70	40	24.84	44	23.65
Total	176	100	161	100	186	100

The percentages of eighth graders in biological sciences and physical sciences and mathematics area were 45.34% and 24.84%, respectively. For ninth graders, there were 44.09% and 23.65% of students who interested in the biological sciences category and physical sciences and mathematics category, respectively. Interestingly, while 83% of seventh graders chose careers related mathematics and science fields (biological sciences and physical sciences and mathematics), there were only 70% of eighth graders and 68% of ninth graders who chose those career categories.

Differences between Gender and Attitude and Belief Scales, Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

First, the attitude and belief scales, mathematics achievement, future mathematics coursework intentions, and career interests by gender are presented. Second, overall gender differences are discussed. Third, percentage outcomes of five career categories focusing on gender are presented. Fourth, the attitude and belief scales, mathematics achievement, future mathematics coursework intentions, career interests by gender in each grade level are explained. Fifth, gender differences in each grade level are reported.

Gender means. Overall, girls' highest mean score of 3.90 was for the usefulness of mathematics, whereas the lowest mean score was 3.41 for motivation in mathematics. The other scales were positive and ranged from 3.42 to 3.56. Additionally, girls' mean mathematics achievement was good. Their mean mathematics achievement was 3.15. The mean score for future mathematics coursework intentions was 2.77. This result may be interpreted that the students were likely to take optional mathematics courses. In addition, their mean career interests scored was 3.62. This means girls were also interested in mathematics and science career fields, but focused on biological fields. Surprisingly, boys' highest mean score for the usefulness of mathematics was 4.16. The lowest mean score of 3.38 for boys was confidence in learning mathematics. For other scales, they were all positively rated from 3.39 to 3.96. Boys' mean for mathematics was achievement was 2.81 (see Table 6).

Table 6. Means and standard deviations for girls' and boys' attitude and belief variables, mathematics achievement, future mathematics coursework intentions, and career interests including the t-test for attitudinal variables as a function of gender

Variables	Girls n=344		Boys N=179		t	p
	M	SD	M	SD		
1. Motivation in mathematics	3.41	.74	3.39	.72	.32	N.S.
2. Confidence in learning mathematics	3.43	.69	3.38	.79	.78	N.S.
3. Mathematics as a male domain	3.56	.47	3.96	.46	-9.21	<.0001
4. The usefulness of mathematics	3.91	.48	4.16	.45	-5.77	<.0001
5. The importance of understanding concepts in mathematics	3.51	.49	3.63	.48	-2.63	=.0089
6. Increasing mathematical ability by efforts	3.42	.49	3.61	.48	-4.24	<.0001
7. Mathematics achievement	3.15	1.05	2.81	1.18	3.40	=.0007
8. Future mathematics coursework	2.77	.76	3.23	.87	-6.27	<.0001
9. Career interests	3.62	1.04	4.09	1.15	-4.82	<.0001

Their future mathematics coursework intentions' mean score was 3.23 and their career interests mean score was 4.09. These results indicate that boys agreed to take mathematics courses once they become available and they also were interested in careers related to mathematics and science fields.

Additionally, considering the five career categories by gender, the first career category that girls were interested in was biological sciences with 54.94%. The second career category that girls were interested in was social science with 15.12%. About 14% of girls indicated physical sciences and mathematics as their first choice (see Table 7).

Table 7. Frequencies and percentages for five career categories in each gender

Career Categories	Girls n=344		Boys n=179	
	Amount	**Percent (%)**	**Amount**	**Percent (%)**
1. Fine arts	21	6.11	11	6.15
2. Humanities	33	9.59	11	6.15
3. Social sciences	52	15.12	10	5.58
4. Biological sciences	189	54.94	65	36.31
5. Physical sciences and mathematics	49	14.24	82	45.81
Total	344	100	179	100

On the other hand, 45.81% of boys were interested in the physical sciences and mathematics category. The second career category that boys were interested in was biological sciences with 36.31%. Additionally, the career category in which girls and boys had the least interest was fine arts. There was only 6.11 % and 6.15 %, respectively.

Gender differences. To investigate gender differences overall among all variables, a two-sample t-test was computed. The results of the t-test for overall gender differences are shown in Table 6. At 95% confidence interval, girls and boys expressed significantly different attitude and beliefs on four of the six attitude and belief scales: mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort. Boys demonstrated stronger beliefs in all of these four attitude and belief scales. However, no gender differences surfaced in the perceptions of motivation in mathematics and confidence in learning mathematics. Overall, while girls had slightly higher mathematics achievement than boys, significant gender differences were indicated in future mathematics coursework intentions and career interests. Boys indicated more likelihood to take future optional mathematics coursework if they become optional than girls. Moreover, boys were more interested in careers in physical sciences and mathematics than girls.

Gender by grade level results. Next, means for all variables are presented according to gender in each grade level. In seventh-grade, girls' highest mean score was 3.70 for motivation in mathematics, whereas the lowest score was 3.24 for mathematics as a male domain. The other attitude and beliefs scales positively ranged from 3.42 to 3.60. For girls, mathematics achievement was good. Their final mathematics grade was 3.23. The mean score for future mathematics coursework intentions was 2.92. The result indicating the seventh-grade girls did not strongly tend to take future optional mathematics courses. In addition, their career interests presented a 3.83 mean score, which means they were interested in mathematics and science career fields.

Surprisingly, seventh-grade boys' highest mean score was 3.84 for the usefulness of mathematics. The lowest mean score of 3.54 for seventh grade boys was confidence in learning mathematics. For other scales, they were all positively rated from 3.62 to 3.77. Seventh-grade boys' achievement in mathematics was also good. Their final mathematics grade was 3.14. Their future mathematics coursework intentions' mean score was 3.26 and their career interests mean score was 4.19. These scores indicated seventh grade boys agreed to take mathematics courses once participation becomes available and they had strong interests in mathematics and science career fields.

In eighth grade, girls had the highest score for the usefulness of mathematics with the mean score of 3.89. Their lowest mean score was 3.37 for motivation in mathematics. The other attitude and beliefs scales positively ranged from 3.40 to 3.89. Girls' mathematics achievement was 3.27. The mean score for future mathematics coursework was 2.65 (see Table 8).

Table 8. Means and standard deviations for attitude and belief variables, mathematics achievement, future mathematics coursework intentions, and career interests in each grade level including the t-test for attitudinal variables as a function of gender

Variables	**Grade 7**				**Grade 8**				**Grade 9**			
	Girls n=119	**Boys** n=57	t	p	**Girls** n=108	**Boys** n=53	t	p	**Girls** n=117	**Boys** n=69	t	p
1. Motivation in mathematics	3.70	3.77	-.76	N.S.	3.37	3.40	-.26	N.S.	3.16	3.07	.79	N.S.
2. Confidence in learning mathematics	3.55	3.54	.16	N.S.	3.48	3.50	-.14	N.S.	3.25	3.15	.86	N.S.
3. Mathematics as a male domain	3.24	3.62	-6.79	<.0001	3.53	3.97	-6.64	<.0001	3.91	4.23	-5.09	<.0001
4. The usefulness of mathematics	3.60	3.84	-4.16	<.0001	3.89	4.19	-4.46	<.0001	4.24	4.39	-2.43	=.0161
5. The importance of understanding concepts in mathematics	3.52	3.68	-2.30	=.0226	3.50	3.70	-2.39	=.0178	3.51	3.54	-.30	N.S.
6. Increasing mathematical ability by effort	3.42	3.62	-2.89	=.0043	3.40	3.67	-3.37	.0010	3.46	3.56	-1.33	N.S.
7. Mathematics achievement	3.23	3.14	-2.81	N.S.	3.27	2.96	1.67	N.S.	2.97	2.42	3.25	=.0014
8. Future mathematics coursework intentions	2.92	3.26	.53	=.0055	2.65	3.30	-4.61	<.0001	2.72	3.14	-3.30	=.0015
9. Career interests	3.83	4.19	-2.28	=.0236	3.45	4.15	-3.59	=.0004	3.55	3.97	-2.60	=.0170

This may indicate that the students were likely to take future optional mathematics courses. Furthermore, their career interests mean score was 3.45. This means they were quite interested in mathematics and sciences career fields.

