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AN INVESTIGATION OF THE RELATIONSHIP BETWEEN STUDENTS' ATTITUDE TOWARD LEARNING MATHEMATICS AND MATHEMATICS ACHIEVEMENT WITH RESPECT TO GENDER AMONG 10TH GRADE PUBLIC SCHOOL STUDENTS IN AMMAN, JORDAN

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A Dissertation APPROVED FOR THE
DEPARTMENT OF INSTRUCTIONAL LEADERSHIP AND
ACADEMIC CURRICULUM

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ABSTRACT

The main purpose of this study is to investigate the relationship between students' attitude toward learning mathematics and mathematics achievement with respect to gender in 10^{th}-grade students in Amman, Jordan. Three instruments were used in the study to collect data; a mathematics achievement test (MAT), consisting of questions selected by the researcher from the (2004) Ohio Graduation Practice Test; an attitude questionnaire (ATM), developed by Taylor (1997) from the Aiken Scale (1976); and student interviews developed by the researcher. The overall results of the study indicate that there were significant differences in attitude and achievement between male and female students in the 10^{th} grade ($F = 16.3$, $p < 0.01$). It also shows, using a Pearson Correlation, that there is a significant correlation between the two dependent variables; attitude toward learning mathematics and mathematics achievement. The main recommendations used in the study are for teachers and other educational professionals to focus on the attitudes of students toward mathematics in order to improve the learning of mathematics. School-wide programs should strive to build positive attitudes toward mathematics in all students. These programs should begin at the primary level and continue throughout the school career, producing positive results in the long run.

Chapter One

Introduction

According to the Principles and Standards for School Mathematics (NCTM, 2000), a school mathematics curriculum is a strong determinant of what students have an opportunity to learn and what they do learn. In a coherent curriculum, "mathematical ideas are linked to and build on one another so that students' understanding and knowledge deepens and their ability to apply mathematics expands" (p. 14). The national standards for mathematics are predicated on the belief that students should connect mathematics to activities of daily living. Our world is becoming more mathematically based. The latest technology makes the acquisition and understanding of mathematics more important to many people. We are constantly surrounded by mathematical situations and are regularly required to make mathematical decisions. However, many educators and school consumers see making connections as a result rather than something intrinsic to mathematics instruction. In recent years, we have learned that children simply do not internalize what teachers tell them in classrooms. Students are challenged to make sense of new information based on meanings they personally construct, and fundamental to all of this is the students' attitude toward mathematics (Tapia and Marsh, 2000).

Prior achievement and home environment influence achievement most powerfully. Motivation, exposure to reading media outside of the classroom, peer environment, and instructional exposure also have significant influences on achievement. Prior attitude has a strong influence on subsequent attitude; although,

the direct effects of instructional quality and the indirect effects of motivation and home environment are also notable. Appropriate teacher uses of instructional time, thorough textbook coverage, and daily introduction of new material, although educationally alterable, are themselves influenced by previous student achievement. Similarly, instructional practices are significant and alterable influences on attitude toward mathematics, but such practices are themselves influenced by students' attitudes (Reynolds and Walberg, 1992).

Fennema (1985) has drawn our consideration to the impact of affective aspects on mathematics achievement. She established that affective variables might assist in explaining gender differences in mathematics.

According to "Everybody Counts" (NRC, 1989):

> Mathematics is the key to opportunity. No longer just the language of science, mathematics now contributes in direct and fundamental ways to business, finance, health and defense. For students, it opens doors to careers. For citizens, it enables informed decisions. For nations, it provides knowledge to compete in a technological economy. To participate fully in the world of the future, America must tap the power of mathematics. (p.1)

Mathematics is a difficult topic for many to study. There is also difficulty in teaching mathematics, which, therefore, produces many problems in learning and understanding. It is common to hear people say, "I hate mathematics," or "I do not understand it." Moreover, achievement in mathematics occurs gradually over many years of student's learning life. It is a sequential experience of related and connected processes or steps. Missing one process or step might affect the whole understanding or achievement process (AL-Rwais, 2000).

Thousands of children in the United States each year have difficulty with mathematics to the extent that they are referred to special education classrooms,

corrective teachers, and clinics for extra help (Gannon and Ginsburg, 1985). Higgins and Heglie-King (1997) cite one 8th-grade middle school student as stating:

> Mathematics is sometimes really annoying to me because I don't know why we need to know a lot of the stuff we are taught. As I see it, when are we going to use the square root of 2 x Y in a grocery store…! I don't want to do it when I don't see how I benefit in the long run. (p.22)

However, Suydam and Weaver (1975) in their review of affective factors of mathematics learning, maintain:

> Teachers and other mathematics educators generally believe that children learn more effectively when they are interested in what they learn and they will achieve better in mathematics if they like mathematics. Therefore, continual attention should be directed towards creating, developing, maintaining, and reinforcing positive attitude. (p.45)

A fundamental relationship between attitude toward mathematics and achievement in mathematics has long been understood to exist. That is, a more positive attitude toward mathematics contributes to a higher level of achievement in mathematics (Suydam and Weaver, 1975).

The concern is not about the contradiction in the causal direction between the attitude toward mathematics and achievement in mathematics, but rather the correctness of specifying a unilateral relationship between attitude toward mathematics and achievement in this subject. Ethington and Wolfle (1986) discussed the relationship between mathematics attitude and exposure:

> Although it might be argued that enrollment in mathematics courses is likely to affect attitudes toward mathematics, an equally plausible argument may be made that these attitudes affect decisions to enroll in mathematics courses. Thus, specifying any unidirectional causal relationship between these factors would be inappropriate. (p. 66)

Gender and Academic Achievement in Mathematics

Mathematics achievement between the sexes has been an extensively researched topic. Society's general belief is that males outperform females in individual, competitive, and analytical dimensions of cognitive styles. "Everybody Counts" (NRC, 1989) maintains that as girls and boys progress through the mathematics curriculum, they show little difference in ability, effort, or interest until the adolescent years. As social pressures increase, girls tend to exert less effort in studying mathematics, which limits their future education and, eventually, their career choices. This report also notes that gender differences in mathematics performance result from sex-role stereotyping by families, schools, and society. The public attitudes perpetuate stereotypes that "girls really can't do math" (p. 23) and that "math is unfeminine" (p.23).

However, the gap in mathematics performance attributed to gender differences appears to be closing. Alkhateeb (2001) explored gender differences in mathematics achievement among high school students in the United Arab Emirates (UAE). Findings of this study indicate a decline of gender difference in high school final mathematic achievement; more precisely, the gender gap on achievement test scores appears to be closing. The researcher believes that some of the traditional society factors of Arabs in UAE may be considered to explain the closure of the gap between the sexes. In the UAE, the general living standards are high. Arab families of high socioeconomic status do not believe in the superiority of males over females; therefore, these families encourage females to study subjects like mathematics. To

fully grasp these changes as they apply to Jordan, it is necessary to have a cursory understanding of Jordan and its education system.

An Overview of the Educational System in Jordan

The Hashemite Kingdom of Jordan is situated on the eastern coast of the Mediterranean between north longitude (33.29) and east latitude (39.34). It is bordered by the Syrian Republic on the north, Iraq and Saudi Arabia on the east, Egypt on the south, and Palestine on the west. Jordan's area covers 92,300 square kilometers, and the desert region comprises 75% of its total area.

The population of Jordan was estimated to be approximately 5,329,000 in 2002, according to the General Statistics Department, with an average annual growth rate of 3.2% between 1994 and 2002. Most of the population reside in the governorate of the capital. Jordanian society is still young despite the decrease of the percentage of those below the age of 15 from 49% in 1979 to 38% in 2002; whereas, the average family size in Jordan for 2002 was 5.7 (General Statistics Department, 2002).

Responsibility for education in Jordan is vested in the central government, represented by the highly centralized Ministry of Education (MOE). All education below the university level is controlled and supervised by the Ministry. In accordance with the Education Act No.3 for the Year 1994, the Ministry of Education is empowered to plan, administer, and develop educational policy and other issues related to the system (MOE, 1996).

Attached to the Ministry of Education is the Board of Education, which was formed in 1969 by a royal decree. It is composed of 15 members, headed by the Minister of Education. The members are chosen from senior educational leaders and

experts. The Board of Education is the supreme educational legislative authority in the country. Among other functions, it formulates the educational policy for the whole country and presents recommendations to the Ministry of Education regarding the implementation of this policy. It also approves the educational programs and textbooks and any proposed alterations or modifications of educational programs (MOE, 2000).

Under the Ministry of Education, the country is divided into six educational districts or zones. In each district, an educational department is headed by a "director general," who is responsible for education in his or her department. Although the directors have recently been given more power in their own departments, they report to and implement the policies, regulations, and orders of the central Ministry of Education.

In addition to the Ministry of Education, several other educational authorities in Jordan run their own schools. There are schools run by the United Nations Relief and Works Agency (UNRWA), and some schools administered by governmental authorities other than the Ministry of Education. These schools, although under the direct administration of their respective authorities, are supervised by the Ministry of Education and governed by its educational policy. The same programs and textbooks that are used in the public schools are also used in private schools.

Public schools comprise the vast majority of the Jordanian schools. Table 1 shows the distribution of schools and students by controlling authority. It can be seen from the table that out of 5,378 schools, 3,105 (58%) are public schools. Official figures (MOE, 2004) show that in the school year 2003/2004, the number of students

in Jordan was 1,515,315. This number represents about 28% of the total population in Jordan. The figures also show that the number of teachers for all levels was 76,946 during the same year.

Table 1

Total Number of Schools and Students in Jordan by Authority

	Educational Authority				
	MOE	Private	UNRWA	Other	Total
Number of schools	3,105	2,063	190	20	5,378
Number of Students	1,068,298	290,940	134,863	21,214	1,515,315

Note: Adapted from *Ministry of Education,* 2004

It is worth noting that in 2002, Jordan ranked first among other Arab countries in the rate of literacy at 89% as compared to 46.2% in Yemen (UNESCO, 2002).

The Ministry of Education provides 12 years of study in its schools, starting from the first grade. Kindergarten education is a private enterprise; although, some kindergarten teachers are provided by the Ministry of Education. The 12 years of education are divided into two cycles, the basic compulsory education cycle (Grades 1 through 10) and the secondary cycle (Grades 11 and 12). Education in the compulsory cycle is free for all students; no tuition is paid, and students receive free textbooks. In the secondary cycle, students do not pay tuition, but they pay for all textbooks. Textbooks are sold to private schools for all grade levels.

Except for a limited number of elementary schools and most private schools, coeducation does not exist in Jordanian schools. Males and females study in separate schools and are generally taught by teachers of the same gender. Due to the shortage

of qualified female teachers in certain subjects such as mathematics, male teachers may teach at a girls' school at the secondary cycle.

Until the end of the compulsory cycle (Grade 10), the same programs are offered to all students in all schools. In the secondary cycle, there are two branches of education, the vocational branch and the academic branch. The enrollment in these two branches depends on a student's preference and on his/her academic achievement in the compulsory cycle. Students in the vocational branch can specialize in one of a number of fields (e.g., nursing, agricultural, hotel, industrial, and commercial). In the academic branch, students study the same programs in all schools until the end of 10th grade. At the beginning of the eleventh grade, they are classified into two "streams": the scientific stream and the literary stream. Again, the classification depends on students' preferences and on their academic achievement. Usually high achievers are placed in the scientific stream. While the focus in the literary stream is on languages and social sciences, the scientific stream emphasizes science and mathematics.

By the end of the 12th grade, students of both branches sit for general examinations administered by the Ministry of Education. Students who pass the examination are awarded a diploma, which is called a "General Secondary School Certificate." This diploma is a prerequisite for admission to higher education institutes.

Mathematics Education in Jordan: A Brief Perspective

Prior to 1971, the content of school mathematics in Jordan was what might be called "traditional mathematics." Students were taught mathematics as separate

subjects (arithmetic, algebra, geometry, etc.), among which they saw few connections. By the end of the 1960s, the international enthusiasm for modern mathematics was infused into the Jordanian education system, as well as other Arab curricula. As a result, dramatic changes were made in the early 1970s to mathematics education, which was inspired and supported first by United Nations Educational, Scientific and Cultural Organization (UNESCO) and then by The Arab League Educational Cultural and Scientific Organization (ALECSO). From this, new topics permeated school mathematics, such as sets, relations, functions, binary operations, groups, rings, fields, number systems, vectors, and vectors spaces. However, sophisticated treatment, intensity of abstractness, and lack of applications caused a setback that ended with a second wave of changes entitled "Back to Basics." Many of the modern concepts were dropped with calls to emphasize problem solving; application; the use of calculators; and if possible, the use of ready-made software. However, algebra, geometry, trigonometry, and calculus are the current dominant features, with paper-and-pencil technology as the most common medium for mathematical activities (Ebied, 1999).

Compared with other school subjects, mathematics is given substantial weight in the total school curriculum. Table 2 shows the number of class periods per week allotted to mathematics compared to the total number of class periods at the compulsory cycle (Grade 1 through 10). The length of the class period ranges between 45-50 minutes.

Table 2

Number of Class Periods Per Week Allotted to Mathematics in the Total Curriculum in Jordan

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Math	5	5	5	5	5	5	5	4	4	4
Total Periods	27	27	28	28	33	34	34	32	33	34
Percentage Of math periods	18.5	18.5	17.8	17.8	15.2	14.7	14.7	12.5	12.12	11.8

Note: Adapted from *Ministry of Education,* 2004

It can be seen from the Table 2 that in the first through seventh grade, five periods are allotted to mathematics, representing an average weight of about 15% in the total curriculum. In the eighth grade through 10th grade, students have four class periods per week, representing a weight of about 12% in the total programs.

Higher Education in Jordan: An Overview

The higher education system in Jordan consists of community colleges and universities. Access to the post-secondary education system generally is limited to those who have completed the basic and secondary education cycles and successfully received the General Secondary School Certificate. Approximately 50 public and private community colleges offer 2-year programs of study. Based on the successful completion of a comprehensive examination at the end of 2 years, students graduate with an Intermediate Diploma. Community colleges offer more than 100 specializations, representing academic and vocational programs of study. Minimal admission standards for public community colleges are established by the Ministry of Higher Education (MOHE) and generally are lower than those expected for entrance

into a university (usually in the 50-60% range). Most community college programs are terminal; there is limited potential to transfer to the university system, and the majority of community colleges are administered by the private sector.

Jordan has 10 public and 13 private universities. Bachelor and master degrees are available in a wide range of specializations, though the number of doctoral degrees is limited. Admission to public universities operates on the basis of a centralized process where applicants prioritize their top 20 faculty, program, and university preferences. Admissions to public universities tend to be more competitive than at the community college level and generally are restricted to those with the highest General Secondary School Certificate scores (MOHE, 2003).

Mathematics Teachers in Jordan

There are two sources for mathematics teachers in Jordan: university graduates and the graduates of community colleges. Generally speaking, university graduates teach at the secondary level, while graduates of community colleges teach at the compulsory level. However, due to the shortage in the number of mathematics teachers who hold university degrees, the Ministry of Education allows experienced teachers who have graduated from community colleges to teach at the secondary level.

Several in-service training programs are held every year for teachers by the Ministry of Education, and every mathematics teacher is required to attend at least one mathematics-training program. Instructors at these programs are usually mathematics supervisors from the Ministry of Education and university professors.

The focus of the program is mainly on the contents of textbooks and on appropriate methods of presenting the material.

One of the most serious problems facing mathematics education in Jordan is the shortage of qualified teachers. Poor salaries and negative social attitudes towards the teaching profession are major factors causing this problem. Many mathematics teachers seek their fortunes in oil-rich Arab countries or in other professions. Another serious problem is the quality of mathematics teachers. As a result of poor salaries and low social status, high school graduates tend to pursue studies in other subjects, such as medicine and engineering. Generally, the high achievers are admitted to these discipline areas, and mathematics and sciences receive students who are lower achievers. In addition, the problems associated with community colleges are even more severe. Students who enroll in these colleges typically had very low grades in high school. They choose to study at community college because they have no other opportunity. The fact that the majority of teachers in Jordan are graduates of community college is a serious problem for the quality of mathematics education.

Statement of the Problem

In this study, the researcher explores Jordanian students' attitudes toward learning mathematics and investigates the relationship between students' attitudes toward learning mathematics and mathematics achievement. More specifically, the purpose of the study is to determine if differences exist between Jordanian male and female students' attitudes toward learning mathematics, the differences in their achievements in mathematics, and the relationship between attitude and achievement in Jordanian students (both males and females).

Research Questions

Interview data and quantitative methods are used to answer the following research questions:

1. What are Jordanian male students' attitudes toward learning mathematics?
2. What are Jordanian female students' attitudes toward learning mathematics?
3. What are the differences and similarities between Jordanian male students' attitudes and Jordanian female students' toward learning mathematics?
4. Is there significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement?
5. Are there significant differences between Jordanian males and females on a combination of students' attitudes towards learning mathematics and mathematics achievement?

Research Hypotheses

For the first three research questions identified above, a qualitative methodology was used; therefore, hypotheses are not listed.

The following null hypotheses are identified for the last two research questions.

H01: Null hypotheses:

No significant correlation exists between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement.

H02: Null hypotheses:

No significant differences exist between Jordanian males and females on a combination of students' attitudes toward learning mathematics and mathematics achievement.

Significance of the Study

The goal and significance of the study are to increase students' achievement in mathematics in Jordan. It is necessary to assess students' achievement and attitudes toward mathematics by clarifying factors that affect them.

This study attempts to assess 10th-grade students' attitudes toward learning mathematics and understanding of the basic mathematics concept. The findings of this study are expected to provide input to the Ministry of Education responsible for mathematics curriculum development, university professors authorized to design curriculum of mathematics to set instructional goals and make decisions about curriculum change in mathematics for secondary schools, as well as educational institutions that provide in-service and pre-service preparations for mathematics teachers. Furthermore, this study provides information for future references and future research studies in this field in Jordan. It is hoped that information from this study will enable math teachers in Jordan to develop positive attitude toward mathematics.

Limitations of the Study

The main purpose of this study is to investigate the relationship between students' attitudes toward learning mathematic and mathematics' achievement. The limitations of this study include the following:

1. The study investigates only 10th-grade mathematics classes.
2. The study concerns male and female students' attitude toward learning mathematics and mathematics achievement.
3. The study involves only schools in Amman, Jordan.
4. The sample of students was 306 tenth grade students: 153 female and 153 male students.
5. Pencil and paper were used in the pilot and posttest.
6. Six males and six females who are studying in the 10th grade in Amman, Jordan will be interviewed individually and tape-recorded to obtain their opinions about mathematics achievement, and their attitude toward learning mathematics and to determine the differences between females and males with respect to mathematics.
7. The reliability of the translated mathematics achievement was r = .63

Definition of Terms

Achievement in Mathematics: Achievement in mathematics is often used as a sign of "how much" mathematics someone knows. For the purpose of this study, achievement in mathematics is measured by the score attained on the mathematics achievement test, with questions selected from the Ohio Graduation Practice Test (see Appendix A).

Attitude Toward Mathematics: Attitude toward mathematics is defined as a general emotional nature toward the school subject of mathematics. This definition can be applied to attitude toward the field of mathematics, attitude toward one's ability to achieve in the field of mathematics, or attitude toward some particular area in

mathematics. In this study, attitude is measured by the scale on the attitude toward learning mathematics with questions selected from Aiken Attitude to Mathematics Scale (1976), which was developed by Taylor (1997)(see Appendix B).

Organization of the Study

Chapter 1 Introduction provides an introduction to the study. It includes an overview of the educational system in Jordan, background of the study, statement of the problem, research questions, research hypotheses, significance of the study, limitation of the study, definition of terms, and organization of the study.

Chapter 2 Literature Review presents a literature review, historical evolution of research between attitude toward mathematics and achievement in mathematics, differences in mathematics achievement studies by gender, and studies of attitude toward mathematics.

Chapter 3 Methodology describes the methodology, which is employed in the present study, the study population, sample, instrumentation, the translation of English version of the questionnaire, pilot study, validity and reliability of the questionnaire, data collection procedures, and data analysis.

Chapter Four Analysis and Results presents the findings of the research and tests hypotheses.

Chapter Five Summary presents the findings of the investigation and some implications and recommendations depending on the results, and offers some suggestions for further research.

Chapter Two

Literature Review

The major purpose of this study is to investigate the relationship between students' attitudes toward learning mathematics and mathematics achievement with respect to gender. Therefore, the review of the literature of this study focuses on (1) historical evolution of research on attitude toward mathematics and achievement in mathematics, (2) studies of attitude toward mathematics, and (3) gender differences in mathematics achievement studies.

Historical Evolution of Research on Attitude Toward Mathematics and Achievement in Mathematics

An overview of research on attitude shows that the construct "attitude" has evolved over the years since Thomas and Znaneick (1918) first introduced the idea of attitude (Stern, 1963). The development of the meaning of the construct "attitude" is manifested in different definitions, different instruments that are supposed to measure attitude, and components of the structure of attitude. Researchers appear to have placed different emphases on the defining characteristics of attitude. For example, Thomas and Znaneick, cited by Stern (1963), viewed attitude as internalized subjective tendencies toward an object. Attitudes were seen as an index of how a person thinks and feels about objects and issues (Dillman, 1978). While Thomas and Znaneick appear to have emphasized general thinking and feeling, Mueller (1986) emphasized the evaluative aspect toward an objective or situation. The value judgment involved making a decision about whether the object or situation is good or

bad or favorable or unfavorable. In contrast, Richardson (1996) emphasized the role of environment and experiences in the formation and development of attitude.

Similarly, McLeod (1992) asserted that attitude results from the automitizing of repeated emotions to mathematics. Although there are different emphases in conceptualizing attitude, there are also similarities. All the conceptions imply that attitudes involve a person's tendencies toward an object or an issue. These tendencies are internalized and are not observable. Therefore, attitude can be inferred, and the inferences are based on responses to attitudinal instruments. Consequently, different psychologists developed the initial instruments for measuring attitude including Thurstone (1928), Likert (1932), and Osgood (1957).

The Likert and Thurstone Scales consist of representative items of the construct. Half of the statements are positive, and the other half negative. The Likert Scale usually has five options (strongly agree, agree, neutral, disagree, or strongly disagree), while the Thurstone Scale has at least seven, and usually 11 options. Some researchers argue against including the neutral option along the agreement-disagreement continuum in the Likert Scale. They assert that no person is neutral in any given issue unless the person has not formed an opinion about the issue. Having not formed an opinion is different from being neutral. A person, in the new version of the Likert scale without the neutral option, indicates the extent to which he or she agrees or disagrees with each statement (Ary, Jacobs, and Razavieh, 1990).

In contrast to Likert and Thurstone, the semantic differential instrument is based on the assumption that an object or situation has denotative and connotative meanings. Therefore, a semantic differential scale involves bipolar adjectives with at

least seven categories or spaces. The respondent is requested to mark with an X in one of the seven spaces to indicate the extent to which each adjective describes the object. Ary, Jacobs, and Razavieh (1990) recommended alternating the direction of the scale in order to discourage respondents from forming a mindset.

Although the instruments of attitude are different, they are based on a common construct. The attitude construct implies a mental set or learned tendency to respond in a consistent favorable or unfavorable manner to objects (Mueller, 1986). The terms "mental set" and "tendency toward objects" imply some structural aspects of attitude: cognitive, affective or emotional, and behavioral (McLeod, 1989). Haden (1990) discussed some functional aspects of attitude in addition to those suggested by McLeod (1989). The structural aspect of attitude explains the components of attitude while the functional aspects indicate what attitude does for people. Haden (1990) identified four functions of an attitude: (a) adaptive, (b) knowledge, (c) self-expressive, and (d) ego defensive. An adaptive function influences a person toward or against an object or situation that gives satisfaction or unpleasantness, respectively. This adaptive function could probably explain the repeated behavior of the relationship between attitude and achievement.

It is possible to imagine a student who starts a mathematics class without having created an attitude toward mathematics and then, subsequently, develops either a positive attitude or negative attitude toward mathematics due to level of achievement. Attitude in this context is a function of achievement. Another student may start with a positive attitude toward mathematics and carefully study mathematical tasks and, subsequently, obtain high grades or marks. In this case,

achievement is a function of attitude. This is supported by some research studies, such as the study of attitude toward science and achievement by Simpson and Oliver (1985) and Shirley's 1990 study which found that attitude and behavior are correlates.

Knowledge, the second functional factor of attitude identified by Haden (1990), guides a person in classifying received information and helps him or her to understand the outside or external world. This is probably associated with attribution of denotative meaning, which is linked to belief, and the cognitive self-expressive of attitude. Self-expression refers to the expression of one's own personality and feelings and is probably associated with connotative meaning. The ego defensive aspect enables a person to deal with unpleasantness in order to maintain self worth (McLeod, 1992). This structural aspect has been an issue over the years. The argument about the construct "attitude" arises from different views that are held about the structure of attitude. For example, social psychologists, cognitive psychologists, and mathematics educators perceive attitude differently. The social psychologists use beliefs and attitude interchangeably and imply that attitudes and beliefs are synonyms referring to one common structure. Contrary to social psychologists, cognitive psychologists understand that beliefs and attitudes differ in cognitive involvement and intensity of feelings (Richardson, 1996: McLeod, 1989 & 1992) and appear to imply different components of the affect.

Nespor (1987) and Abelson (1979) presented some arguments for features of belief systems as perceived by cognitive psychologists. Nespor (1987) identified at least four structural components of beliefs:

1. Existential presumption.
2. Episodic structure.
3. Alternativity.
4. Affective and evaluative loading.

Existential presumption refers to assumptions about existence or non-existence of entities. In a school context, existential presumption would be manifested by descriptions that teachers use to describe students with respect to learning or achievement, such as: student A is mature, has high ability, has average ability, has below average ability, or is lazy. Such descriptions indicate beliefs that are held by the teacher about student A. For example, a traditional teacher, who believes that learning mathematics occurs through drill and practice and that students fail due to laziness, is most likely to give more exercises for practice. Another teacher may believe that learning mathematics is a function of maturity and such beliefs are based on developmental psychology (Bruner, 1966). Influences of developmental psychology led to new curriculum organization, such as a spiral approach with emphasis on integration of traditionally dissevered curriculum such as algebra, trigonometry, and geometry (DeBoer, 1991). Affective and evaluative loading refers to making a value judgment about whether an idea or object is good or bad. The evaluative, together with the other structural components, entangle belief systems with knowledge systems.

Abelson (1979) identified seven features of the belief system that distinguish beliefs from knowledge systems. His features include non-consensuality, limitless, variable belief and episodic structure, existential presumption, alternativity, affective,

and evaluative -- the last four features being suggested by Nespor (1987). Abelson (1979) asserted that structured knowledge has a network of interrelated concepts or propositions. Therefore, there appears to be some agreement among researchers or educators about knowledge wherein beliefs are divisive. Novack and Hansen (1968) used the idea of interrelationship among related concepts to establish meaningful learning. Similarly Novak and Gowin (1984) suggested a teaching strategy; concept mapping that ensures meaningful learning and establishes interrelationships among related concepts.

The literature suggests that structural features of beliefs are different from structural components of attitude. Haden (1990) implied that beliefs and attitude are different constructs. Furthermore, the definition of beliefs that was suggested by cognitive psychologists, a mental state of accepting that something as true or false based on reasonable assumptions, shows significant differences from the definition of attitudes as suggested by social psychologists.

Social psychologists defined attitude as a stable tendency to think, feel, and behave favorably or unfavorably toward a specific object, event or idea (Hart, 1989). Attitude in the 1960s and 1970s was viewed as a construct that included beliefs, evaluation, action, and emotion. Social psychologists emphasized that concepts, beliefs, evaluations, and emotions that constitute attitude produce a specific focus on individuals and consistency in behavior. The belief component is cognitive and organizes people's information about objects or ideas (Richardson, 1996).

Although cognitive psychologists divided the affective domain into beliefs, attitudes, and emotional components, they no longer thought of beliefs and emotions

as sub-concepts that constitute attitude. That is, they felt attitudes, beliefs, and emotions represent different concepts in the affective domain. Based on this belief, they ordered the concept beliefs, attitudes, and emotions in order of decreasing cognitive involvement and increasing intensity of feeling (McLeod and Ortega, 1993). The dispute or controversy that arose among cognitive and social psychologists' views of attitudes and beliefs dismantled the hierarchical structure of attitude as a construct with beliefs, feelings, emotions, and experience as sub-concepts. The different views from psychology have influenced mathematics education in terms of the type of research, curriculum development, teaching, and learning process (Kilpatrick, 1992). For example, research studies that were done in the period between mid 1950s and 1970s imply that attitude was perceived in the same way that was suggested by social psychologists. Studies that were done during1980s display a bias toward cognitive psychologists' views. However, there are some problematic areas where the distinction between social psychology and cognitive psychology is blurred.

Brahier (1995) and National Council of Teachers of Mathematics (NCTM) (1989) appear to use disposition as a construct that is different from attitude. Yet, they define disposition in almost the same terms used by social psychologists to define attitude. Brahier, (1995) and NCTM (1989) defined disposition as a tendency to think and act. Similarly, social psychologists defined attitude as a disposition to act or react in certain ways to particular objects or ideas (Aiken, 1976).

The inclination toward cognitive views is implied by mathematics educators who adopted the cognitive view toward attitude, probably in response to the NCTM

(1989) recommendation to emphasize problem solving in teaching and the pursuit of a deeper understanding of learning mathematics. Another possible reason for the rise of cognitive psychology in mathematics education may be the gradually increasing interest in conceptual processes as opposed to product processes and acceptance or recognition of qualitative research methods as legitimate ways of understanding the teaching-learning process (NCTM, 1989). In response, mathematics educators encouraged mathematics education researchers to focus on teachers' and students' beliefs about teaching and learning mathematics (Silver, 1990). This was a significant shift of emphasis from process-product research to information processing and thought process.