Eighth-grade boys had the highest mean score of 4.19 for the usefulness of mathematics. They had the lowest mean score of 3.40 for motivation in mathematics. For other scales, they positively ranged from 3.50 to 3.97. Their mathematics achievement was moderate with the mean score of 2.96. Their future mathematics coursework intentions' mean score was 3.30 and their career interests mean score was 4.15. These results indicated boys agreed they would take mathematics courses once they become available and they were strongly interested in career related mathematics and science fields.

For ninth-grade, girls' highest mean score was 4.24 for the usefulness of mathematics. The lowest mean score for 9th grade girls was 3.16 for motivation in mathematics. The other attitude and beliefs scales were between 3.25 and 3.84. Their mathematics achievement was 2.97. Their mean score of future mathematics coursework was 2.72, indicating that students might take future mathematics courses once courses are available. Additionally, their career interests show a 3.55 mean score, which means they were fairly interested in mathematics and science careers.

Ninth-grade boys had the highest mean score for the usefulness of mathematics. The mean score of the scale was 4.39. Their lowest mean score of 3.07 was motivation in mathematics. Other attitude and belief scales rated from

3.54 to 4.23. Boys' mean mathematics achievement was not high. Their mathematics achievement was 2.42. Their future mathematics coursework intentions' mean score was 3.14 and their career interests mean score was 3.97. These results indicated that boys tended to take mathematics courses once they were available and they also had to some extent interests in careers involved in mathematics and science areas.

Gender differences by grade level. With the aim of exploration gender differences among all variables in each grade level, a two-sample t-test was computed. The results of the t-test for gender differences in each grade level are presented in Table 8. At 95% confidence interval, for seventh grade, there were significant gender differences on four attitude and belief scales. Boys had stronger beliefs about mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort. The finding also found significant gender differences in their future mathematics courses-taking plans and career interests.

For eighth grade, there were significant gender differences on four attitude and belief scales. Again, boys expressed stronger beliefs in mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort. There was no gender difference in mathematics achievement in this grade level. Again, boys showed more willingness to take optional mathematics courses than girls. Additionally, there was a significant gender difference favoring boys in career interests.

For ninth grade, surprisingly, significant gender differences were found in two attitude and belief scales. Boys still had a stronger belief about mathematics as a male domain and the usefulness of mathematics. However, the results indicated significant gender differences in students' mathematics coursework intentions and their mathematics achievement. Boys still expressed more interest in taking future optional mathematics courses. Nonetheless, girls demonstrated higher mathematics achievement.

Question 4: The Relationships among Students' Attitudes and Beliefs about Mathematics, Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

What are the relationships among Thai middle school students' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework intentions, and career interests? First, the correlations between attitude and belief scales and mathematics achievement are described. Second, the correlations between attitude and belief scales and future mathematics coursework intentions are discussed. Third, the correlations between attitude and belief scales and career interests are focused. Fourth, the correlations among mathematics achievement, future mathematics coursework intentions, and career interests as well as the prediction of students' mathematics achievement, future mathematics coursework, and career interests are discussed.

The Correlations among Attitude and Belief Scales, Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests

The correlations among the attitude and belief scales, mathematics achievement, future mathematics coursework intentions, and career interests are presented. Students' mathematics achievement strongly correlated with the following attitudes and belief scales in a positive manner: motivation in mathematics, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort.

The variable that had the highest correlation to mathematics achievement was the importance of understanding concepts in mathematics ($r_s = .69$, $p < .0001$). The next strongest correlation arose between mathematics achievement and increasing mathematical ability by effort ($r_s = .60$, $p < .0001$). The usefulness of mathematics and motivation in mathematics also expressed a moderately strong relationship to mathematics achievement ($r_s = .40$, .37 respectively, $p < .0001$). These correlatations indicated that those who expressed stronger beliefs in the importance of understanding concepts in mathematics, increasing mathematical ability by effort, the usefulness of mathematics, or motivation in mathematics tend to outperform their counterparts in mathematics. Interestingly, future mathematics coursework intentions and career interests were positively related to five attitude and belief scales: motivation in mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort (see Table 9).

Table 8. Means and standard deviations for attitude and belief variables, mathematics achievement, future mathematics coursework intentions, and career interests in each grade level including the t-test for attitudinal variables as a function of gender

Variables	Grade 7				Grade 8				Grade 9			
	Girls n=119	Boys n=57	t	p	Girls n=108	Boys n=53	t	p	Girls n=117	Boys n=69	t	p
1. Motivation in mathematics	3.70	3.77	-.76	N.S.	3.37	3.40	-.26	N.S.	3.16	3.07	.79	N.S.
2. Confidence in learning mathematics	3.55	3.54	.16	N.S.	3.48	3.50	-.14	N.S.	3.25	3.15	.86	N.S.
3. Mathematics as a male domain	3.24	3.62	-6.79	<.0001	3.53	3.97	-6.64	<.0001	3.91	4.23	-5.09	<.0001
4. The usefulness of mathematics	3.60	3.84	-4.16	<.0001	3.89	4.19	-4.46	<.0001	4.24	4.39	-2.43	=.0161
5. The importance of understanding concepts in mathematics	3.52	3.68	-2.30	=.0226	3.50	3.70	-2.39	=.0178	3.51	3.54	-.30	N.S.
6. Increasing mathematical ability by effort	3.42	3.62	-2.89	=.0043	3.40	3.67	-3.37	.0010	3.46	3.56	-1.33	N.S.
7. Mathematics achievement	3.23	3.14	-2.81	N.S.	3.27	2.96	1.67	N.S.	2.97	2.42	3.25	=.0014
8. Future mathematics coursework intentions	2.92	3.26	.53	=.0055	2.65	3.30	-4.61	<.0001	2.72	3.14	-3.30	=.0015
9. Career interests	3.83	4.19	-2.28	=.0236	3.45	4.15	-3.59	=.0004	3.55	3.97	-2.60	=.0170

These results indicated that those who had stronger beliefs in the related attitude and belief scales: motivation in mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, as well as increasing mathematical ability by effort were more likely to take future mathematics coursework when participation was available and had more interests in mathematics and science related career fields.

Focusing on future mathematics coursework, increasing mathematical ability by effort was the variable that had the highest correlation to future mathematics coursework ($r_s = .82$, $p < .0001$). The understanding concept in mathematics variable was the second highest correlation to future mathematics coursework ($r_s = .71$, $p < .0001$). There were also high correlation coefficients between future mathematics coursework and mathematics as a male domain and the usefulness of mathematics ($r_s = .65$ and .67, respectively, $p < .0001$).

Focusing on career interests, the increasing mathematical ability by effort variable had the highest correlation coefficient ($r_s = .82$, $p < .0001$) among other attitude and belief variables, which correlated to career interests. The importance of understanding concepts in mathematics scale had the next highest correlation coefficient ($r_s = .73$, $p < .0001$) relating to career interests. Mathematics as a male domain and the usefulness of mathematics correlated to career interests with the same correlation coefficient ($r_s = .65$, $p < .0001$).

Finally, the correlation among mathematics achievement, future mathematics coursework, and career plans are described. Interestingly, the correlation occurring between mathematics achievement and future mathematics coursework was significant but not strong ($r_s = .21$, $p < .0001$). In the same way, the correlation coefficient between mathematics achievement and career interests was small ($r_s = .23$, $p < .0001$), whereas, the strongest correlation was the correlation between future mathematics coursework and career interests ($r_s = .97$, $p < .0001$).

The Regression Analysis for The Prediction of Mathematics Achievement

In order to evaluate the relationship of attitudes and beliefs about mathematics to achievement, a stepwise multiple regression analysis was conducted using the final mathematics course grades as the dependent variable. There were different types of variables in this analysis. The six numerical independent variables were all attitude and belief scales.

Table 10. The results of stepwise multiple regression analysis for prediction of mathematics achievement

Variables	Beta	Correlation Coefficient (r)	Multiple Correlation (R)	R^2	R^2 Increment
1. The importance of understanding concepts in mathematics	12.51*	.69*	.69	.48	
2. Increasing mathematical ability by effort	-9.97*	.60*	.83	.69	.21
3. Confidence in learning mathematics	-.81*	.06	.89	.79	.10
4. Motivation in mathematics	-.91*	.37*	.96	.92	.13
5. Grade level	-.24*	-.16*	.97	.95	.03

Note. * $p < .0001$.