The process-product research efforts were intended to identify behavior characteristics that effective teachers exhibit and to explain how mathematics achievement was related to some selected teacher characteristics and efficient teaching (Everston, Emmer, and Brophy, 1980). The studies used a quantitative research design. For example, Everston et al. identified two groups of teachers -- effective teachers and less effective teachers -- and studied their behavior in classrooms, methods they used, classroom climate, and their management styles. The effective teachers were identified in terms of students' performance and the opinions of supervisors and principals. They concluded that some teacher characteristics and behaviors are associated with the achievement of their students. These studies implied a relationship between teachers' instructional practices and students' achievement in mathematics.

In contrast, qualitative researchers employed different research methodologies, such as case studies, observations, interviews, and other appropriate naturalistic methods, to understand the teaching process (Cooney, 1994). The qualitative researchers, like the quantitative researchers, were interested in identifying teacher characteristics that are associated with high achievement of students. Examples of qualitative studies include wait time, critical thinking, higher-order thinking, independent thinking, and divergent questioning techniques (Duell, 1994). The synthesized ideas from this research influenced curriculum development. Curriculum developers wanted to develop teacher characteristics that foster effective learning and high performance (NCTM, 1991).

Curriculum development was also used to instill positive attitudes toward school and school subjects. The main purpose of the curriculum reform movement was to improve school mathematics curricula, together with the teaching and learning processes (Bell, Costello, and Kuchemann, 1983). Researchers and educators started to question the effectiveness of traditional curricula and accompanying teaching methods.

A shift in emphasis from a teacher-centered to student-centered curriculum that focused on investigation inquiry methods occurred. There was also an emphasis on meaningful learning, where the student actively makes connections or links between previous knowledge and new knowledge or actively constructs concepts (NCTM, 1989). This was a significant shift from passive learning that was encouraged by behavioral learning theories. Traditionally, learning was viewed as a change of behavior brought about by observation, imitation and practice (Behr, 1980). In

contrast, in the new curriculum, learning was viewed as a reorganization of thought that was accompanied by insight. Consequently, discovery and inquiry methods were adopted as instructional strategies.

Review of Various Studies

It is important to have an understanding of how research on the attitude toward mathematics and achievements in mathematics evolved and how it is affected by gender and other factors if we are to understand specific study findings. With this understanding and knowledge, we can begin to examine the specific results of this study.

Studies of attitude toward mathematics

It has been recognized that the affective background factors play a central role in learning mathematics (McLeod, 1992). Attitude itself can affect the level of energy and aspiration (Abu-Hilal, 2000). The general relationship between attitude and achievement is based on the concept that the better the attitude a student has towards a subject or task, the higher the achievement or performance level tends to be (Schreiber, 2002).

Investigations relating mathematics achievement to attitudes toward mathematics have produced varied results. While, in some studies, a negative, or at least no distinct relationship existed between mathematics achievement and attitudes toward mathematics, other studies showed that attitude towards mathematics is a predictor of academic performance in that subject (Reynolds and Walberg, 1992).

In a review of research studies that examined the relationship between attitudes and achievement in mathematics, Aiken (1976) concluded that when attitude

scores were used as predictors of achievement, low but significant correlations were mostly reported. Aiken found this to be true at various school levels and also at the college level. He contended that "there is a dynamic interaction between attitude and ability in mathematics." In other words, Aiken believes that the relationship between attitudes and achievement is reciprocal. Not only do attitudes affect achievement, but achievement affects attitudes.

In another review of related studies, Schofield (1982) concluded that, in most studies that he reviewed, low significant correlations were found between mathematical achievement and attitudes toward mathematics. Schofield conducted a study on 850 sixth graders and their mathematics teachers in order to investigate their mathematical competence and their attitudes toward mathematics. He found that students who enjoyed mathematics tended to work hard in acquiring competence in the subject. He concluded:

> The promotion of desired cognitive outcomes (or achievement) in pupils is dependent on the prior promotion of desired affective outcomes, such as favorable attitudes toward the subject and furthermore, that teachers not possessing the desired cognitive and affective outcomes may be unable to inspire them in their pupils. (p.462)

Many other studies found significant relationships between attitudes and achievement in mathematics (Hammouri, 2004; Ma and Xu, 2004; Tapia and Marsh, 2000; Kim and Hocevar, 1998; Ma, 1997). Few researchers reported that there is no relationship between these two variables (Autry, 2002).

Ma (1997). Ma investigated the reciprocal relationship between attitude toward mathematics and mathematics achievement, with a sample of 1,044 high school seniors. The results indicated that the reciprocal or interactive nature between

attitude toward mathematics and mathematics achievement could substantially modify their causal relationship. A unilateral relationship is likely to overestimate the causal effect between attitude toward mathematics and mathematics achievement.

Vanayan, White, and Teper (1997). Vanayan et al. conducted a survey on attitudes toward mathematics of third- and fifth-grade students enrolled in a large urban school district in Ontario, Canada. The survey addressed: (a) students' enjoyment of mathematics in general, (b) perceived competence at mathematics, and (c) the perceived importance, usefulness, and relevance of mathematics. A total of 1,344 third-grade students (679 girls and 665 boys) and 1,412 fifth-grade students (745 girls and 667 boys) participated in the survey. A sample was randomly selected for further analyses with 660 girls and 660 boys from each grade selected. The authors categorized the survey items into three sections: (a) liking mathematics, (b) perceived mathematics competence, and (c) beliefs regarding the relevance of mathematics. The results indicate that more boys than girls consider themselves to be "good" at mathematics, even though no gender differences were observed on many other variables including "liking mathematics."

Randhawa, Beamer, and Lundberg (1993). Randhawa et al. also examined the role of self-efficacy as a mediator between attitudes and mathematics achievement, with a sample of 225 (117 male and 108 female) high school students enrolled in 12th grade, whose ages ranged from 17 to 19 years old. The results demonstrated that mathematics self-efficacy among boys was statistically superior to that of girls, which resulted in their better performance in mathematics.

Tapia and Marsh (2000). Tapia and Marsh examined the effects of gender, mathematical achievement, and ethnicity on attitudes toward mathematics with the use of an inventory called Attitudes Toward Mathematics Instrument (ATMI). The four factors of math attitude as dependent variables included self-confidence, value, motivation, and enjoyment of mathematics. The sample size of this study was 545 high school students (302 boys and 243 girls) from grades 9 through 12, attending a private, bilingual college preparatory school in Mexico City, Mexico. The results indicate that gender has an overall significant effect on two factors of ATMI. Male students scored higher than female student on self-confidence and value.

Ma and Xu (2004). Ma and Xu examined the causal ordering (predominance) between attitude toward mathematics and achievement in mathematics in secondary school (grades 7 through 12). The researchers used data from the Longitudinal Study of American Youth (LSAY), a national 6-year panel study of mathematics and science education in public middle and high schools in the United States. The sample size was 3,116 students (1,626 males and 1,490 females). In each of the 6 years, students took an achievement test that measured their performance in mathematics, and they completed a student questionnaire that covered a wide range of measures, including attitude toward mathematics. The results indicate that both the effect of prior attitude on later attitude and the effect of prior achievement on later achievement were significant across grades 7-12. More important, prior achievement significantly predicted later attitude across grades 7-12. Prior attitude, by contrast, did not meaningfully predict later achievement. They concluded that achievement

demonstrated causal predominance (priority) over attitude in the entire secondary school.

Hammouri (2004). Hammouri examined the effects of student-related variables on achievement in mathematics. The sample consisted of 3,736 13-year-old, eight-grade Jordanian students, who participated in the Third International Mathematic and Science Study (TIMSS). The participating students completed questionnaires on home and school experiences related to learning mathematics. The survey addressed their mothers' perceptions of mathematics importance, attitudes towards mathematics, and self-perception of mathematics importance. The results indicate a strong positive correlation between the mothers' perception of the importance of mathematics and mathematics achievement. Students, who believed that his/her mother thought that doing well in math was important for him/her, was more likely to achieve higher scores. The researcher found a positive correlation between mathematics achievement and attitude towards mathematics. This means that the more positive attitudes students had, the higher the scores they were likely to achieve in mathematics.

Autry (2002). Autry examined first-grade student achievement in mathematics and attitudes toward mathematics using different instructional approaches. Two classes, each comprised of 22 first-graders, were used for this study. One class was taught by a teacher using a direct instruction approach, while the other class was taught by a teacher using a constructivist approach. In the constructivist approach, the teacher modeled strategies rather than presenting a finished product (as in the direct instruction classroom). One method lets the students present suggestions

and try their ideas to determine why they do or do not work. The researcher found no significant correlation between the achievement and attitude of students toward mathematics in the constructivist classroom. Also, no correlation was found between the achievement and attitude of students in the direct instruction classroom. These findings suggest that the method of instruction between constructivist and direct instruction classroom environment does not affect the attitude of students towards mathematics.

Schreiber (2002). Schreiber examined the relationships among advanced mathematics achievement and student and institutional (school) factors. The sample size was 1,839 12th-grade students from 162 schools. The data were obtained from the Third International Mathematics and Science Study Population (TIMSS). The results indicate that, on average, student attitude toward mathematics was significantly and negatively related to advanced mathematics achievement; students with poor attitudes toward mathematics tended to perform lower on the test.

Shymansky, Yore, and Anderson (2000). Shymansky et al. examined the changes of student science attitude, awareness, and achievement by implementation of interactive-constructivist teaching strategies, using data from TIMSS. Results indicate no significant difference exists between strategies and attitude, awareness, or achievement.

Lokan and Greenwood (2000). Lokan and Greenwood analyzed results from the Third International Mathematics and Science Study (TIMSS) for Australia and noted that the importance of student attitude towards mathematics is reinforced by TIMSS findings.

Gadalla (1999). Gadalla analyzed the TIMSS data and found that attitude factors explain only a very small percentage of the observed variation in mathematics achievement at age 9, but attitude explained more of the variation in mathematics achievement at age 13.

Abu-Hilal (2000). Abu-Hilal tested the structure of attitudes to school subjects and the causal relationship between attitudes, level of aspiration (goal) and achievement. The sample size was 280 students (121 boys, 159 girls), who were randomly selected from a comprehensive high school in the State of California. The sample was drawn from grades 9, 11, and 12. Prior to sitting for achievement-standardized tests in reading, writing, and math, the subjects responded to an instrument, designed to measure attitudes towards four subjects (English, math, science, and social study) and towards school in general. The results indicate that attitudes towards school subjects have substantial influence on the level of aspiration. Students, who believed that the four subjects are important to them, currently and in the future, had higher level of aspiration. Academic attitudes had very small direct effect on achievement. However, the former had significant direct effect on achievement via level of aspiration. The level of aspiration had a significant effect on achievement, indicating that students with higher level of aspiration had better achievement.

Papanastasiou (2000). Papanastasiou studied the effect of attitude and beliefs on mathematics achievement. This study sampled 1,026 eighth-grade students in Cyprus, 4,980 in Japan, and 5,249 in the United States. The results show that the great majority of students in Cyprus (approximately 80%) have positive attitudes toward

mathematics; in fact, this is one of the highest percentages found among the countries that participated in the study. On the other hand, the level of student achievement falls between 165 and 769, with an average of 474 and SD = 88. Therefore, although attitudes were positive for the majority of the students, achievement did not duplicate the pattern. The same pattern, but in reverse, appeared in Japan. The results show that almost half (48%) of the students in Japan have negative attitudes toward mathematics; in fact, this is the lowest percentage found among the participating countries. On the other hand, the level of student achievement in Japan falls between 245 (80 points higher than Cyprus) and 891 (121 points higher than Cyprus), with an average of 604 and SD= 122. Therefore, although attitudes were negative for half of the students, achievement did not follow that pattern. In the case of the United States, the lowest student grade was 172 points (7 points higher than Cyprus), and the highest grade was 817 (48 points higher than Cyprus). One possible explanation is that teachers in Cyprus and Cypriot society, in general, have low expectations for their students, who thus can easily satisfy the requirements demanded by the educational system. Because of this attitude of the teachers and society, the students feel comfortable with their level of achievement and, as a result, develop positive attitude toward mathematics. The opposite, however, happens in Japan. Teachers in Japan, the educational system, and, perhaps, the family have very high expectations, which students struggle to fulfill. As a result, Japanese students develop negative attitudes toward mathematics. From this study, it appears that mathematics achievement cannot be influenced to a great extent by the student's attitudes or beliefs.

Gender differences in mathematics achievement studies.

The following studies examine the effect that gender plays on achievements in mathematics.

Fennema and Carpenter (1981). Fennema and Carpenter reported the results of the 1978 mathematics assessment of the National Assessment of Educational Progress (NAEP), which involved a nationally representative sample of more than 70,000 students at the ages of 9, 13, and 17. Although no distinct pattern of gender differences was demonstrated at the ages of 9 and 13, the results did indicate that females in these two age groups averaged higher scores in number and numeration skills; whereas, males averaged higher scores on word problems, geometry, and measurement exercises. However, at age 17, the mean performance of males was higher than that of females in all areas of mathematics achievement.

Feingold (1988). Feingold examined gender differences in cognitive abilities, using the four standardization samples of the Differential Aptitude Test and the Preliminary Scholastic Aptitude Test. These results indicate that girls have higher mean scores in grammar, spelling, and perceptual speed; whereas, boys have higher mean scores in spatial visualization, high school mathematics, and mechanical aptitude. The results further indicate that these gender differences have declined over the last 35 years. Also, previously reported increases in cognitive gender differences during high school years have declined. However, one important exception to the decreasing gender differences is the difference in favor of males in the upper levels of performance in high school mathematics. According to Feingold, this gender gap in high school mathematics remained consistent from 1960 to 1983.

Fennema, Peterson, Carpenter, and Lubinski (1990). Fennema et al. interviewed 38 first-grade teachers who were asked to recognize their two most and least successful girls and boys in mathematics, to attribute causation of these students' successes and failures, and to describe the students' characteristics. Teachers' choices of most and least successful student were contrasted to mathematic test scores of their students. The subjects for this study were 38 first-grade female teachers in 24 schools in the United States. Through the attribution interview, 8% of the teachers chose no boys for their free choice selection of most successful math students, while 45% of the teachers chose no girls. A boy was selected first as most successful 79% of the time, and a boy was selected second 58% of the time. When choosing least successful mathematics students, 82% of teachers chose at least one boy while 61% of the teachers chose at least one girl. Thus, boys tended to be chosen more often as both most and least successful mathematics students. The results indicate that the gender differences were not evident in choice of least successful students. On the other hand, with most successful students, teachers were more precise with girls than with boys (13 imprecise choices of girls vs. 24 imprecise choices of boys). These teachers appear to have more precise knowledge of achievement of highly successful girls than of highly successful boys.

Sadker and Sadker (1994). Sadker and Sadker contend that the longer girls stay in school, the further behind they fall in mathematics. Sadker and Sadker write, "Females are the only group in America to begin school testing ahead and leave having fallen behind."

The American Association of University Women (1999). The AAUW conducted a review of the Third International Mathematics and Science Study (TIMSS). This is an achievement test that was given to 500,000 fourth, eighth, and 12th graders in 41 nations. According to AAUW, the gender gap in the field of mathematics increases with age. A gender gap in mathematics is nonexistent in fourth grade, but by 12th grade, males had a significantly higher average achievement than females in mathematics. There were also significant gender gaps in "special" fields, which would include higher, more advanced mathematics classes.

Wiest (2001). Wiest agrees that boys are ahead of girls in math and claims that girls are fine in math until they reach the middle school grades when their math achievement scores begin to decline.

The Council for School Performance (2001). The CSP, an organization founded to examine math proficiency level in the State of Georgia, found that the most critical time for the development of a gender gap in mathematics is during adolescence. This is especially crucial in the seventh grade, when girls' math performance begins to decline. Some feel that although the gap begins in middle school, it widens, as students get older.

Alkhateeb (2001). Alkhateeb explored gender differences in mathematics achievement of students in the last grade of high school and changes in these differences over a 10-year period in United Arab Emirates. A random sample of 2,000 students -- 100 males and 100 females for each of the 10 academic years -- was taken from Ministry of Education records, and achievement results for males and females were compared. The results indicate that high school females outperformed

males in mathematics achievement, in contrast with the general result of several studies in which males usually outperformed females. Findings from this study indicate a decline of gender difference in high school final mathematic achievement; and, more precisely, the gender gap for achievement test scores appears to be closing.

Xiaoxia (2002). Xiaoxia focused on gender differences in growth in mathematics achievement to various social-psychological factors. The study involved a sample of 3,116 seventh graders, randomly selected from 52 public schools. This group of students was followed through to the end of their high school years (i.e., from Grades 7 to 12). However, for this study, only data from Grade 7 to Grade 10 were used. Results indicate that gender differences in growth in mathematics varied by one's initial status in mathematics. For those who started low, girls started higher than boys, but their average growth rate was slightly lower than boys. Although the average gender gap in growth rate was not statistically significant, the gap varied across schools. In some schools girls' average growth rates were higher; whereas, in other schools, boys' average growth rates were higher. For those who started high, there were no gender differences in initial status and growth rate. However, the effect of math attitude and math teacher encouragement for mathematics differed for boys and girls who started high. The effect of attitude towards mathematics was stronger for boys than for girls. The effect of math teacher encouragement on mathematics varied across schools for boys, but no math teacher encouragement effect was found for girls. Results also show that home resources, individual behavior problems, and attitude toward mathematics were related to growth in mathematics. In addition, aggregated school resources had significant effect on growth in mathematics.

Sprigler and Alsup (2004). Sprigler and Alsup designed a study to detect any difference between elementary girls and boys in the mathematical reasoning ability sub-skills of analysis- synthesis. This study involved 120 boys and 119 girls (grades 1-5), from a moderate-sized rural community in South Dakota. The results indicate that students at the elementary level do not demonstrate a gender difference in the sub-skill of analysis-synthesis; the lack of difference between genders would add support to findings that gender differences begin at the middle school. Also, this study found that when time constraints are removed, girls perform as well as boys.

Other factors that affect mathematics achievement.

Barbara (1996). Barbara interviewed high school students to investigate the interaction of ethnicity, mathematics achievement, socioeconomic status (SES), and gender on mathematics attitudes. The results of this survey of 100 high school students indicate that the significant reported interactions involve mathematics achievement; however, mathematics coursework and achievement level are not commonly studied when reporting socioeconomic, gender, or ethnic differences of mathematics attitudes. Males are more likely than females to attribute inherent constructs as reasons for their mathematics grade.

Kim and Hocevar (1998). Kim and Hocevar examined racial differences in mathematics achievement to determine whether the mean scores of mathematics achievement, exposure to instruction, attitude toward mathematics, and parental support were different for African-American and for European-American students. The study sampled 683 African-American students and 683 randomly chosen European-American students from the United States population, who represented age

13 in the Second International Mathematics Study (SIMS). The following findings stood out in this study: first, African-American students perceived themselves as having had significantly less exposure than did European-American students (exposure is a significant determinant of achievement in mathematics). Second, African-American students scored significantly lower in achievement than European-American students. Third, parental support was a significant determinant of attitude toward mathematics for both African-American and European-American students, and the attitude toward mathematics factor was significantly correlated with achievement.

The Educational Testing Service (2001). The ETS conducted a study that attempted to identify any gender differences within various racial groups. According to ETS, males in all racial and ethnic groups outscored females on the SAT I Mathematics Test. The average gender gap in all ethnic groups was between 32 and 38 points. The lowest point difference was found between black males and black females, with only 19 points separating the scores. The greatest point difference was between Latin-American males and females with a spread of 55 points. ETS also found that within all ethnic groups males outscored females on the GRE Quantitative Mathematics Test. For this test, ETS found that white males outperformed white females by 70 points, while black males outscored black females by 43 points.

Rowe (1988). Rowe examined the effects of single-sex and mixed-sex classes on student achievement, confidence, and participation in mathematics. The subjects were seventh grade (N=189) and eighth grade (N=209) student groups, randomly allocated to either single-sex classes or mixed-sex classes. The results indicate that

gender differences in mathematics achievement and confidence on the three test occasions were not significant, although boys commonly gained higher scores than girls on both the mathematics achievement and confidence measures (but not significantly higher). Further, the results indicate a strong relationship between achievement and confidence, with confidence being a significant predictor of achievement, especially for students in single-sex classes. Additionally, the change in mathematics achievement overtime, independent of confidence, was similar for all students regardless of class type, and there was significant class-type effect on students' confidence in learning and using mathematics, independent of achievement. Students in single-sex classes indicate significantly higher gains in confidence over time than those in mixed-sex classes.

Leder and Forgasz (1994). Leder and Forgasz examined both the short- and long-term effects on students' attitudes and performance in mathematics with the introduction of single-sex mathematics classes in the Grade 10. The subjects were from a co-educational state school in the outer area of Melbourne, Australia, with a sample of 82 males and 84 females. The results indicated that more females than males rated themselves average at mathematics, while more males than females rated themselves excellent. Also, more males than females indicated that their classmates would probably think they were excellent at mathematics.

The Australian Council for Educational Research (2001). The Australian Council for Educational Research released in 2001 an elaborate comparison of single-sex and coed schools. The study covered six years, considered 53 academic subjects and included more than 270,000 students. The results showed that boys and girls who

attended single-sex classes averaged scores that were 15 to 22 percentile ranks higher than boys and girls who attended coed classes.

England's National Foundation for Educational Research (2002). England's National Foundation for Educational Research studied almost 3,000 high schools throughout England in 2002 to determine the effects of single-sex education. The study concluded that both girls and boys performed substantially better in single-sex schools than in coed schools. The documented experiences of many individual schools also support the conclusion that single-sex education can help boys and girls learn better.

Ayalon (2003). Ayalon studied the effect of the courses taken in mathematics and science in high school on the gender gap in fields of study at the university, with a sample of 6,139 students. The results indicate that women are underrepresented among the applicants to the mathematics-related fields of study; mathematical background in high school is particularly effective in narrowing the gender gap in applying to selective and attractive, but not mathematically related, fields of study at the university; women rely on high qualifications more than men when applying to selective and male-dominated fields of study.

Summary

It is obvious from this literature review that there are few current papers and dissertations explaining the relationship between students' attitudes toward learning mathematics and mathematics achievement with respect to gender in Jordan. This means that this study will contribute greatly to the knowledge of mathematics

education research in Jordan in general, and the relationship between students' attitudes toward learning mathematics and mathematics achievement, in particular.

Knowledge of students' attitudes toward mathematics can be used as a base for meaningful in-service and pre-service programs, enabling teachers to learn to provide their students with effective instructions. Also, because the educational system in Jordan is not gender mixed, the findings of this study are expected to provide information to the Ministry of Education about gender differences, as well as to the educational institutions that deal with teacher preparation.

Mathematics teachers in Jordan are expected to benefit from this study. This study will provide them with recent information about the influence of attitude on the learning of mathematics. Thus, the teacher must assume a large part of both the responsibility and challenge of development of positive attitude of students towards mathematics.

Chapter Three

Methodology

In this study, the researcher explored Jordanian students' attitudes toward learning mathematics and investigated the relationship between students' attitudes toward learning mathematics and mathematics achievement using interview data and quantitative methods. The sample was selected from tenth grade students in Amman, Jordan. Three instruments were used in this study: a mathematics achievement test adapted by the researcher from the (2004) Ohio Graduation Practice Test (see Appendix A), an attitude scale developed by Taylor (1997) from the Aiken Scale (1976) (see Appendix B), and interviews of students (see Appendix C).

This chapter describes the methodology, which was used in the study, including the sample, the instruments used, the pilot study, the data collection procedures, and the data analysis procedures.

Research Questions

Interview data and quantitative methods were used to answer the following research questions:

1. What are Jordanian male students' attitudes toward learning mathematics?
2. What are Jordanian female students' attitudes toward learning mathematics?
3. What are the differences and similarities between Jordanian male students' attitudes and Jordanian female students' toward learning mathematics?
4. Is there significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement?

5. Are there significant differences between Jordanian males and females on a combination of students' attitudes towards learning mathematics and mathematics achievement?

Research Hypotheses

For the first three research questions identified above, a qualitative methodology will be used and therefore hypotheses are not listed.

The following null hypotheses are identified for the last two research questions.

H01: Null hypotheses

There is no significant correlation between Jordanian male and female students' attitudes towards learning mathematics and mathematics achievement.

H02: Null hypotheses

There are no significant differences between Jordanian males and females on a combination of students' attitudes towards learning mathematics and mathematics achievement.

The Population and Sample

The population of this study was 10^{th}-grade students who were studying in the academic year 2004-2005 in Amman, Jordan. According to the educational system in Jordan, the 10th-grade is the last year before students choose to study in the scientific or literary branch.

The sample consisted of 306 10^{th}-grade students (153 females and 153 males). In order to have a representative sample of students, the stratified random sampling technique was used to ensure that each individual in the defined population have an

equal and independent chance of being selected as a member of the sample (Best and Kahn, 1998). The researcher used as a co-researcher, a representative in Jordan, who has been a Professor in Jordan for 20 years. The co-researcher was used to collect data for this study.

The schools used in this study were selected randomly. First, the co-researcher received the names of male and female schools and permission for involving students in this study from the Ministry of Education in Amman. Next, the co-researcher randomly selected four male and four female schools. Finally, the co-researcher contacted the principals of each school to ask for permission to collect data in their schools.

The schools in which to conduct the interviews were also selected randomly from the same schools of the sample. The co-researcher asked students to volunteer for the interviews from the selected schools. More than six students volunteered, the co-researcher picked at random six males for interviews. In a similar procedure, the co-researcher selected six females for interviews.

Stevens (1996) acknowledged that the sample size is determined by several factors: the desired power, alpha level for controlling Type I error (the probability of rejecting the null hypotheses when it is true), effect size, and the number of variables used in the analysis.

To get a desired power of 0.80, with moderate effect size 0.25, and an alpha level 0.05, according to Cohen (1987), the required sample for this study is approximately 130 students. According to Tuckman (1999), the reasonable expected percentage of sample subject who will return or answer the questionnaire is about

80%. Also, the researcher did not expect more than 85% to answer the achievement test and attitude scale seriously or appropriately. Therefore, the test and the questionnaire were distributed to about 350 participants to alleviate this problem.

Instruments

Three instruments were used in the study; a mathematics achievement test (see Appendix A) consisting of items selected by the researcher from the (2004) Ohio Graduation Practice Test (see Appendix A), an attitude questionnaire (see Appendix B), which was developed by Taylor (1997) from the Aiken Scale (1976), and student interviews developed by the researcher (see Appendix C).

The Mathematics Achievement Test (MAT) used to measure mathematics achievement was a modified version of the (2004) Ohio Graduation Practice Test. It consisted of 20 questions; all of them multiple-choice, scored at 1 point each. Gronlund (1998) stated that "the multiple-choice item can be used to measure knowledge outcomes and various types of complex learning outcomes. The single item format is probably most widely used for measuring knowledge, comprehension, and application outcomes" (p.61).

The (2004) Ohio Graduation Practice Test consists of 44 questions available on the Ohio Department of Education website. The researcher selected 20 questions from it to assess his subjects' knowledge of mathematics achievement. Those questions were selected to be in agreement with the mathematics curriculum that is used in the 10th grade in Jordan. The highest possible score is 20 on the MAT, and the lowest possible score is 0.

Aiken's Attitudes Toward Mathematics (ATM) scale was used to measure attitude. The scale consisted of 24 items in a 5-point Likert-style format. The responses ranged from strongly disagree to strongly agree (1-5). Thus, the highest possible score is 120, and the lowest possible score is 24. Taylor (1997) noted that the Aiken Attitude Toward Mathematics was administered to 430 adult students enrolled in a tertiary preparation program. The factorial validity of the scale was examined by grouping factor analysis using principal axis technique with contrast max rotation. Two factors (enjoyment and value) were extracted with high reliability.

The researcher designed interview questions to be used with 12 students. The questions were designed to give the researcher insight into the attitudes of the students toward learning mathematics.

The MAT, the ATM, and interview questions were originally constructed in English, but because the language of the subjects was Arabic; they were translated to Arabic to make it easier for the subjects to understand. First, the researcher translated them, because his native language is Arabic, and then the co- researcher gave the instruments to two linguistic teachers in Amman to check the translation from English to Arabic and make any needed correction or clarification. Second, the co-researcher, after translation to Arabic, gave the Arabic version of the instruments to five mathematics teachers to check whether the questions were appropriate for the 10th-grade students and to ask for comments.

Pilot Study

The researcher attempted to determine whether the instruments were of high quality and appropriate for male and female 10th-grade students. Also, the researcher

examined the validity and reliability of the instruments and determined whether there were any confusing or unclear items. Five mathematics teachers, who currently teach 10th grade in Jordan for the 2004-2005 academic year, were asked to review the instruments to be sure that they achieved high content validity. Also, 50 male and female 10th-grade students in Amman school district participated in a pilot study. The Arabic version was used for the pilot study for three reasons. First, the native language for the subjects of this study was Arabic. Second, the validity and reliability would be more appropriate, because Arabic would be the language of the instruments used to collect the data. Third, the researcher could better observe the weaknesses and strengths of the instruments.

After receiving the responses from the sample in the pilot study, the researcher examined the reliability of the questionnaire. The comments and suggestions from the sample were collected and classified to check which were most frequently reported.

The result of the pilot study showed that the time the students needed to complete the achievement test ranged from 50-60 minutes, and the attitude toward learning mathematics item ranged from 15-20 minutes. Some teachers made comments, which assisted in improving the clarity of the achievement test. In general, this pilot study provided the researcher with important insights on how to modify and administer the study.

Validity pertains to the degree to which a test or instrument measures what is supposed to measure. Oosterhof (1994) stated that, “If a test does not measure what is

supposed to measure, it is useless. Validity is the most important quality in the development, interpretation, and use of educational measure" (p.53).

The content validity in this study was developed by submitting the achievement test (Arabic version) to five mathematics teachers, who teach 10^{th} grade, to review the instrument to be sure that the test had achieved content validity. The co-researcher asked them to validate the content by determining whether any items were missing or needed to be added. Depending on their comments and suggestions, the achievement test was revised.