Two categorical variables: grade level and gender were added into the analysis. Of the independent variables used in the analysis (gender, grade level, motivation in mathematics, confidence in learning mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort), only five contributed significantly to the prediction of mathematics achievement. The relationship of the composite of beliefs about the importance of understanding concepts in mathematics, increasing mathematical ability by effort, confidence in learning mathematics, motivation in mathematics, and grade level with mathematics achievement was $R^2 = .95$. The five variables accounted for 95 percent of the variance in mathematics achievement as measured by the final mathematics course grade. In other words, 95 percent of the variation in final mathematics grades was explained by the linear regression on all five variables: beliefs about the importance of understanding concepts in mathematics, increasing mathematical ability by effort, confidence in learning mathematics, motivation in mathematics, and grade level. Seemingly, gender differences favored girls in mathematics achievement. However, gender variable was not correlated to all five attitude and belief variables involving prediction of mathematics achievement, except increasing mathematical ability by effort. Therefore, it may explain why the gender variable was not one of the variables in predicting the mathematics achievement equation.

The Regression Analysis for The Prediction of Future Mathematics Coursework Intentions

In order to investigate the relationship between attitudes and beliefs about mathematics and future mathematics coursework (as measured by the likelihood of continuing to participate in mathematics courses once enrollment becomes available), a stepwise multiple regression analysis was conducted using the likelihood of continuing to enroll in mathematics courses once such enrollment becomes available as the dependent variable. The six numerical independent variables were also all attitude and belief scales. Two categorical variables: grade level and gender were added into the analysis as well. The results are presented in Table 11.

Table 11. The results of stepwise multiple analysis for prediction of future mathematics coursework intentions

Variables	Beta	Correlation Coefficient (r)	Multiple Correlation (R)	R^2	R^2 Increment
1. Increasing mathematical ability by effort	7.20*	.82*	.82	.67	
2. The importance of understanding concepts in mathematics	-6.00*	.71*	.96	.93	.26
3. The usefulness of mathematics	.10*	.67*	1	1	.07
4. Gender	-.20*	.26*	1	1	0
5. Grade level	-.30*	-.07	1	1	0

Note. * $p < .0001$.

Of the independent variables used in the analysis (gender, grade level, motivation in mathematics, confidence in learning mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort), only five variables contributed to the prediction of whether a student would continue to take mathematics coursework once courses became available. The combined relationship of these five variables (beliefs about increasing mathematical ability by effort, the importance of understanding concepts in mathematics, the usefulness of mathematics, gender, and grade level with future mathematics coursework) was R^2=1.00. The five variables accounted for 100 percent of the variance in the dependent variable. In other words, beliefs about increasing mathematical ability by effort, the importance of understanding concepts in mathematics, the usefulness of mathematics, gender, and grade level, all together were possible to predict students' future mathematics coursework intentions. None of them were able to predict future mathematics coursework intentions alone.

The Regression Analysis for the Prediction of Career Interests

To study the relationship of attitudes and beliefs about mathematics to career interests, a stepwise multiple regression analysis was conducted using the career interest scores as the dependent variable. Again, the six numerical independent variables were all attitude and belief scales. Two categorical variables:

grade level and gender were also added into the analysis. The results are presented in Table 12.

Table 12. The results of stepwise multiple regression analysis for prediction of career interests

Variables	Beta	Correlation Coefficient (r)	Multiple Correlation (R)	R^2	R^2 Increment
1. Increasing mathematical ability by effort	12.10*	.82*	.82	.68	
2. The importance of understanding concepts in mathematics	-6.65*	.73*	.93	.87	.19
3. The usefulness of mathematics	-4.46*	.65*	.96	.93	.06
4. Grade level	.98*	-.09*	.97	.94	.01
5. Motivation in mathematics	-.08*	.27*	.97	.95	.01

Note. * $p < .0001$.

Of all independent variables used in the analysis (gender, grade level, motivation in mathematics, confidence in learning mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort), only five variables (beliefs about increasing mathematical ability by effort, the importance of understanding concepts in mathematics, the usefulness of mathematics, grade level, and motivation in mathematics) were significant to the prediction of career interests. The relationship of these five variables with career interests was $R^2 = .95$. The five variables accounted for 95 percent of the variance in the dependent variable or the variance in the career interests was described by all of these five variables. Surprisingly, gender variable did not enter the equation. Boys expressed more interests in career related to mathematics and science fields and girls had better grades. However, of all six variables involved in predicting career interests, three of them: grade level, motivation in mathematics and the importance of understanding concepts in mathematics did not relate to gender. Thus, this may be the reason for why the gender variable was not included in the equation of predicting students' career interests.

Conclusion

In closing, there were some interesting relationships demonstrated in this study. In regard to overall mean scores, students had positive attitudes and beliefs about mathematics in all six attitude and belief scales with the most positive being that of the usefulness of mathematics and the least positive being that of motivation in mathematics and confidence in learning mathematics. None of the scales were below neutral. In general, students had good mathematics achievement and had uncertain intentions to take future mathematics coursework if courses were available. Many students were interested in careers related to mathematics and science fields.

Regarding grade level, the attitude and belief scale mean scores were positive for all grade levels. Students in seventh grade had the highest mean score for motivation in learning mathematics. The lowest mean score for seventh graders was the mean score on mathematics as a male domain scale. Meanwhile, students in eighth and ninth grade both had the highest score on the usefulness of mathematics. Interestingly, again both eighth and ninth graders had the lowest score on motivation in mathematics. Four attitude and belief variables were not stable among seventh through ninth graders. The means decreased for students' motivation in mathematics and confidence in learning mathematics means, whereas the means increased for students' beliefs about mathematics as a male domain and the usefulness of mathematics. Compared to other grade levels, seventh graders had the highest mean score on mathematics achievement, future mathematics coursework, and career interests. In addition, the mean scores on these variables decreased at higher-grade levels. However, there was not a significant grade level difference in their future mathematics coursework intentions.

Focusing on gender overall, girls and boys had the highest mean scores on the usefulness of mathematics variable. Girls had the lowest mean score on the motivation in mathematics while the lowest mean score that boys received was confidence in learning mathematics. Surprisingly, there was no gender difference on motivation in mathematics and confidence in learning mathematics. However, boys had stronger beliefs about mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort.

In regard to gender differences in each grade level, gender differences mostly favored boys. For seventh grade, boys indicated stronger beliefs about mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort. Boys expressed more intentions to take optional mathematics coursework and stronger interests in mathematics and science careers. For eighth grade, boys had stronger beliefs about mathematics as a male domain, the usefulness of mathematics, and increasing mathematical ability by effort. Furthermore, boys also expressed more intentions of taking optional mathematics coursework and more interests in careers related to mathematics and science fields. Interestingly, there was no significant gender difference in either seventh or eighth graders in mathematics achievement. For ninth grade, boys still had stronger beliefs about mathematics as a male domain and expressed more willingness to take optional mathematics coursework and more interests in mathematics and science careers. Surprisingly, a significant gender difference favored girls in mathematics achievement at the ninth grade level.

Interesting findings were noted in correlations between the six attitude and belief variables and mathematics achievement, future mathematics coursework intentions, and career interests. Beliefs about the importance of understanding concepts in mathematics and increasing mathematical ability by effort were highly correlated to mathematics achievement, future mathematics coursework, and career interests.

According to the correlations among mathematics achievement, future mathematics coursework, and career interests, the lowest correlation was the correlation between mathematics achievement and future mathematics coursework intentions. The highest correlation was the correlation between future mathematics coursework and career interests.

In regard to the prediction of students' mathematics achievement, future mathematics coursework, and career interests, three interesting results were reported. First, the relationship of the composite of beliefs about the importance of understanding concepts in mathematics, increasing mathematical ability by effort, confidence in learning mathematics, motivation in mathematics, and grade level predicted mathematics achievement. Second, the combined relationship of beliefs about the importance of understanding concepts in mathematics, increasing mathematical ability by effort, confidence in learning mathematics, motivation in mathematics, and grade level predicted the intention to continue to participate in mathematics courses once enrollment becomes available. Finally, the relationship of beliefs about increasing mathematical ability by effort, the importance of understanding concepts in mathematics, the usefulness of mathematics, grade level, and motivation in mathematics were significant for predicting career interests.

CHAPTER V

DISCUSSION AND CONCLUSION

Introduction

There are four sections in this chapter. The first section reports the most important findings of the study relating to students' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework intentions, and career interests as well as the relationship among these variables comparing to other research. The second section focuses on the implications of the findings for teachers and educators. The third section discusses the limitations of the study, and the last section recommends future research.