Reliability refers to the degree to which the instrument measures phenomena in a consistent manner (Oosterhof, 1994). In order to estimate the consistency of the items of the questionnaire, the coefficient alpha (Cronbach's Alpha) of internal consistency was used. The researcher conducted a pilot test after the questionnaire was revised by experts and submitted the instruments to 25 male students and 25 female students from the targeted population.

The aim of the pilot study was to examine the reliability of the instruments; attitude toward learning mathematics and mathematics achievement test before distributing them to the subjects of the study. Fifty students were selected, 25 males and 25 females, from two schools to answer the pilot study. According to their answers, the reliability of the achievement test returned a coefficient alpha of 0.63. Also, the reliability of the attitude toward learning mathematics returned an acceptable coefficient alpha 0.92 (see Appendix D).

Data Collection Procedures

The Ministry of Education was contacted to request written permission to conduct the research study in Amman, Jordan. After receiving permission, schools and students were selected as described earlier. With the permission of the principals, the co-researcher solicited help from teachers in administering the questionnaires. With the help of principals and teachers, the questionnaires were completed. The co-researcher then held individual interviews with the students selected for interview.

Data Analysis Procedures

To answer the first three research questions, the researcher analyzed responses to each interview question based on both notes and the audio-tapes of each interview. The researcher decided that instead of using the real names of the students he would use a code for each student in the analyses. Additionally, responses to each item on the ATM scale were analyzed using descriptive statistics.

To answer the last two research questions, the researcher used the Statistical Package for the Social Sciences (SPSS) version 11.0. Four types of analysis were used in this study:

1. The coefficient alpha (Cornbach's Alpha) reliability test was used to measure the attitude and mathematics achievement, the two dependent variables.
2. Descriptive statistics such as percentage, frequencies, means, and standard deviations will be reported for gender, the independent variable of the study.
3. In addition to descriptive statistics, inferential statistics were used to analyze the data. In this study, one-way multivariate analysis for variance (MANOVA) was used to test the hypothesis. The reason for using one-way

MANOVA was that this study has two dependent variables (attitude and mathematics achievement) with one related independent variable (gender).

4. The differences between students' attitude toward learning mathematics and mathematics achievement were examined by using the Pearson correlation procedure.

Summary

This chapter discusses the research methodology used to collect the data for this study, identification of the population, and description of the sample including the required for this study. This chapter also discusses the three instruments, which were Attitude Toward Mathematics Scale (ATM), the Mathematics Achievement Test (MAT) and the students' interview. Translation of the instruments, the pilot study, including a reliability of the questionnaire, validity of the questionnaire, data collection procedures, and data analysis procedures are also discussed.

Chapter Four

Analysis and Results

This chapter presents the results of the analysis of the data collected from 10th-grade students in Amman, Jordan. The study used interview data and quantitative methods to answer the following questions:

1. What are Jordanian male students' attitudes toward learning mathematics?
2. What are Jordanian female students' attitudes toward learning mathematics?
3. What are the differences and similarities between Jordanian male students' attitudes and Jordanian female students' toward learning mathematics?
4. Is there significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement?
5. Are there significant differences between Jordanian males and females on a combination of students' attitudes towards learning mathematics and mathematics achievement?

The sample was composed of male and female 10th-grade students in Amman, Jordan. The sample size of the study was 350 students, 175 males and 175 females. Eight schools (four schools for males and four schools for females) were randomly selected. All students in the eight schools were given the Mathematics Achievement Test (MAT) and the Aiken Attitude Toward Mathematics (ATM) scale. However, 44 individuals were excluded because of missing data (e.g., not completing the instrument seriously). Some students responded to the attitude scale by selecting only one column, such as agree for all 24 items, and some of them did not respond to all

items. Accordingly, the final sample size was 306 students (153 males and 153 females).

The instruments for the study consisted of the 20-item MAT and the 24-item ATM. In order to estimate the consistency of the items of the questionnaire, the coefficient alpha (Cronbach's Alpha) of internal consistency for the MAT was calculated at 0.63 and for the ATM at 0.92. Both coefficients indicated that internal consistency of the instruments had an acceptable level of reliability (see Appendix D).

Qualitative Data from Interviews

The main purpose of the interviews was to further understand the findings of the quantitative element. The interviews were conducted with 10th-grade students, six males and six females, each interview lasted approximately 20 minutes. Subjects were from two schools, one for males and one for females. Table 3 categorizes the interview subjects by gender and code.

Table 3

Interview Categorization by Gender and Code

Student	Code	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Gender		M	M	M	M	M	M	F	F	F	F	F	F

(M = Male student and F = Female student)

The co-researcher began the interviews with a brief explanation about the study and the reason for the interview. The following summarizes the students' responses to the interview questions.

1. When did you start studying mathematics? Before entering school, did you know how to count or anything related to math?

Three male (S1, S3, and S6) and four female (S8, S9, S11, and S12) students responded that they began learning mathematics while they were in kindergarten. Three male (S2, S4, and S5) and two female (S7 and S10) students started learning mathematics while they were in the first grade. Overall, the students all reported that they knew little about mathematics prior to entering school, but all indicated knowing how to count from 1 to 10 and some simple geometrical shapes.

2. Did anyone change your thinking about mathematics (e.g., your teacher, dad, and friend)? Why or why not?

The responses of three male (S1, S4, and S6) and four female (S7, S8, S9, and S10) students were that their math teachers affected their attitude toward mathematics, because these teachers tried to make mathematics easier to understand by teaching them more about mathematics than simply how to solve problems. The other five subjects, three male (S2, S3, and S5) and two female (S11and S12) students responded that their parents affected their attitude toward mathematics by teaching them at home, clarifying the difficult part of mathematics when they needed help, and through explaining the importance of mathematics in their future studies.

3. Do you like mathematics? Why or why not?

The response of one male (S2) and one female (S10) student was no. In response to the second portion of the question, which asked why they did not like mathematics, they said, “because it is a difficult subject, and I don’t understand it.” The responses of the five other males (S1, S3, S4, S5, and S6) and five female (S7, S8, S9, S11, and

S12) students were yes. They indicated that they liked mathematics because they believed it is a very important subject for their future studies and requires understanding rather than memorization; therefore, mathematics allows students to use their thinking skills to get the right answer.

4. What mathematics subjects do you like (geometry, algebra, statistics, etc)? Why?

One male (S3) and two female (S7 and S12) students preferred geometry. In response to the second portion of the question, which asked why they preferred geometry, they stated that they prefer geometry because "it is fun and easy at the same time." Four male (S1, S4, S5, and S6) and four female (S8, S9, S10, and S11) students preferred algebra because they like to solve equations rather than drawing and solving geometrical problems. One male student (S2) said, "I prefer statistics because it requires thinking and is easy to understand."

5. Do you think to be good in math you have to be good and fast in solving puzzles? Why or why not?

Three male (S1, S2, and S5) and five female students (S7, S9, S10, S11, and S12) responded "no" to this question. They indicated that they believed that there was no relationship between mathematics and puzzles. One male (S3) and one female (S8) student said, "Puzzles need to be solved quickly, but mathematics needs more thinking." Two male students (S4 and S6) answered, "yes" to this question, because they believed that in order to be good and fast in solving puzzles, one must also be good in mathematics.

6. Do you think to be good in math you have to do all mathematics homework correctly without any mistakes? Why or why not?

Three male (S1, S2, and S5) and four female (S7, S9, S11, and S12) students responded "no" to this question. In responding to the second part of the question, which asked why or why not, they all had the same idea "because homework is done to learn from our mistakes." Three male (S3, S4, and S6) and two female (S8 and S10) students responded "yes" to this question, because they believed by practicing more they learn more.

7. Which of the following statements would you choose and why?
    a. Math is a fun subject.
    b. Math is not a fun subject.

All of the male and female students agreed with the first statement that "math is a fun subject." For the second part of the question, which asked why, they had the same opinion stating, "Mathematics problems are always a challenge for students to solve. Solving problems makes us happy about ourselves and motivates us to solve more problems."

8. Do you think mathematics is an important subject for your future life? Why or why not?

Six male (S1, S2, S3, S4, S5, and S6) and four female (S7, S9, S11, and S12) students answered "yes" to this question, because they believe that "mathematics is a very important subject in other courses like chemistry and physics. It is also important in their daily life and for their future careers." One male student (S5) said, "I am planning to study computer engineering, and mathematics is important for this major." Two female students (S8, and S10) responded "no" to this question and

stated, “We are not planning to major in any math related subjects at the university, and we do not believe more mathematics courses are necessary beyond high school.”

9. Do you think mathematics is more difficult than other subjects? Why or why not?

Three male (S1, S5, and S6) and four female (S7, S8, S10, and S11) students answered “no” to this question because they believe some courses, such as physics, are more difficult than mathematics. However, this depends on the students’ beliefs; some students dislike it so they find it difficult to understand, while other students prefer it and study hard to understand it. Three male (S2, S3, and S4) and two female (S9 and S12) students responded “yes” to this question; they believed mathematics requires more understanding, while other subjects require more memorization.

10. How do you feel during mathematics exams, and do you know how other students feel during mathematics exams? Why?

Four male students (S2, S4, S5, and S6) said they “were relaxed in their math exams,” because they always prepared in adequate time, and if there was a hard problem, they would ask the teacher or a friend to clarify it. Two male (S1 and S3) and six female (S7, S8, S9, S10, S11, and S12) students responded to this question by saying “mathematics exams make them uncomfortable, “because they are afraid of failing the course or because the exam was too difficult. For the second part of the question that asked if they knew how other students felt during mathematic exams. All of the students responded the same, “Most students were afraid of mathematics exams, because most students dislike mathematics and do not pay enough attention.”

11. Do you like to study mathematics without taking examinations? Why or why not?

Six male (S1, S2, S3, S4, S5, and S6) and four female (S7, S8, S9, and S11) students answered "no" to this question. They stated, "By taking exams, we can recognize our understanding for the topics we have learned in the classroom. Exams provide an opportunity to learn from our mistakes." Two female students (S10 and S12) answered "yes" to this question because they believe the exams make them nervous; therefore, they are more likely get low grades.

12. How do you feel about mathematics, and do you know how other students feel about mathematics? Why?

Five male (S1, S2, S4, S5, and S6) and five female (S7, S8, S9, S10, and S12) students said, "Mathematics requires hard work to understand the concepts." Three male (S2, S4, and S6) and one female student (S10) added "feelings about mathematics depend on the teachers, because some teachers influencing students like or dislike mathematics through their methods of teaching and their interactions with students." One male (S1) and one female (S11) student said, "Mathematics is hard for them to understand." In response to the second part of the question that asked if they knew how other students feel about mathematics, all subjects agreed that most students dislike mathematics, because they do not understand it. One male student (M6) added, "Most students are scared of math, because they do not understand its symbols and its strange theories."

13. Did any math teacher affect your mathematics achievement, and how do you think mathematics teachers affect students' achievements? Why?

Six male (S1, S2, S3, S4, S5, and S6) and six female (S7, S8, S9, S10, S11, and S12) students responded "yes" to this question. They all indicated that math teachers can

influence students by using methods of teaching that help to clarify difficult parts of the course. For the second part of the question, which asked the students how they think mathematics teachers affect student achievement, all subjects indicated that math teachers should be patient and should not talk about the difficulty of mathematics in the classroom. As well, students indicated that teachers should not be quick to anger if students make mistakes.

14. Who do you think does better in mathematics, males or females? Why?

One male (S1) and one female (S9) student said, "Males do better in mathematics than females, because males are more involved in the life outside their homes, and this might increase their ability to think; therefore, their math grades will be higher than girls'. Two male (S4 and S6) and two female (S7 and S8) students said that females do better in mathematics than males, because females have more time at home and they study more (traditionally, Arab females do not have many activities outside their homes). Three male (S2, S3, and S5) and one female (S12) students said, there are no differences in mathematics achievement between males and females, because math depends on students' intelligence, and whoever has a good brain for math will get high grades, regardless of the gender. Two female students (S10, and S11) responded that they did not know whether males or females do better in mathematics.

15. Do you think there are differences between males and females toward learning mathematics? Why or why not?

One male (S6) and six female (S7, S8, S9, S10, S11, and S12) students responded "yes" to this question. These individuals indicated that females achieve better in

mathematics, because they study harder than males. Two male students (S1 and S3) responded "yes" to this question and suggested that males in Jordan have more interests in studying engineering at college and in order to succeed as an engineer students must be good in mathematics; therefore males work harder and achieve better than females. Three male students (S2, S4, and S5) said, there are no differences, because mathematics needs good thinking skills and intelligence.

Descriptive Statistics for the Aiken's Attitude Scale

The descriptive statistics represented in Table 4 illustrate the results of the attitude toward learning mathematics scale, which was developed using the Aiken Attitude Scale. This is a 24-item 5-point Likert-scale (see Appendix B). The item scale ranges from strongly disagree to strongly agree (1-5). Therefore, the maximum possible score was 120 and the minimum possible score was 24. Table 4 shows that the mean score for male students was 81.52 and the mean score for female students was 80.23. An independent t test was conducted to evaluate whether a difference in attitude toward learning mathematics among 10^{th}-grade male and female students was present in Amman, Jordan. The results indicated no significant difference in the mean scores of males' and females' attitude toward learning mathematics, $t(306) = 0.55$, $p>0.05$, as shown in Table 5.

Table 4

Mean, Standard Deviation, Minimum, and Maximum of Students' Attitude Toward Learning Mathematics of All Items

Gender	Mean	Number	S.D.	Minimum	Maximum
Male	81.52	153	19.64	38	120
Female	80.23	153	20.85	32	114
Total	80.87	306	20.23	32	120

Table 5

Independent t Test for Gender Difference in Attitude Toward Learning Mathematics

	t-test for equality of means			
	t	df	sig.	Mean diff.
Attitude	0.55	306	0.58	1.29

Further analyses of the Aiken's Attitude Scale indicated that there was a significant difference in the mean scores of only one question (question number 18) as shown in Table 6.

Table 6

Independent Samples Test of Aiken's Attitude Scale

Survey's Questions	Mean				
	Female	Male	F	t	sig.(2-tailed)
P1	3.31	3.32	2.4	0.08	0.94
P2	3.75	3.78	1.24	0.34	0.73
P3	3.91	3.93	1.09	0.3	0.77
P4	3.05	3.12	0.06	0.37	0.72
P5	3.46	3.56	1.06	0.66	0.51

P6	2.8	2.75	1.19	-0.2	0.84
P7	2.82	2.9	0.09	0.64	0.53
P8	3.08	3.35	0.29	1.75	0.08
P9	2.88	2.9	1.22	0.28	0.78
P10	3.42	3.7	2.67	1.9	0.06
P11	4.33	4.38	0.95	0.41	0.68
P12	3.03	3.11	0.15	0.45	0.66
P13	3.23	3.14	1.65	-0.29	0.77
P14	2.93	2.76	1.36	-0.91	0.37
P15	3.76	3.53	11.01	-1.48	0.14
P16	3.42	3.43	0.75	0.06	0.95
P17	3.14	3.16	0	0.2	0.84
P18	2.96	3.29	0.72	1.97	0.05
P19	3.95	4.23	0.15	1.87	0.06
P20	3.4	3.39	2.71	-0.14	0.89
P21	3.45	3.62	4.65	0.98	0.33
P22	3.37	3.26	0.59	-0.85	0.4
P23	3.4	3.41	0.71	0.02	0.99
P24	3.31	3.49	0.92	1	0.32

Table 6 also represents descriptive statistics for each question on the attitude questionnaire. The mean score for students' responses for all items was (M = 3.36). It should be noted that question 11, "Mathematics helps to develop the mind and teaches a person to think" and question 19, "Mathematics has contributed greatly to the progress of civilization" had the highest mean score for all subjects. On the other

hand, question 6, "I do not want to take any more mathematics than I absolutely have to" had the lowest mean score for all subjects.

To understand the students' responses to the interview questions and able to make connection between the qualitative and quantitative data, it is necessary to represent the frequencies and percentages of students answers to the questionnaire's questions as shown on Tables 7 to 31.

Table 7 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Slightly more than half of the males (55.5%) and more than half of the females (59.5%) disagree or strongly disagree with the statement. Figure 1 provides distribution of student responses toward the statement, "Mathematics is not a very interesting subject."

Table 7

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Is Not a Very Interesting Subject."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	32	20.9	26	17.0
A	18	11.8	26	17.0
U	18	11.8	10	6.5
D	38	24.8	59	38.6
SD	47	30.7	32	20.9
TOTAL	153	100.0	153	100.00

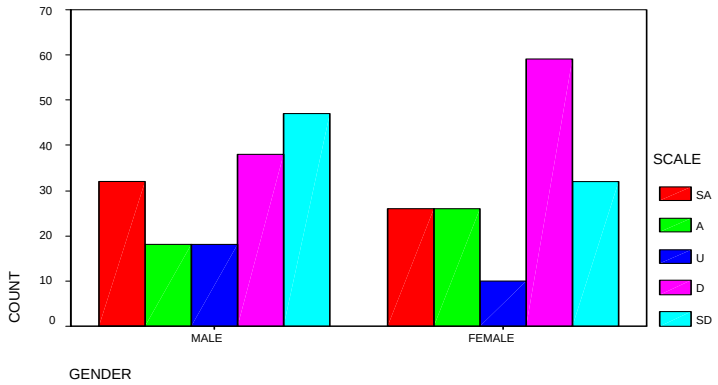

Figure 1. Distribution of student responses toward the statement, "Mathematics is not a very interesting subject."

Students were asked about the statement, "I want to develop mathematics skills and study this subject more." Table 8 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Exactly two thirds of the males (66.6%), and two thirds of the females (66%) agreed or strongly agreed with this statement. Figure 2 shows the distribution of student responses toward the statement, "I want to develop mathematics skills and study this subject more."

Table 8

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Want To Develop Mathematics Skills and Study This Subject More."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	64	41.8	56	36.6
A	38	24.8	45	29.4
U	23	15.0	25	16.3
D	11	7.2	16	10.5
SD	17	11.1	11	7.2
TOTAL	153	100.0	153	100.00

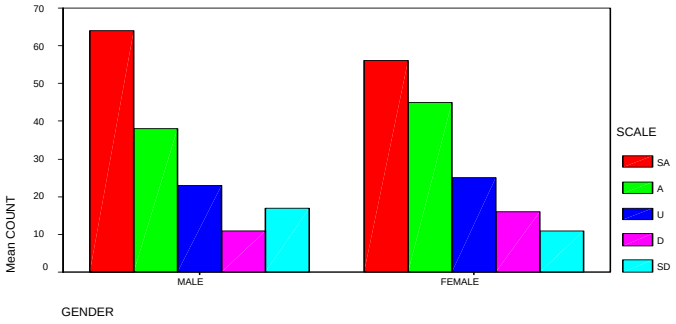

Figure 2. Distribution of student responses toward the statement, "I want to develop mathematics skills and study this subject more."

The students were asked if "Mathematics is a very worthwhile and necessary subject." Table 9 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Approximately 73% of the males and 77% of the females agreed or strongly agreed with the statement. Figure 3 show the distribution of student

responses toward the statement, “Mathematics is a very worthwhile and necessary subject.”

Table 9

Frequency and Percentage Scores of Student Responses Toward the Statement, “Mathematics Is a Very Worthwhile and Necessary Subject.”

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	75	49.0	64	41.8
A	37	24.2	55	35.9
U	15	9.8	8	5.2
D	9	5.9	9	5.9
SD	17	11.1	17	11.1
TOTAL	153	100.0	153	100.00

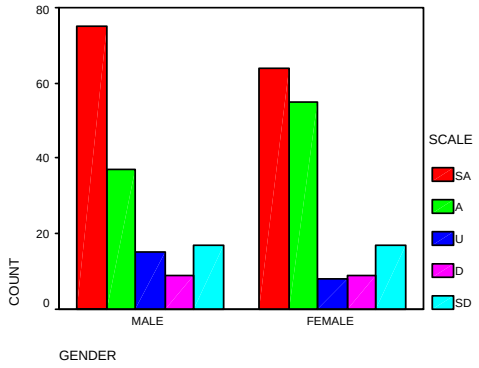

Figure 3. Distribution of student responses toward the statement, “Mathematics is a very worthwhile and necessary subject.”

The students were asked about the statement, “Mathematics makes me feel nervous and uncomfortable,” Table 10 illustrates the information based upon the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Almost less than half of the males (46.4%) and slightly less

than half if the females (47.7%) disagreed or strongly disagreed with this statement. Figure 4 shows the distribution of student responses toward the statement.

Table 10

Frequency and Percentage Scores of Student Responses Toward the Statement, ”M*athematics Makes Me Feel Nervous and Uncomfortable.”*

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	36	23.5	45	29.4
A	24	15.7	16	10.5
U	22	14.4	19	12.4
D	28	18.3	38	24.8
SD	43	28.1	35	22.9
TOTAL	153	100.0	153	100.00

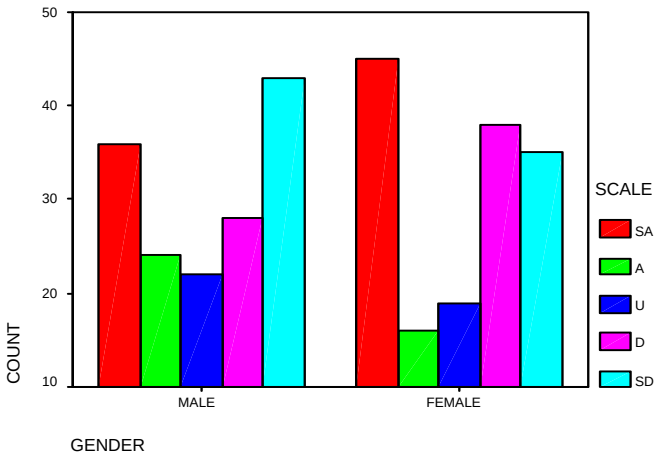

Figure 4. Distribution of student responses toward the statement, “Mathematics makes me feel nervous and uncomfortable.”

The students were asked about the statement, “I have usually enjoyed studying mathematics at school.” Table 11 illustrates the information based upon the scale

used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Almost 60% of the males and 60% of the females agreed or strongly agreed with the statement. Figure 5 shows the distribution of student responses toward the statement.

Table 11

Frequency and Percentage Scores of the Student Responses Toward the Statement, "I Have Usually Enjoyed Studying Mathematics at School."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	42	27.5	41	26.8
A	50	32.7	50	32.7
U	25	16.3	20	13.1
D	23	15.0	26	17.0
SD	13	8.5	16	10.5
TOTAL	153	100.0	153	100.00

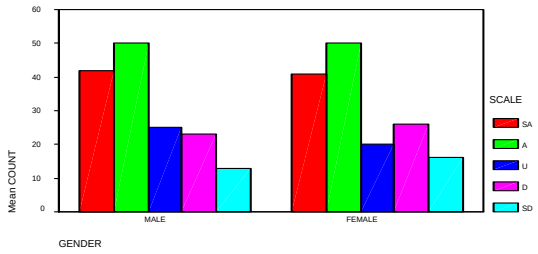

Figure 5. Distribution of student responses toward the statement, "I have usually enjoyed studying mathematics at school."

The students were asked about the statement, "I do not want to take any more mathematics than I absolutely have to." Table 12 illustrates the information based upon the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Only 36% of the males and approximately 40%

of the females disagreed or strongly disagreed with the statement. Figure 6 shows the distribution of the students' responses toward the statement.

Table 12

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Do Not Want To Take Any More Mathematics Than I Absolutely Have To."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	44	28.8	40	26.1
A	29	19.0	30	19.6
U	25	16.3	23	15.0
D	33	21.6	45	29.4
SD	22	14.4	15	9.8
TOTAL	153	100.0	153	100.0

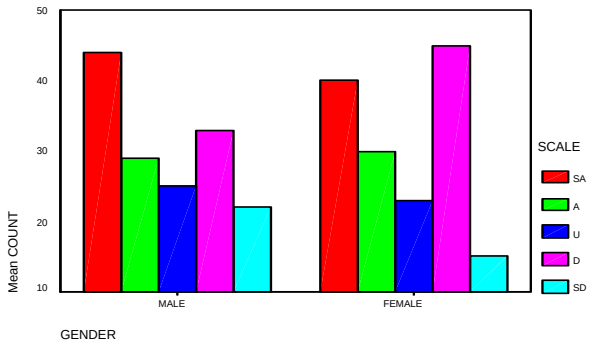

Figure 6. Distribution of the students' responses toward the statement, "I do not want to take any more mathematics than I absolutely have to."

The students were asked about the statement, "Other subjects are more important to people than mathematics." Table 13 illustrates the information based upon the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Approximately 33.3% of the males and 30.1%

of the females disagreed or strongly disagreed with this statement. Figure 7 shows the distribution of student responses toward the statement.

Table 13

Frequency and Percentage Scores of Student Responses Toward the Statement, "Other Subjects Are More Important to People than Mathematics."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	32	20.9	28	18.3
A	23	15.0	39	25.5
U	47	30.7	40	26.1
D	23	15.0	24	15.7
SD	28	18.3	22	14.4
TOTAL	153	100.0	153	100.0

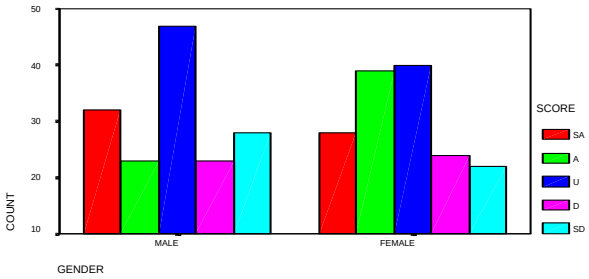

Figure 7. Distribution of student responses toward the statement, "Other subjects are more important to people than mathematics."

The students were asked about the statement, "I am very calm and unafraid when studying mathematics." Table 14 illustrates the information based upon the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Slightly more than half of the males (52.3%)

and slightly less than half of the females (47.7%) females agreed or strongly agreed with this statement. Figure 8 shows the distribution of student responses toward the statement.

Table 14

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Am Very Calm and Unafraid When Studying Mathematics."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	45	29.4	32	20.9
A	35	22.9	41	26.8
U	28	18.3	19	12.4
D	22	14.4	28	18.3
SD	23	15.0	33	21.6
TOTAL	153	100.0	153	100.0

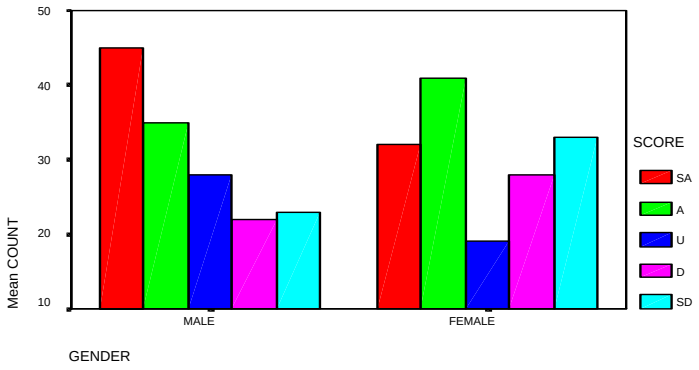

Figure 8. Distribution of student responses toward the statement, "I am very calm and unafraid when studying mathematics."

Students were asked about the statement. "I have seldom liked studying mathematics." Table 15 illustrates the information based upon the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Approximately 37.9 of the males and less than half of the females (43.2%)

disagreed or strongly disagreed with the statement. Figure 9 shows the distribution of the students' responses toward the statement.

Table 15

Frequency and Percentage Scores of Student responses toward the statement, "I Have Seldom Liked Studying Mathematics."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	32	20.9	33	21.6
A	35	22.9	42	27.5
U	28	18.3	12	7.8
D	32	20.9	44	28.8
SD	26	17.0	22	14.4
TOTAL	153	100.0	153	100.0

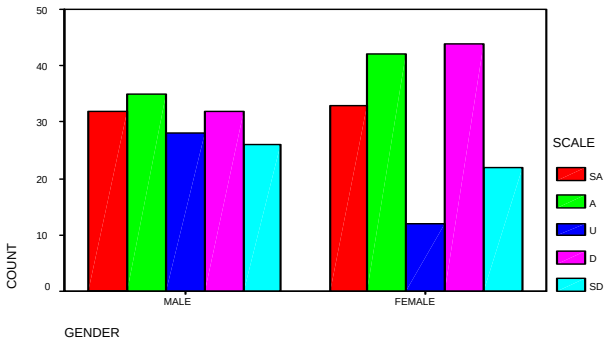

Figure 9. Distribution of student responses toward the statement, "I have seldom liked studying mathematics."

Students were asked about the statement, "I am interested in acquiring further knowledge of mathematics." Table 16 illustrates the information based upon the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. About 66.7% of the males and 56.9% of the females agreed

or strongly agreed with this statement. Figure 10 shows the distribution of the students' responses toward the statement.

Table 16

Frequency and Percentage scores of Student Responses Toward the Statement, "I Am Interested in Acquiring Further Knowledge of Mathematics."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	45	29.4	37	24.2
A	57	37.3	50	32.7
U	25	16.3	24	15.7
D	12	7.8	27	17.6
SD	14	9.2	15	9.8
TOTAL	153	100.0	153	100.0

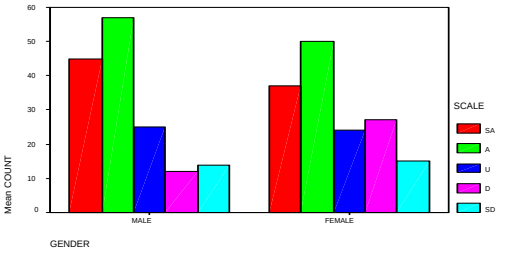

Figure 10. Distribution of student responses toward the statement, "I am interested in acquiring further knowledge of mathematics."

Students were asked about the statement, "Mathematics helps to develop the mind and teaches a person to think." Table 17 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. The majority of the males (84.3%) and the majority of the females (85.6%) agreed or strongly agreed with this statement. Figure 11 shows the distribution of student responses toward the statement.