Discussion of Findings

Several findings of this study warrant additional discussion. It is important to note that the mean rating of student's attitude and belief scales were positive overall. Students' mean scores on their mathematics achievement, future mathematics coursework intentions, and career interests were also above neutral. However, some differences were found in each grade level and gender. Furthermore, some findings of this study have supported to the previous studies, which concerned about students' attitudes and beliefs about mathematics.

Grade Level Differences

First, it is noteworthy to report that the mean rating of student' s attitude and belief scales were all positive by grade level. This finding supported Throndike-Christ's (1991) study of middle and high school students in the United States. However, these findings were different from Telese's (1997) study of high school students in the United States.

Students' attitudes and beliefs about mathematics. Overall, Thai middle school students had positive attitudes and beliefs about motivation in mathematics, confidence in learning mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort. Thai middle school students had the strongest belief about the usefulness of mathematics and the lowest belief about motivation and confidence in mathematics. As a previous study in the United States, lower grade students expressed higher motivation and confidence in mathematics. Additionally, older middle school students were found to have a stronger belief regarding the usefulness of mathematics for their lives (Fleener, 1996; Kloosterman, 1991; Kloosterman & Cougan, 1994; Telese, 1997). However, this study contradicted Simich-Dudgeon's (1996) international study, where older middle school students were not found to have stronger beliefs about mathematics as a male domain. Furthermore, Thai middle school students were also found to have constant beliefs across grade levels about the importance of understanding concepts in mathematics and increasing mathematical ability by effort.

Students'mathematics achievement, future mathematics coursework intentions, and career interests. Overall, the students' mean mathematics achievement was about 3.00 out of 4.00 and their future mathematics intentions about taking future mathematics coursework were uncertain. This might be explained by the fact that there were few optional mathematics courses offered in Thai middle schools and they might not think ahead to high schools. Thai middle school students were also interested in careers related to mathematics and science. More than half of the students were interested in professions related to biological and physical sciences and mathematics.

Students' mathematics achievement means declined from seventh to ninth grades, while the mathematics coursework intentions mean was steady for Thai middle school students at different grade levels. Interestingly, lower grade students had stronger career interests related to mathematics and science, particularly biological and physical sciences and mathematics. However, older Thai middle school students had changed their career interests a bit. They had slightly more interest in social sciences and humanities categories while students' interest in fine arts fluctuated without any particular trend.

Gender Differences

Attitudes and beliefs about mathematics. Some findings of this study agreed with previous studies' findings about gender differences in attitudes and beliefs about mathematics. In this study, as in the United States, boys expressed stronger beliefs about mathematics as a male domain (Throndike-Christ, 1991), the usefulness of mathematics (Fleener, 1996; Kloosterman & Cougan, 1994; Kloosterman et al. 1996), and increasing mathematical ability by effort (Kloosterman & Stage, 1992). Interestingly, boys in all three grade levels showed stronger beliefs about mathematics as a male domain in this study. This belief may relate to Thai society's traditional belief that mathematics careers are inappropriate for women. In the past, men were expected to go to school and work while women were expected to stay at home. Mathematics, however, is highlighted in school and work in the 21st century. However, the belief that advanced mathematics is for boys more than for girls may still be evident in male students from old Thai families with traditional lifestyles. In contrast, gender equity is promoted in the new world since many women will prepare for careers outside the home. This may cause female students to believe less strongly in gender stereotype statements.

Students' mathematics achievement, future mathematics coursework intentions, and career interests. This study's findings supported the results of other studies about gender differences in mathematics achievement, future mathematics coursework intentions and career interests. In a previous international study of middle school levels, there was no gender difference or a slight superiority in mathematics achievement was found among girls (Beaton et al., 1996). Significant gender differences were found that favored boys focusing on students' intentions to take future mathematics coursework and interests to work in careers related to mathematics and science. These findings supported previous studies, which were conducted in the United States at the high school level and in Germany at the middle and high school levels (Kaiser-Messmer, 1993; Singer et al., 1996).

Nevertheless, in this study, there were no gender differences in motivation and confidence scales. These findings were in contrast to the results of other previous studies in the United States and other countries (Beaton et al., 1996; Throndike-Christ, 1991), which noted that boys expressed more motivation and confidence in learning mathematics. When compared with Throndike-Christ's (1991) study, this study agreed that more boys than girls were interested in physical sciences and mathematics categories. However, there was a different result for girls. Throndike-Christ found that most girls were interested in fine arts with little involvement in mathematics and science. In contrast, this study found that many Thai girls were interested in careers related to mathematics and sciences but with more focus on biological science than boys.

<u>The Relationships among Attitudes and Beliefs about Mathematics, Mathematics Achievement, Future Mathematics Coursework Intentions, and Career Interests</u>

The results of this research supported the relationships between attitudes and beliefs and mathematics achievement, future mathematics coursework intentions, and career interests for the middle school grade level and replicated findings noted by other researchers (Beaton et al., 1996; Kloosterman, 1991; Kloosterman & Cougan, 1994; Schoenfeld, 1989; Simich-Dudgeon, 1996; Throndike-Christ, 1991).

Students' positive attitudes and beliefs about mathematics consisting of motivation in mathematics, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort were related to higher mathematics achievement. The students who had more willingness to continue taking optional mathematics coursework and interests in careers that were more mathematically-oriented had more positive attitudes and beliefs about motivation in mathematics, mathematics as a male domain, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort.

Beliefs about how to learn mathematics, such as the importance of understanding concepts in mathematics and increasing mathematical ability by effort, significantly contributed to the prediction of mathematics achievement, future mathematics coursework, and career interests. Additionally, as in previous studies' findings, motivation in mathematics and confidence in learning mathematics were significantly predictive of mathematics achievement as well (Simich-Dudgeon, 1996; Schoenfeld, 1989; Throndike-Christ, 1991).

A highly significant relationship surfaced between future mathematics coursework intentions and career interests. This suggested that the students who had more intentions to take optional mathematics coursework had strong interests in careers related to mathematics and science. Remarkably, there were nearly the same group of attitudes and beliefs about mathematics that demonstrated potential to prophesy students future mathematics coursework intentions and career interests according to the following categories: fine arts, humanities, social sciences, biological sciences, and physical sciences and mathematics.

The other noteworthy findings were two attitude and belief scales (the importance of understanding concepts in mathematics and increasing mathematical ability by effort) were presented in the predictions of mathematics achievement, future mathematics coursework intentions, and career interests. In the prediction of students' mathematics achievement, findings supported a previous study in the United States that beliefs about how to learn mathematics were related to students' achievement in mathematics (Kloosterman, 1991).

Implications of the Study

Several implications for educators result from this study. First, the study provides more awareness for teachers and educators of the significance of student attitudes and beliefs, which benefit their mathematics performance and affect their future lives. Mathematics teachers should be setting up their classroom environments to help their students develop more realistic beliefs about mathematics. For example, the teachers may point out the usefulness of mathematics to the students. When the students see examples of the utility of mathematics, they believe in its usefulness and enthusiastically work to learn it. When the students see anyone who is successful in mathematics by effort, they believe that effort is a solution to success. Then, the students might develop positive attitudes and beliefs about the importance of mathematics study and seek to master the subject.

Focusing on Thai students' mathematics achievement, motivation in mathematics is related to their mathematics performance. Therefore, teachers and parents should work together to enhance student's motivation in mathematics and not to think of mathematics as boring. Perhaps, mathematics teachers should attempt to use alternative teaching approaches to motivate some students who have low achievement in mathematics.

The impact of gender differences in learning mathematics and under-representation of women in careers related to mathematics and science fields makes educators aware of gender equity issues in mathematics classrooms. It is important for mathematics teachers and educators to provide equal opportunities for boys and girls in mathematics classrooms. Furthermore, the issues of gender equity in teaching are still largely ignored in classrooms of practicing teachers (Streitmatter, 1994). Therefore, not only teachers, but also student teachers should be conscious of their behaviors towards girls and boys. It is certainly likely that they will contribute to and strengthen differences in girls' and boys' perceptions of themselves as learners of mathematics; perceptions which may ultimately be translated into differences in achievement, participation in mathematics (Leder, 1990), and even making decisions to work in careers related to mathematics and science. For these reasons, teachers and student teachers must give equal attention and classroom participation to both girls and boys. Additionally, teachers and student teachers should learn to use a variety of approaches to encourage students to change their gender-stereotypical belief and behavior about courses and careers.

Furthermore, mathematics curriculum should be developed in order to decrease gender difference gaps. Mathematics, which is rich in contexts, seems to contain many subjects from the male cultural domain, e.g. the connection between mathematics/science and technology. Therefore, it should contain more topics or examples from the female cultural domain in the contexts of mathematics (Verhage, 1990).

Limitations of the Study

There are several limitations in this study because of restrictions on time and resources. The first limitation of this study was the sample selected. The participants or students were volunteers and from a single school: the Chiang Mai University Demonstration School. Most of the students came from the northern part of Thailand. In addition, most of the students had middle to higher mathematics ability. This study was not a representative sample taken from the entire country. It may not be the same with other populations in other school settings. Therefore, the results of this study cannot be generalized to other populations.

Second, a limitation occurred in the two sample t-test analyses because the number of girls and boys were quite different. However, the effect was moderate. Ramsey and Schafer's (1997) noted that if the sample sizes are not approximately the same, then the validity of the t-tool is effected moderately. The adverse effects diminish, however, with increasingly large sample sizes.

Third, a limitation also existed in the multiple linear regression analyses for predictions of mathematics achievement, future mathematics coursework intentions, and career interests. This study was designed to explore the influence of attitudes and beliefs about mathematics and was limited by the number of variables that could reasonably be included in the regression analyses. Variables, such as mathematics self-efficacy and mathematics anxiety, might help (more definitely) to predict students' mathematics achievement, future mathematics coursework intentions, and career interests. These variables were not included in the study. However, many attitude and belief variables, which were selected according to significant effects noted by previous studies, were explained in this study.

The student responses to the attitude and belief questionnaire were another limitation of this study. The participants or students in this study were supposed to respond to the questionnaire honestly. The information gathered from the students was interpreted to represent their attitudes and beliefs about mathematics. However, it was possible that some students responded to the questionnaire dishonestly. The students might not have realized that their responses are important in developing effective mathematics education.

A final limitation of this study was the instrument or the questionnaire used to measure students' attitudes and beliefs about mathematics. It was expected that the participants and the researcher understood the statements in the questionnaire in the same way. Since the questionnaire was translated from English to Thai language, the exact meaning of the statements might have been lost. For example, in one of the attitude and belief scales: in solving time-consuming mathematics problems, students responded to similar statements in the opposite direction. Therefore, the reliability for the ability to solve time-consuming mathematics problem scale was very low. In brief, the reliability for the scales in this study may be affected if the students did not understand the statements in the questionnaire clearly and in the same manner as the researcher intended. Furthermore, some cultural differences between students in Thailand and in the United States might also have caused the responses given by Thai students to differ from the responses given to the same questions by students in the United States.

Recommendations for Further Research

The findings of this study provide a number of directions for further research. First, further investigations about mathematics need to be conducted in order to find other attitudes and beliefs, which might effect Thai middle school students' mathematics achievement, their future mathematics coursework intentions, and career interests. We need to focus on these attitude and belief factors in order to appropriately develop Thai middle school students' mathematics achievement, their participation in study of the subject, and career intentions. Additionally, whatever involves young girls' attitudes and beliefs should be studied.

Second, further research is needed to explore other types of variables, such as parents' and teachers' beliefs, as well as a variety of teaching strategies. Since we might find other variables that could help improve students' mathematics achievement, future mathematics coursework intentions, career interests.

Third, additional research is needed to reiterate constraint on the ability to generalize this study's findings to other populations. For example, replicating the study in different age levels or different populations in various parts of the country might be illuminating.

Fourth, further research might include a larger number of middle school students from every part of Thailand. In order to make the samples more adequate and represent all regions of Thailand, a stratified random sample could be used.

Fifth, suggested research might be focused on mathematics curriculum in order to improve the contents in teaching mathematics and develop teaching strategies to help students to succeed in mathematics and their future lives. In addition, future research emphasis on finding some methods that play a role in facilitating gender equitable teaching is warranted.

Finally, one direction for further research would be to use qualitative methods, including interviews and observations in order to validate some findings of this study and gather more information about what causes an increase or a decrease in mathematics learning and its subsequent effect on student's career paths.

Conclusion

In conclusion, this study has brought into view 523 Thai middle school students' attitudes and beliefs about mathematics, mathematics achievement, future mathematics coursework intentions, and career interests. The findings suggest some alarming trends and tendencies. The findings are indicative of some problems. Higher middle school students were found to have lower motivation and confidence in learning mathematics, and their mathematics achievement is also lower than lower middle school students. Moreover, boys expressed stronger belief about mathematics as a male domain than girls; they also indicated more intentions to take optional mathematics coursework and careers related to mathematics and science fields than girls. Remarkably, even though ninth-grade boys had lower mathematics achievement than girls, they showed stronger beliefs about mathematics, the usefulness of mathematics, the importance of understanding concepts in mathematics, and increasing mathematical ability by effort.

At the ninth grade level, no gender differences existed in two attitudes and beliefs about mathematics variables: the importance of understanding concepts in mathematics and increasing mathematical ability by effort. Additionally, boys expressed more interest in the physical sciences and mathematics category, whereas girls showed more interest in the biological sciences category.

Future research will be needed to replicate and extend this study. Research should be aimed at looking at some of the other factors, which potentially underlie these findings. The focus of these investigations should be the role that teachers and educators play in attitudes and beliefs about mathematics development, as well as the mathematics curriculum and teaching strategies. Each of these has both unique and interactive effects on students' attitudes and beliefs about mathematics.

REFERENCES

Beaton, A. E., Mullis, I. V. S., Martin, M. O., Gonzales, E. J., Kelly, D. L., & Smith, T. (1997). Mathematics achievement in the middle school years: IEA's Third International Mathematics and Science Study (TIMSS). Chestnut Hill, MA: Boston College.

Borasi, R. (1990). The invisible hand operating in mathematics instruction: Students conceptions and expectations. In J. C. Thomas (Ed.), Teaching and learning mathematics in the 1990s (pp. 174-182). Reston, VA: National Council of Teachers of Mathematics, Inc.

Borich, G. D., & Tombari, M. L. (1997). Educational psychology: A contemporary approach. New York, NY: Addison Wesley Educational Publishers, Inc.

Burrill, G. (1998). Change in your classroom: from the past to the present to the future. Teaching Children Mathematics, 28, 24-29.

Clewell, B. C., Anderson, B. T., & Thorpe, M. E. (1992). Breaking the barriers. San Francisco, CA: Jossey-Bass Publishers.

Ethington, J. C. (1990). Gender differences in mathematics: An international perspective. Journal for Research in Mathematics Education, 21, 74-80.

Fennema, E. (1974). Mathematics learning and the sexes. Journal for Research in Mathematics Education, 5, 126-129.

Fennema, E. (1996). Mathematics, gender, and research. In G. Hanna (Ed.), Towards Gender Equity in Mathematics Education (pp. 9-26). Norwell, MA: Kluwer Academic Publishers.

Fennema, E. & Peterson, P. (1984). Classroom processes, sex differences, and autonomous learning behaviors in mathematics: Final report to the National Science Foundation. Madison: University of Wisconsin, School of Education.

Fennema, E., & Sherman, J. (1977). Sex-related differences in mathematics achievement, spatial visualization, and affective factors. American Education Research Journal, 14, 51-71.

Fennema, E., & Sherman, J. (1978). Sex-related differences in mathematics Achievement and related factors: A further study. Journal for Research in Mathematics Education, 9, 189-203.

Fleener, M. J. (1996). Scientific world building on the edge of chaos: High school student's beliefs about mathematics and science. School Science and Mathematics, 96(6), 312-319.

Garafalo, J. (1989). Beliefs and their influence on mathematical performance. Mathematics Teacher, 82(7), 50-54.

Goldman, R. D. & Hewitt, B. N. (1976). The scholastic aptitude test "explains" why college men major in science more often than college women. Journal of Counseling Psychology, 23, 50-54.

Harbermas, J. (1992). Knowledge and human interests (2nd Ed.). London: Heinemann.

Halpern, D. F. (1986). A different answer to the question, "Do sex-related differences in spatial abilities exist?" American Psychologist, 40, 1014-1015.