Table 17

Frequency and Percentage Scores of the Student Responses Toward the Statement, "Mathematics Helps To Develop the Mind and Teaches a Person to Think."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	104	68.0	88	57.5
A	25	16.3	43	28.1
U	9	5.9	13	8.5
D	8	5.2	2	1.3
SD	7	4.6	7	4.6
TOTAL	153	100.0	153	100.0

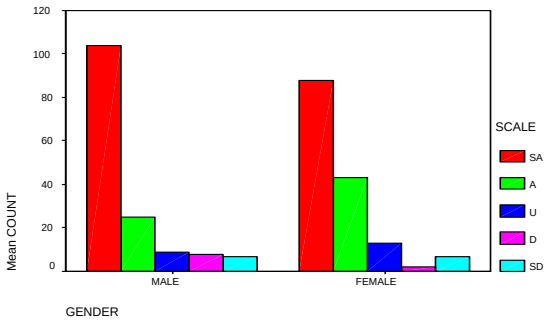

Figure 11. Distribution of student responses toward the statement, "Mathematics helps to develop the mind and teaches a person to think."

Students were asked about the statement, "Mathematics makes me feel uneasy and confused." Table 18 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Slightly less than half of the males (46.4%) and slightly less than the half of the females (47%) disagreed or strongly disagreed with the statement. Figure 12 shows the distribution of student responses toward the statement.

Table 18

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Makes Me Feel Uneasy and Confused."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	35	22.9	40	26.1
A	29	19.0	19	12.4
U	18	11.8	22	14.4
D	30	19.6	36	23.5
SD	41	26.8	36	23.5
TOTAL	153	100.0	153	100.0

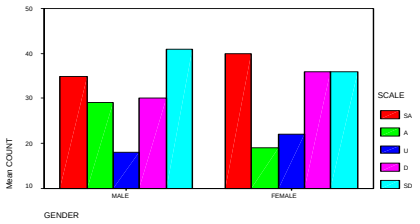

Figure12. Distribution of student responses toward the statement, "Mathematics makes me feel uneasy and confused."

Students were asked about the statement, "Mathematics is enjoyable and stimulating to me." Table 19 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Slightly less than half of the males (45.7%) and slightly more than half of the females (52.3%) agreed or strongly agreed with this statement. Figure 13 shows the distribution of student responses toward the statement.

Table 19

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Is Enjoyable and Stimulating to Me."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	45	29.4	39	25.5
A	25	16.3	41	26.8
U	25	16.3	18	11.8
D	24	15.7	30	19.6
SD	34	22.2	25	16.3
TOTAL	153	100.0	153	100.0

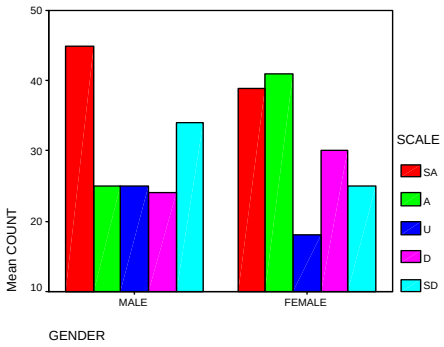

Figure13. Distribution of student responses toward the statement, "Mathematics is enjoyable and stimulating to me."

Students were asked about the statement, "I am not willing to take more than the required amount of mathematics." Table 20 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Only 34.6% of the males and 43.1% of the females disagreed or strongly disagreed with this statement. Figure 14 shows the distribution of student responses toward the statement.

Table 20

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Am Not Willing To Take More Than the Required Amount of Mathematics."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	42	27.5	24	15.7
A	29	19.0	50	32.7
U	29	19.0	13	8.5
D	26	17.0	47	30.7
SD	27	17.6	19	12.4
TOTAL	153	100.0	153	100.0

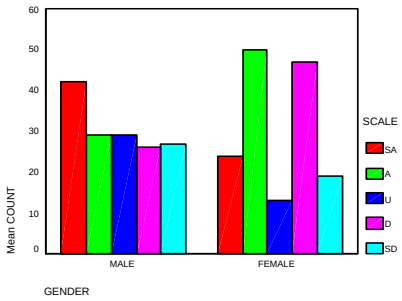

Figure14. Distribution of student responses toward the statement, "I am not willing to take more than the required amount of mathematics."

Students were asked about the statement, "Mathematics is not especially important to everyday life." Table 21 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Approximately 61.4% of the males and 68.6% of the females disagreed or strongly disagreed with the statement. Figure 15 shows the distribution of student responses toward the statement.

Table 21

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Is Not Especially Important to Everyday Life."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	28	18.3	16	10.5
A	13	8.5	12	7.8
U	18	11.8	20	13.1
D	39	25.5	53	34.6
SD	55	35.9	52	34.0
TOTAL	153	100.0	153	100.0

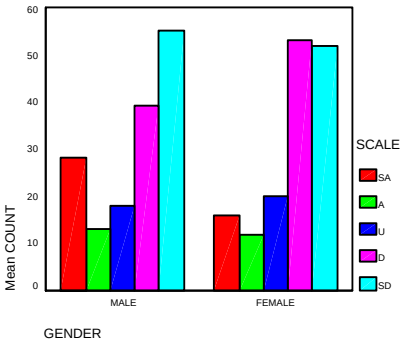

Figure15. Distribution of student responses toward the statement, "Mathematics is not especially important to everyday life."

Students were asked about the statement, "Trying to understand mathematics does not make me anxious." Table 22 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. More than half of the males (58.1%) and 63.4% of the females agreed or strongly agreed with this statement. Figure 16 shows the distribution of student responses toward the statement.

Table 22

Frequency and Percentage Scores of Student Responses Toward the Statement, "Trying to Understand Mathematics Does Not Make Me Anxious."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	40	26.1	40	26.1
A	49	32.0	57	37.3
U	24	15.7	11	7.2
D	21	13.7	19	12.4
SD	19	12.4	26	17.0
TOTAL	153	100.0	153	100.0

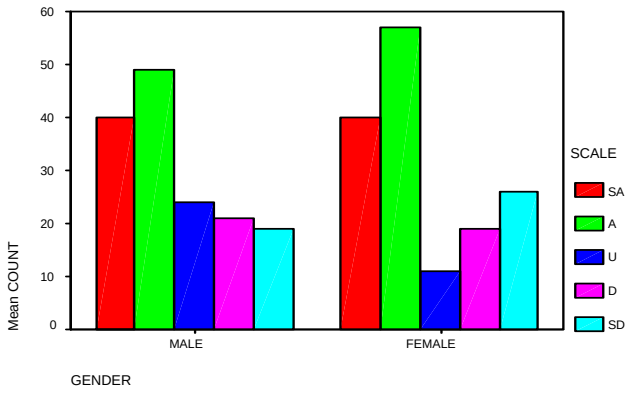

Figure16. Distribution of student responses toward the statement, "Trying to understand mathematics does not make me anxious."

Students were asked about the statement, "Mathematics is dull and boring." Table 23 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Only 35.3% of the males and 39.2% of the females agreed or strongly agreed with this statement. Figure 17 shows the distribution of student responses toward the statement.

Table 23

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Is Dull and Boring."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	34	22.2	35	22.9
A	20	13.1	25	16.3
U	25	16.3	16	10.5
D	30	19.6	38	24.8
SD	44	28.8	39	25.5
TOTAL	153	100.0	153	100.0

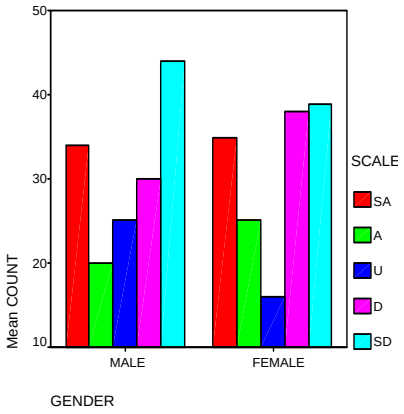

Figure 17. Distribution of student responses toward the statement, "Mathematics is dull and boring."

Students were asked about the statement, "I plan to take as much mathematics as I possibly can during my education." Table 24 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Only 28.7% of the males and 39.9% of the females disagreed or strongly disagreed with this statement. Figure 18 shows the distribution of student responses toward the statement.

Table 24

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Plan To Take as Much Mathematics as I Possibly Can During My Education."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	41	26.8	26	17.0
A	29	19.0	44	28.8
U	39	25.5	22	14.4
D	19	12.4	26	17.0
SD	25	16.3	35	22.9
TOTAL	153	100.0	153	100.0

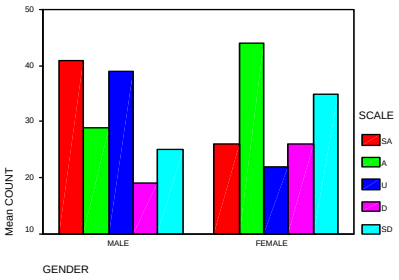

Figure 18. Distribution of student responses toward the statement, "I plan to take as much mathematics as I possibly can during my education."

Students were asked about the statement, "Mathematics has contributed greatly to the progress of civilization." Table 25 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Most of the males (79.1%) and most of the females (74.6%) agreed or strongly agreed with this statement. Figure 19 shows the distribution of student responses toward the statement.

Table 25

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Has Contributed Greatly to the Progress of Civilization."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	90	58.8	70	45.8
A	31	20.3	44	28.8
U	18	11.8	18	11.8
D	5	3.3	10	6.5
SD	9	5.9	11	7.2
TOTAL	153	100.0	153	100.0

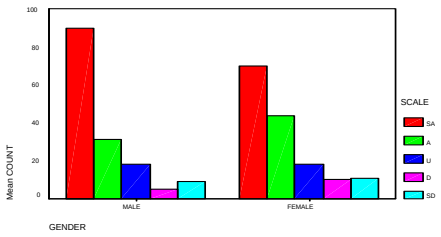

Figure 19. Distribution of student responses toward the statement, "Mathematics has contributed greatly to the progress of civilization."

Students were asked about the statement, "Mathematics is one of my most dreaded subject." Table 26 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Approximately 54.9% of the males and 59.5% of the females disagreed or strongly disagreed with this statement. Figure 20 shows the distribution of student responses toward the statement.

Table 26

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Is One of My Most Dreaded Subjects."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	35	22.9	34	22.2
A	17	11.1	12	7.8
U	17	11.1	16	10.5
D	18	11.8	39	25.5
SD	66	43.1	52	34.0
TOTAL	153	100.0	153	100.0

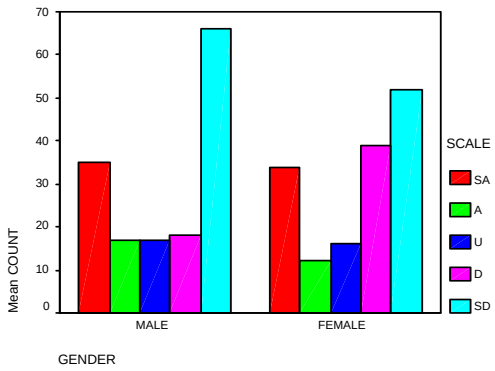

Figure 20. Distribution of student responses toward the statement, "Mathematics is one of my most dreaded subject."

Students were asked about the statement, "I like trying to solve new problems in mathematics." Table 27 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Approximately 59.5% of the males and 62.1% of the females agreed or strongly agreed with this statement. Figure 21 shows the distribution of student responses toward the statement.

Table 27

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Like Trying To Solve New Problems in Mathematics."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	50	32.7	48	31.4
A	41	26.8	47	30.7
U	28	18.3	12	7.8
D	18	11.8	20	13.1
SD	16	10.5	26	17.0
TOTAL	153	100.0	153	100.0

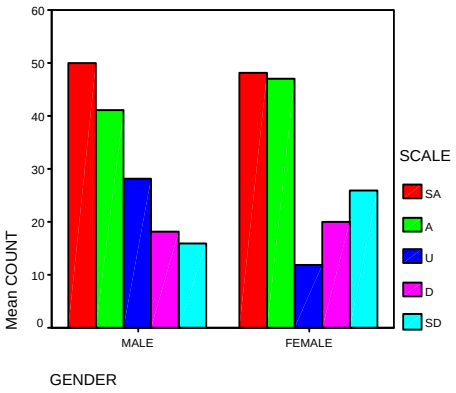

Figure 21. Distribution of student responses toward the statement, "I like trying to solve new problems in mathematics."

Students were asked about the statement, "I am not motivated to work very hard on mathematics problems." Table 28 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Slightly less than half of the males (47.0%) and more than half of the females (57.5%) disagreed or strongly disagreed with this statement. Figure 22 shows the distribution of student responses toward the statement.

Table 28

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Am Not Motivated To Work Very Hard on Mathematics Problems."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	21	13.7	24	15.7
A	22	14.4	16	10.5
U	38	24.8	25	16.3
D	40	26.1	51	33.3
SD	32	20.9	37	24.2
TOTAL	153	100.0	153	100.0

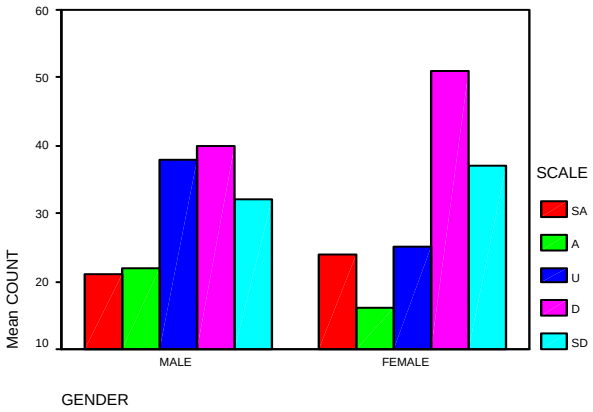

Figure 22. Distribution of student responses toward the statement, "I am not motivated to work very hard on mathematics problems."

Students were asked about the statement, "Mathematics is not one of the most important subject for people to study." Table 29 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Only 30.1% of the males and 30.7% of the females agreed or strongly agreed with this statement. Figure 23 shows the distribution of student responses toward the statement.

Table 29

Frequency and Percentage Scores of Student Responses Toward the Statement, "Mathematics Is Not One of the Most Important Subjects for People To Study."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	26	17.0	23	15.0
A	20	13.1	24	15.7
U	23	15.0	16	10.5
D	31	20.3	45	29.4
SD	53	34.6	45	29.4
TOTAL	153	100.0	153	100.0

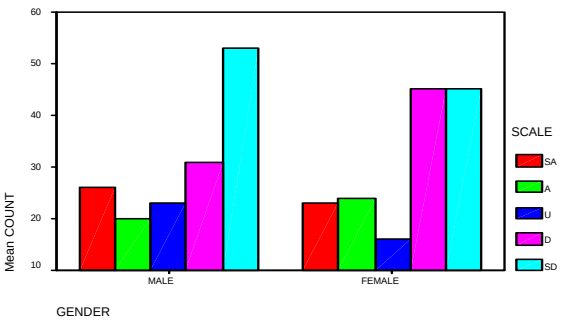

Figure 23. Distribution of student responses toward the statement, "Mathematics is not one of the most important subjects for people to study."