Hanna, G. K. E., & Larouche, C. (1990). Mathematical achievement of grade 12 girls in fifteen countries. In L. Burton (Ed.), Gender and mathematics: An international perspective (pp.87-97). Singapore: Page Bros (Norwich) Ltd.

Henerson, M. E., Morris L. L., & Fitz-Gibbon, C. T. (1978). How to measure attitudes. Beverly Hills, CA: Sage.

House, J. D. (1993). Students attitudes and academic background as predictors of achievement in college mathematics. Paper presented at the Annual Meeting of the Illinois Association for Institutional Research. Oakbrook Terrance, IL (ERIC Document Reproduction Service No. ED 404 108).

Hyde, J. S., Fennema, E., and Lemon. S. J. (1990). Gender differences in mathematics performance: A meta-analysis. Psychological Bulletin, 107(2), 139-155.

Ibe, R. E. (1994). The enduring effects of productivity factors on eighth grade students' mathematics outcome. Paper presented at the Annual Meeting of the American Educational Research Association. New Orleans, LA (ERIC Document Reproduction Service No. ED 374 968).

Kaiser-Messmer, G. (1993). Results of empirical study into gender differences in attitudes towards mathematics. Educational Studies in Mathematics, 25(3), 209-233.

Kloosterman, P. (1991). Beliefs and achievement in seventh-grade mathematics. Focus on Learning Problems in Mathematics, 13(3), 3-5.

Kloosterman, P. (1996). Students' beliefs about knowing and learning mathematics: Implication for motivation. In C. Martha (Ed.), Motivation in mathematics (pp. 131-156). Cresskill, NJ: Hampton Press Inc.

Kloosterman, P., Raymond, A. M., & Emenaker, C. (1996). Students' beliefs about mathematics: A three-year study. The Elementary School Journal, 97(1), 38-55.

Kloosterman, P. &, Cougan, M. C. (1994). Students' beliefs about learning school mathematics. Elementary School Journal, 94(4), 375-388.

Kloosterman, P. &, Stage, F. K. (1992). Measuring beliefs about mathematical problem solving. School Science and Mathematics, 92(3), 109-115.

Kloosterman, P. &, Stage, F. K. (1995). Gender, beliefs, and achievement in remedial college-level mathematics, Journal of Higher Education, 66(3), 294-311.

Leder, G. (1990). Gender and classroom practice. In L. Burton (Ed.), Gender and mathematics: An international perspective (pp. 9-19). Singapore: Page Bros (Norwich) Ltd.

Linn, M. (1991). Gender differences in educational achievement: Proceeding of the 1991 EST Invitational Conference: Sex equity in educational opportunity, achievement, and testing. Princeton, NJ: Educational Testing Service.

Loebl, M. K. (1993). A causal model of variable predicting mathematical achievement at first-grade children (Doctoral dissertation, Fordham University, 1990). Dissertation Abstracts international, 54, 463.

Ma, X. & Kishor, N. (1997). Assessing the relationship between attitudes toward mathematics and achievement in mathematics: A meta-analysis. Journal for Research in Mathematics Education, 28(1), 26-47.

Maccoby, E. & Jacklin, C. (1974). The psychology of sex differences. PaloAlto, CA: Standford University Press.

McLeod, D. A. (1992). Research on affect in mathematics education: A Reconceptualization. In D. A.Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 575-596). New York, NY: Macmillan.

Meece, J. L. (1996). Gender differences in mathematics achievement: The role of motivation. In C. Martha (Ed.), Motivation in mathematics (pp. 113-130). Cresskill, NJ: Hampton Press Inc.

Mohamad-Ali, B. H. (1995). Attitudes toward mathematics of secondary school students in Malaysia: Current status, development, and some relationships. Indiana University: Indiana Bloomington.

Mouly, G. J. (1982). Psychology for teaching. Boston, MA: Allyn and Bacon.

Mueller, D. J. (1986). Measuring social attitudes: A handbook for researchers and practitioners. New York: Teachers college, Columbia University.

Mulhern F. & Rae G. (1998). Development form of the Fenemma-Sherman mathematics attitudes scales, Educational and Psychological Measurement, 58(2), 295-306.

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: National Council of Teachers of Mathematics.

National Science Foundation (1990). Women and minorities in science and engineering. Washington, DC. National Science Foundation.

Nicholls, J. G. (1984). Conceptions of ability and achievement. In R. E. Ames & C. Ames (Eds.), Research on motivation in education: Volume 1, student motivation (pp. 39-73). New York: Academic Press.

Nickson, M. (1992). The culture of the mathematics classroom: An unknown quantity? In D.A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 101-114). New York, NY: Macmillan.

Pittey, R. E., & Cacioppo, J. T. (1996). Attitudes and persuasion: Classic and contemporary approach. Boulder, CL: Westview Press, Inc.

Rajeki, D. W. (1990). Attitudes. Sunderland: Sinauer Associates, Inc.

Ramsey, F. L. & Schafer, D. W. (1997). The statistics sleuth: a course in methods of data analysis. Belmon, CA: Duxbury Press.

Reynolds, A. J. & Walberg, H. J. (1992). A process model of mathematics achievement and attitude. Journal for Research in Mathematics Education, 23(4), 306-328.

Ruggiero, V. R. (1998). A changing attitudes. Needham Heights, MA: Allyn and Bacon A Viacom company.

Sayers, R. (1994). Gender differences in mathematics education in Zambia. Educational Studies in Mathematics (International journal), 26(4), 389-403.

Schoenfeld, A. H. (1989). Exploration of students' mathematical beliefs and behavior. Journal for Research in Mathematics Education, 20(4), 338-355.

Silver, E. A., Strutchens, M. E., & Zawojewski, J. S. (1997). NAEP findings regarding race/ethnicity and gender: Affective issues, mathematics performance, and instructional context. In P.A. Kenny, & E. A. Silver (Ed.), Results from the sixth mathematics assessment of the national assessment of educational progress (pp. 33-59). Reston, VA: National Council of Teachers of Mathematics, Inc.

Simich-Dudgeon, C. (1996). Ethnicity, gender, attributes and mathematics achievement: The 1992 NAEP Trial State Assessment. Paper presented at the Annual Meeting of the American Educational Research Association. New York, NY (ERIC Document Reproduction Service No. ED 414175.

Singer, B., Beasley, M., & Bauer, E. (1996). A study of interaction of ethnicity. Math achievement. Socioeconomic status and gender on math attitudes of high school students. Paper presented at the Annual Meeting of the American Educational Research Association. New York, NY (ERIC Document Reproduction Service No. ED 400 302).

Stipek, D. S. (1984). The development of achievement motivation. In R. E. Ames & C. Ames (Eds.), Research on motivation in education: Volume 1, student motivation (pp. 145-174). New York: Academic Press.

Streitmatter, J. (1994). Toward gender equity in the classroom. Albany, NY: State University of New York Press.

Telese, J. A. (1997). Hispanic students' attitudes toward mathematics and their classroom experience. Paper presented at the Annual Meeting of the Southwest Educational Research Association. Austin, TX (ERIC Document Reproduction Service No. ED 407 256).

Thorndike-Christ, T. (1991). Attitudes toward mathematics: Relationships to mathematics achievements, gender, mathematics course-taking plan, and career interests. Washington, USA: Western Washington University (ERIC Document Reproduction Service No. ED 347 066).

Tocci, C. M. (1991). Attitudes toward mathematics related to gender, achievement, and parent support or adolescent from different social classes in the United States and Thailand (Mathematics attitudes). Emory University. Dissertation Abstract: (Eric Document Reproduction Accession No. AAG9127627).

Vanayan, M., White, N., Yuen, P., Teper, M. (1997). Beliefs and attitudes toward mathematics among third-and fifth-grade students: A descriptive study. School Science and Mathematics, 97(7), 345-351.

Verhage, H. (1990). Curriculum development and gender. In L. Burton (Ed.), Gender and mathematics: An international perspective (pp. 60-71). Singapore: Page Bros (Norwich) Ltd.

Whitney L., & Hoffman R. M., (1998). Middle school advisories: A vehicle for developing students' gender self-confidence. Education, 119, 232-233.

Wilson, L. M. D. (1995). Students' beliefs about doing mathematics. Paper presented at the Annual Meeting of the North American Chapter of the international Group for the Psychology of Mathematics Education. Columbus, OH (ERIC Document Reproduction Service No. ED 389 562).

APPENDICES

APPENDIX A
STUDENT QUESTIONNAIRE

Student's identification numbers (ID number) ________________

Student Questionnaire

Instructions to students:

1. This questionnaire is NOT a test and no grade will be given. The purpose of this study is to get opinions on aspects of mathematics, their personal feelings about mathematics, and learning mathematics. This questionnaire consists of two sections, A, and B. Section A contains several statements while section B consists of several questions about students' career interests, about students personally, and about your mathematics classrooms.
2. The statements in Section A are designed so that we would understand what your ideas are and how you feel about mathematics and about learning mathematics. Please give your opinion on each of statements by circling the appropriate letters that agree with your choice of response.
3. The questionnaire in Section B contains several questions about your personal information, future career plans, and some information about your mathematics classrooms. Please give your answer on each of statements by circling the appropriate letters that agree with your choice of response.
4. Please give your answer to all statements and questions according to how you feel. There are no "right" or "wrong" answers in this questionnaire. The only correct answers are those that are true for you.

5. Your answers are completely anonymous. I will need your ID number on this front page so that I can check your mathematics grades from the school record. The mathematics grades will be obtained from the teachers using ID number only. I will immediately destroy this front page of the questionnaire after I am able to record your grades on the response booklets. In this way no one (including the researcher) will be able to connect your name with your responses.
6. Thank you very much for your cooperation. If you have any questions at any time about the study or the procedures, you may reach me by email. My address is katwibud@ucs.orst.edu.

Section A: For this section please chooses your choice of response to each statement.

If you strongly disagree with the statement given circle	1
If you disagree with the statement given circle	2
If you are neutral about the statement given circle	3
If you agree with the statement given circle	4
If you strongly agree with the statement given circle	5

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I'm not the type to do well in math.	1	2	3	4	5
2. Mathematics is a worthwhile and necessary subject.	1	2	3	4	5
3. Math puzzles are boring.	1	2	3	4	5
4. When a question is left unanswered in math class, I continue to think about it afterwards.	1	2	3	4	5
5. Time used to investigate why a solution to a math problem works is time well spent.	1	2	3	4	5
6. If I can't solve a math problem quickly, I quit trying.	1	2	3	4	5
7. Studying mathematics is just as appropriate for women as for men.	1	2	3	4	5
8. By trying hard, one can become smarter in math.	1	2	3	4	5
9. I can get good grades in mathematics.	1	2	3	4	5
10. Mathematics is enjoyable and stimulating to me	1	2	3	4	5
11. Girls can do just as well as boys in mathematics.	1	2	3	4	5

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
12. If I can't do a math problem in a few minutes, I probably can't do it at all.	1	2	3	4	5
13. I am sure I could do advanced work in mathematics.	1	2	3	4	5
14. I cannot get smarter in math if I try hard.	1	2	3	4	5
15. I'm not very good at solving math problems that take a while to figure out.	1	2	3	4	5
16. A person who doesn't understand why an answer to a math problem is correct hasn't really solved the problem.	1	2	3	4	5
17. Ability in math do not increase when one studies hard.	1	2	3	4	5
18. Math problems that take a long time don't bother me.	1	2	3	4	5
19. I definitely will continue to take mathematics once participations become available.	1	2	3	4	5
20. It's not important to understand why a mathematical procedure works as long as it gives a correct answer.	1	2	3	4	5
21. Once I start trying to work on a math puzzle I find it hard to stop.	1	2	3	4	5
22. In addition to getting a right answer in mathematics, it is important to understand why the answer is correct.	1	2	3	4	5
23. Getting a right answer in math is more important than understanding why the answer works.	1	2	3	4	5
24. Working can improve one's ability in mathematics.	1	2	3	4	5
25. It's hard to believe a female could be a genius in Mathematics.	1	2	3	4	5
26. I feel I can do math problems that take a long time to complete.	1	2	3	4	5
27. Hard work can not increase one's ability to do math.	1	2	3	4	5
28. Math has been my worse subject.	1	2	3	4	5
29. I do as little work in math as possible.	1	2	3	4	5

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
30. Mathematics will not be important to me in my life's work.	1	2	3	4	5
31. I don't understand how some people can spend so much time on math and seem to enjoy it.	1	2	3	4	5
32. I would have more faith in a answer for a math problem solved by a man than a woman.	1	2	3	4	5
33. I find I can do hard math problems if I just hang in there.	1	2	3	4	5
34. Knowing mathematics will help me earn a living.	1	2	3	4	5
35. Mathematics is of no relevance to my life.	1	2	3	4	5
36. It doesn't really matter if you understand a math problem if you can get the right answer.	1	2	3	4	5
37. I think I could handle more difficult mathematics.	1	2	3	4	5
38. Studying mathematics is a waste of time.	1	2	3	4	5
39. I can get smarter in math by trying hard.	1	2	3	4	5
40. Girls who enjoy studying math are different.	1	2	3	4	5
41. Males are not naturally better than females in mathematics.	1	2	3	4	5
42. For some reason, even though I study, math seems unusually hard for me.	1	2	3	4	5
43. Time used to investigate why a solution to a math problem works is time well spent.	1	2	3	4	5

Section B: Please circle the answer to the following questions.

1. What grade are you in?

   A. 7th grade

   B. 8th grade

   C. 9th grade

2. Are you male or female?

   A. Male

   B. Female

3. How old are you?

   A. 12

   B. 13

   C. 14

   D. 15

   E. 16

4. What field of careers that you are interested to work in the future?

   A. Fine Arts

   B. Humanities

   C. Social Sciences

   D. Biological Sciences

   E. Physical Sciences and Mathematics

THANK YOU

APPENDIX B
THAI TRANSLATION OF STUDENT QUESTIONNAIRE

รหัสประจำตัวนักเรียน ________________________

<u>แบบสอบถามนักเรียน</u>

คำชี้แจง

1. แบบสอบถามชุดนี้ไม่ใช่แบบทดสอบและไม่มีคะแนนสำหรับการตอบคำถาม จุดประสงค์ของการศึกษาครั้งนี้เพื่อเก็บข้อมูลเกี่ยวกับความเชื่อทางคณิตศาสตร์, ความรู้สึกที่มีต่อคณิตศาสตร์ และการเรียนคณิตศาสตร์ แบบทดสอบชุดนี้ประกอบด้วย 2 ส่วนหลักคือตอนที่ 1 และ 2
2. แบบทดสอบตอนที่ 1เป็นข้อความเกี่ยวกับทัศนคติ ความเชื่อทางคณิตศาสตร์ และความสนใจในการเรียนคณิตศาสตร์ในอนาคต เพื่อความเข้าใจที่ชัดเจนเกี่ยวกับความคิดเห็นของนักเรียนในหัวข้อเหล่านี้
   กรุณาแสดงความคิดเห็นต่อแต่ละข้อความโดยการวงกลมตามตัวอักษรที่ตรงกับความรู้สึกของท่าน
3. แบบสอบถามตอนที่ 2 ประกอบด้วยคำถามเกี่ยวกับประวัติส่วนตัวของนักเรียน ความสนใจด้านอาชีพ ดังนั้น กรุณาตอบคำถามแต่ละคำถามโดยการวงกลมตัวเลือกที่นักเรียนคิดว่าเห็นด้วย
4. ขอความกรุณานักเรียนตอบคำถามในแบบทดสอบตามความรู้สึกที่แท้จริง ไม่มีคำตอบใดผิดหรือถูกในแบบสอบถามชุดนี้
   คำตอบที่เหมาะสมที่สุดคือคำตอบที่ตรงกับความคิดเห็นของนักเรียน
5. เพื่อรักษาคำตอบของนักเรียนให้เป็นความลับจึงใช้รหัสประจำตัวนักเรียน แทนการใช้ชื่อ-สกุลจริงในการศึกษาผลการเรียนวิชาคณิตศาสตร์กับคำตอบของท่านในแบบทดสอบ หลังจากนั้นข้อมูลเกี่ยวกับรหัสประจำตัวนักเรียนจะถูกทำลายเพื่อให้คำตอบของท่านในแบบสอบถามชุดนี้ถูกเก็บเป็นความลับ
6. ขอแสดงความขอบคุณมา ณ ที่นี่ในความร่วมมือ หากมีปัญหาหรือข้อปรึกษาใด ๆ กรุณาติดต่อ katwibud@ucs.orst.edu

ตอนที่ 1

คำชี้แจง ให้นักเรียนวงกลมตัวเลขขวามือ(1, 2, 3, 4, 5)ที่ตรงกับความเป็นจริงมากที่สุด

โดยหมายเลข	1	หมายถึง	ไม่เห็นด้วยอย่างยิ่ง
โดยหมายเลข	2	หมายถึง	ไม่เห็นด้วย
โดยหมายเลข	3	หมายถึง	ไม่แน่ใจ
โดยหมายเลข	4	หมายถึง	เห็นด้วย
โดยหมายเลข	5	หมายถึง	เห็นด้วยอย่างยิ่ง

	ข้อความ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
1.	ฉันไม่ใช่คนเก่งคณิตศาสตร์	1	2	3	4	5
2.	วิชาคณิตศาสตร์จำเป็นและมีคุณค่าต่อมนุษย์	1	2	3	4	5
3.	โจทย์คณิตศาสตร์เป็นเรื่องที่น่าเบื่อ	1	2	3	4	5
4.	เมื่อโจทย์ข้อใดที่ทำไม่ได้ในห้องเรียน ฉันจะพยามทำให้ได้ในภายหลัง	1	2	3	4	5
5.	การเสียเวลาเพื่อหาผลลัพธ์เป็นการใช้เวลาอย่างคุ้มค่า	1	2	3	4	5
6.	ถ้าฉันไม่สามารถแก้ปัญหาคณิตศาสตร์ในเวลาอันสั้นได้ ฉันก็จะพยายามทำอีก	1	2	3	4	5
7.	ไม่ว่าเพศชายหรือเพศหญิงก็สามารถเรียนคณิตศาสตร์ได้	1	2	3	4	5
8.	ความพยายามทำให้เราเก่งคณิตศาสตร์ได้	1	2	3	4	5
9.	ฉันทำคะแนนดีในวิชาคณิตศาสตร์	1	2	3	4	5
10.	ฉันคิดว่าคณิตศาสตร์เป็นวิชาที่เรียนสนุก	1	2	3	4	5
11.	ไม่ว่าเด็กหญิงหรือเด็กชายก็เรียนคณิตศาสตร์ให้เก่งได้	1	2	3	4	5
12.	เมื่อใช้เวลา 2-3 นาทีแล้วแก้ปัญหาคณิตศาสตร์ไม่ได้ฉันจะเลิกล้ม	1	2	3	4	5

ข้อความ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
13. ฉันคิดว่าจะเรียนคณิตศาสตร์ต่อไปในขั้นสูง	1	2	3	4	5
14. แม้ว่าจะพยายามอย่างไรฉันก็ไม่เก่งคณิตศาสตร์	1	2	3	4	5
15. ฉันแก้ปัญหาทางคณิตศาสตร์ที่ยากไม่ค่อยได้	1	2	3	4	5
16. ผู้ที่ไม่รู้ที่มาของผลลัพธ์ คือผู้ที่ไม่รู้วิธีการแก้โจทย์ข้อนั้น ๆ	1	2	3	4	5
17. ความพยายามไม่ได้ช่วยให้เก่งคณิตศาสตร์	1	2	3	4	5
18. ฉันไม่ท้อแท้กับการแก้โจทย์คณิตศาสตร์ที่ต้องใช้เวลาทำนาน	1	2	3	4	5
19. ฉันแน่ใจว่าเมื่อมีโอกาส ฉันจะเรียนคณิตศาสตร์อีกต่อไป	1	2	3	4	5
20. ขั้นตอนวิธีทำโจทย์ไม่มีความจำเป็น มีผลลัพธ์ที่ถูกต้องก็เพียงพอแล้ว	1	2	3	4	5
21. เมื่อทำโจทย์ข้อใดข้อหนึ่งไม่ได้ ฉันจะพยายามต่อไป	1	2	3	4	5
22. ในการแก้โจทย์คณิตศาสตร์ เมื่อได้ผลลัพธ์มาแล้วและสามารถตรวจคำตอบได้ นั้นมีความสำคัญ	1	2	3	4	5
23. ฉันไม่จำเป็นต้องรู้วิธีการแก้โจทย์ เพียงได้คำตอบที่ถูกต้องฉันก็พอใจแล้ว	1	2	3	4	5
24. การทำแบบฝึกหัดมาก ๆจะช่วยเพิ่มความสามารถทางคณิตศาสตร์ได้	1	2	3	4	5
25. เพศหญิงเป็นอัจฉริยะทางคณิตศาสตร์ได้ยาก	1	2	3	4	5
26. ฉันแก้ปัญหาคณิตศาสตร์ที่ต้องใช้เวลาทำนานได้	1	2	3	4	5
27. การทำแบบฝึกหัดมาก ๆไม่ได้ช่วยเพิ่มทักษะทางคณิตศาสตร์	1	2	3	4	5
28. ฉันได้คะแนนในวิชาคณิตศาสตร์ต่ำเสมอ	1	2	3	4	5
29. ฉันจะเกี่ยวข้องกับงานทางคณิตศาสตร์เท่าที่จำเป็นเท่านั้น	1	2	3	4	5

	ข้อความ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
30.	คณิตศาสตร์จะไม่มีความสำคัญต่ออาชีพของฉันในอนาคต	1	2	3	4	5
31.	ฉันไม่เข้าใจว่าทำไมบางคนชอบวิชาคณิตศาสตร์และใช้เวลากับมันมากนัก	1	2	3	4	5
32.	เพศชายเก่งกว่าเพศหญิงในการแก้ปัญหาทางคณิตศาสตร์	1	2	3	4	5
33.	ฉันแก้ปัญหาคณิตศาสตร์ข้อที่ยากได้ ถ้าฉันตั้งใจทำอย่างแน่วแน่	1	2	3	4	5
34.	ความรู้ทางคณิตศาสตร์จะมีประโยชน์ในการประกอบอาชีพในอนาคต	1	2	3	4	5
35.	คณิตศาสตร์ไม่เหมาะกับฉัน	1	2	3	4	5
36.	การเข้าใจโจทย์และทราบคำตอบที่ถูกต้อง ก็เพียงพอแล้ว	1	2	3	4	5
37.	ฉันสามารถจะเรียนวิชาคณิตศาสตร์ที่มีเนื้อหายากกว่านี้ได้	1	2	3	4	5
38.	การเรียนคณิตศาสตร์เป็นการเสียเวลา	1	2	3	4	5
39.	ถ้าพยายามมากกว่านี้ ฉันจะเก่งคณิตศาสตร์	1	2	3	4	5
40.	นักเรียนหญิงที่เก่งคณิตศาสตร์มีลักษณะพิเศษต่างจากนักเรียนหญิงอื่น ๆในชั้นเดียวกัน	1	2	3	4	5
41.	ในวัยผู้ใหญ่ ไม่ว่าผู้หญิงหรือผู้ชาย สามารถเก่งคณิตศาสตร์ได้	1	2	3	4	5
42.	ฉันไม่ประสบผลสำเร็จในการเรียนวิชาคณิตศาสตร์แม้จะพยายามมากแล้ว	1	2	3	4	5
43.	ฉันเรียนคณิตศาสตร์เพราะตระหนักดีว่ามีประโยชน์	1	2	3	4	5

ตอนที่ 2

คำชี้แจง

โปรดเติมข้อความลงในช่องว่างที่กำหนดไว้หรือวงกลมคำตอบตามความเป็นจริง

1. ท่านกำลังศึกษาอยู่ในระดับชั้นใด?
   - ก. ม. 1
   - ข. ม. 2
   - ค. ม. 3

2. ท่านเป็นเพศใด?
   - ก. หญิง
   - ข. ชาย

3. ท่านมีอายุเท่าไหร่?
   - ก. 12
   - ข. 13
   - ค. 14
   - ง. 15

4. นักเรียนมีความต้องการจะประกอบอาชีพเกี่ยวกับสาขาวิชาใด
   - ก. วิจิตรศิลป์หรือศิลปะ
   - ข. มนุษยศาสตร์
   - ค. สังคมศาสตร์
   - ง. วิทยาศาสตร์การแพทย์
   - จ. วิทยาศาสตร์เทคโนโลยี

ขอขอบคุณมา ณ ที่นี้