Students were asked about the statement, "I do not get upset when trying to work mathematics problems." Table 30 illustrates the information based on the scale used in the questionnaire and provides the frequency and percentage of responses; there were 306 responses. Slightly more than half of the males (55.5%) and approximately 59.5% of the females agreed or strongly agreed with the statement. Figure 24 shows the distribution of student responses toward the statement.

Table 30

Frequency and Percentage Scores of Student Responses Toward the Statement, "I Do Not Get Upset When Trying To Work Mathematics Problems."

Scale	Male		Female	
	Frequency	Percentage	Frequency	Percentage
SA	49	32.0	39	25.5
A	36	23.5	52	34.0
U	27	17.6	15	9.8
D	21	13.7	17	11.1
SD	20	13.1	30	19.6
TOTAL	153	100.0	153	100.0

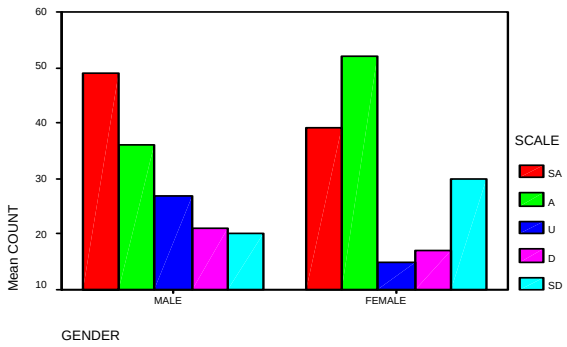

Figure 24. Distribution of student responses toward the statement, "I do not get upset when trying to work mathematics problems."

Statistical Method

The Ohio Graduation Practice Test was selected as the mathematics achievement test to be used for this study. The test consisted of 20 items, and each correct item was worth 1 point. The minimum possible score was 0, and the maximum possible score was 20.

Table 31 shows the distribution of the scores for the mathematics achievement test. Scores ranged from 2 to 20, with the lowest two scores (2 and 4), received by

four students or 1.30% of the students. The highest two scores (18 and 19) were received by seven students or 2.29% (see Appendix G).

Table 31

Mean, Standard Deviation and Minimum and Maximum Scores of Mathematics Achievement Test

Gender	Mean	Number	S.D.	Minimum	Maximum
Male	13.10	153	3.06	4	19
Female	11.15	153	2.88	2	18
Total	12.12	306	3.12	2	19

An independent t test was conducted to evaluate whether a gender difference was present among 10th-grade students on achievement in Amman, Jordan (see Table 32). The results indicated a significant difference in the mean scores for males' and females' achievement on the Ohio Graduation Test, t (306) =5 .72, p<0. 01.

Table 32

Independent t Test for Gender Difference in Mathematics Achievement

	t-test for equality of means			
	t	df	sig.	Mean diff.
Achievement	5.72	306	0.000	1.95

The multivariate analysis of variance (MANOVA) was used to test the null hypotheses, which are stated in Chapter One:

H01: Null hypotheses

There is no significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement.

H02: Null hypotheses

There are no significant differences between Jordanian males and females on a combination of students' attitudes toward learning mathematics and mathematics achievement.

Because MANOVA was used to examine the hypotheses of the study, it was important to test whether the assumptions were met or not.

1. Independence of observations.

   Each student answered the items of the questionnaire independently, and thus the assumption was met.

2. Homogeneity of covariance.

   There were no significant differences between the variance and covariance matrices. Box's Test of Equality of Covariance Matrices, $p > .05$ ($p = .76$) was the statistical procedure used to examine this assumption, as shown in Table 33, so the assumption is met.

Table 33

Box's Test of Equality of Covariance Matrices

Box's M	F	df1	df2	sig.
1.149	0.380	3	16548211.25	0.76

3. Normality.

The univariate normality assumption was examined by using Kolmogorov-Smirnov Test. In the first dependent variable (Mathematics Achievement), the normality assumption was not met for male and female students, $p < 0.05$ ($p = 0.001$, $p = 0.005$). Also, in the second dependent variable (Attitude Toward Learning Mathematics), the normality was not met for male and female students, $p < 0.05$ ($p = 0.00$, $p = 0.002$, respectively), as shown in Table 34. Foster (1998) explains that with large sets of data, non-perfect distribution is almost certain to occur.

Table 34

Test of Normality

		Kolmogorov- Smirnov		
	Gender	Statistics	df	Sig.
Achievement	Male	0.098	153	0.001
	Female	0.089	152	0.005
Attitude	Male	0.113	153	0
	Female	0.095	152	0.002

The Pearson Correlation and Scatter Plot were used to test the first null hypothesis of the study, which was:

H01: There is no significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement.

Using the Pearson Correlation (0.167) and Scatter Plot, a positive correlation was found between the two dependent variables (attitude toward learning

mathematics and mathematics achievement). This indicates that the first null hypotheses should be rejected, as shown in Table 35. Figure 25 shows the distribution of the students' attitude toward learning mathematics and mathematics achievement.

Table 35

The Correlation Between Two Dependent Variables

		Achievement	Attitude
Achievement	Pearson Correlation	1	.167**
	Sig. (2-tailed)		0.003
	N	306	306

** Correlation is significant at the 0.05 level.

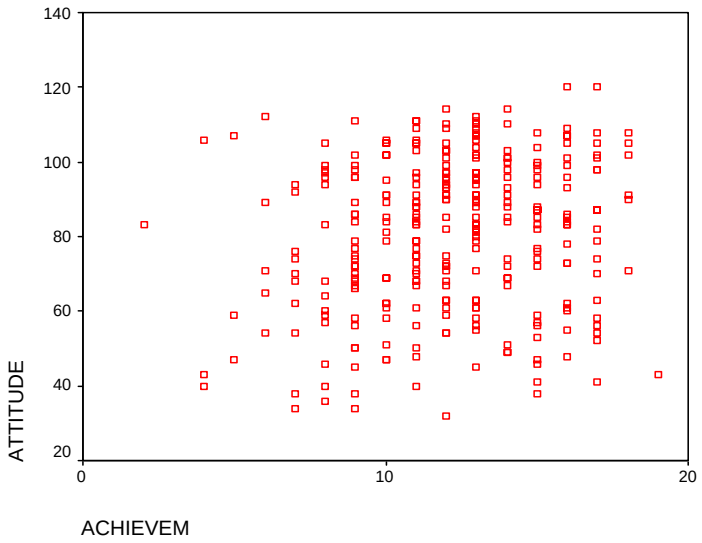

Figure 25. Distribution of student attitude toward learning mathematics and mathematics achievement.

A one-way multivariate analysis of variance (MANOVA) was conducted to test the second null hypothesis, which was:

H02: There are no significant differences between Jordanian males and females on a combination of students' attitudes toward learning mathematics and mathematics achievement.

A Wilks' Lambda of 0.903 is significant ($F\ 2, 302 = 16.3$, $p < 0.01$) indicating that we can reject the null hypothesis. The overall results indicated that there were significant differences between male and female students in 10^{th} grade in a combination of students' attitude toward learning mathematics and mathematics achievement, as shown in Table 36.

Table 36

Multivariate Test for the Combination of Student Attitudes Toward Learning Mathematics and Mathematics Achievement.

Effect	Value	F	Df	Sig.	Error df
Gender Wilks' Lambda	0.903	16.3	2.000	0.000	302

Chapter Five

Summary, Discussion and Conclusions, and Recommendations

In this study, the researcher explored Jordanian 10th-grade students' attitude toward learning mathematics and investigated the relationship between Jordanian students' attitudes toward learning mathematics and mathematics achievement using qualitative and quantitative methods. The sample was selected from 10th-grade students in Amman, Jordan. The researcher used three instruments: a mathematics achievement test adapted from the (2004) Ohio Graduation Test (see Appendices A and I), an attitude scale developed by Taylor (1997) from the Aiken Scale (1976) (see Appendix B) and interviews of students (see Appendix C).

Interview data and quantitative methods were used to answer the following research questions:

1. What are Jordanian male students' attitudes toward learning mathematics?
2. What are Jordanian female students' attitudes toward learning mathematics?
3. What are the differences and similarities between Jordanian male students' attitudes and Jordanian female students' toward learning mathematics?
4. Is there significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement?
5. Are there significant differences between Jordanian males and females on a combination of students' attitudes towards learning mathematics and mathematics achievement?

For the first three research questions identified above, a qualitative methodology was used; therefore, hypotheses are not listed.

The following null hypotheses were identified for the last two research questions:

H01: Null hypotheses

There is no significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement.

H02: Null hypotheses

There are no significant differences between Jordanian males and females on a combination of students' attitudes toward learning mathematics and mathematics achievement.

Summary of Findings

In the qualitative portion of the research, interviews were utilized to collect data that could support the study with richer findings to reach a more meaningful conclusion. The interview was conducted with a sub-sample of 10^{th}-grade students (i.e., six males and six females).

The interview consisted of 15 open-ended questions to enhance the understanding of the quantitative component. The questions were prepared to determine students' knowledge and opinions toward learning mathematics. The results of the interviews were summarized and categorized to narrow the scope and assist in analysis from which conclusions were drawn.

The first question asked students when they first started learning about mathematics and about their knowledge in mathematics before entering school. Their responses indicated that for the most part they started learning mathematics in the

kindergarten and all of the subjects knew how to count from 1 to 10 before entering school.

Students were also asked about who influenced their thinking toward mathematics. The subjects responses were varied, five indicated that their parents affected their attitude toward mathematics by teaching them at home and clarifying the difficult part of mathematics. Seven students responded that their math teachers affected their attitude toward mathematics, because teachers tried to make mathematics easier to understand by teaching more than way to solve any math problem.

Students were asked if they if they liked or disliked mathematics and what mathematics they preferred. Most of the subjects indicated that they liked mathematics and explained how it was important in their future studies. Two students disliked mathematics because it was “difficult subject” and they could not understand it. As well, most subjects preferred algebra rather than geometry or statistics. Those students who indicated a preference for geometry or statistics stated that these areas of mathematics were easier to understand.

Students were asked about their opinion about the relationship between mathematics and puzzles. Responses indicated that students believed that there was little or no relationship between mathematics and solving puzzles. The small number of students who indicated that there was a relationship between mathematics and puzzles indicated that in order to be good and fast in solving puzzles, one must be good in mathematics.

Students' beliefs regarding the relationship between mathematics achievements and solving all mathematics homework was also explored. Most students (three males and four females) did not agree with the statement "in order to be good in mathematics you have to answer all the homework correctly." However, five students agreed with the statement, because they believed by practicing more they would learn more mathematics.

Following this, subjects were asked if they thought mathematics was fun. Surprisingly, all students agreed, "math is a fun subject." Reasons given by students included "mathematics problems are always a challenge to solve," and "solving problems make me happy about myself and motivated to solve more problems."

Of the 12 subjects interviewed, 10 indicated that mathematics was a central subject in their future study, their daily life, and other courses that were required as part of their future studies. Two of the students, who responded to this question, indicated that they were not planning to major in any math related subjects and did not see math as an important subject in their future studies.

The ninth question asked about the difficulty of mathematics as compared to other courses they have taken. Seven of the 12 students agreed that that some courses were more difficult than mathematics, such as physics. Five students believed that it required more understanding to be accomplished in mathematics, while most other subjects required more memorization.

A goal of the interview was to determine the students' opinion regarding their feelings during mathematics exams. Four interviewees' indicated they were relaxed in their mathematics exams because they were always prepared, and if there were any

hard problems, they would ask the teacher or friend to clarify. However, eight students indicated that mathematics exams scared them, and they were afraid of failing those exams. Yet, when asked about studying mathematics without having exams, the majority of subjects indicated that they gain an understanding about mathematics from their mistakes; hence, they learn more through attempting the exams. Two students, however, felt that studying mathematics without having exams might reduce their fear of mathematics.

The aim of the 12th question was to learn the students' feeling about mathematics. Most students believed that their feeling toward mathematics depended on the teachers, because some teachers let their students like or dislike mathematics by their methods of teaching and their behaviors with students. The 13th question was asked to determine if the math teacher influenced the students' attitude toward learning mathematics and how. All 12 students said their math teachers influenced their attitude toward mathematics in positive or negative ways.

In the 14th question, the researcher wanted to know who did better in mathematics, females or males. Two students believed that males did better in mathematics than females, because males are more involved in the life outside their homes. This outside involvement might increase their thinking skills; therefore, their math grades will be higher than girls' grade. Four students indicated that females did better in mathematics than males, because females had more time at homes and they study more; traditionally, Arab females do not have many activities outside their homes. Four students believed that there are no differences in mathematics achievement between males and females, because math depends on students'

intelligence, and whoever has a good brain for math will get high grades regardless of the gender.

In the 15th question, the researcher wanted like to know if there were differences between males' and females' attitudes toward learning mathematics according to their belief. Most students indicated that females achieve better in mathematics, because they study harder than males. Two male students believed that males in Jordan have more interests in studying engineering at college. To succeed in this major, they have to be good in mathematics; therefore males work harder and achieve better than females.

In the quantitative portion of the research, the researcher grouped attitude scale items according to their responses in Chapter Four to summarize the students' attitude toward learning mathematics.

Item 1 and 17 indicate whether or not students find mathematics interesting. In this study, about one third of the students (males and females) reported thinking that mathematics is not interesting. About 33% of the males and 34% of the females agreed or strongly agreed with the statement, "Mathematics is not a very interesting subject." However, about 35% of the males and 40% of the females agreed or strongly agreed that mathematics is dull and boring.

Items 2, 6, 10, 14, and 18 show whether or not Jordanian male and female 10^{th} -grade students would like to study mathematics more. The responses to these questions were mixed. About 66.6% of the males and 66% of the females agreed or strongly agreed with the statement, "I want to develop mathematics skills and study this subject more." Further, about 66.7% of the males and 56.9% of the females who

responded agree or strongly agree with the statement, “I am interested in acquiring further knowledge of mathematics.” On the other hand, about 47.8% of the males and approximately 45% of the females agreed or strongly agreed with the statement, “I do not want to take any more mathematics than I absolutely have to.” About 46.5% of the males and 48.4% of the females agreed or strongly agreed not to take more than the required amount of mathematics. Also, 45.8% of the males and 45.8% of the females agreed or strongly agreed to take as much mathematics as they can during their education.

Items 3, 7, 11, 15, 19, and 23 gave an indication of students’ perceptions of the importance of mathematics. About 73% of the males and 78% of the females agreed or strongly agreed with the statement, “Mathematics is a very worthwhile and necessary subject.” On the other hand, about 36% of the males and 44% of the females agreed or strongly agreed that other subjects are more important than mathematics. However, the majority of the males (84%) and the majority of females (85%) agreed or strongly agreed that mathematics develop the mind and teach a person to think. On the other hand, 26.8% of the males and 28.3% of the females agreed or strongly agreed that mathematics is not important to everyday life. In addition, 79.1% of the males and 74.6% of the females agreed or strongly agreed that mathematics is important to the progress of civilization. However, 30.1% of the males and 30.7% of the females agreed or strongly agreed with the statement, “Mathematics is not one of the most important subjects for people to study.”

Items 4, 8, 12, and 16 indicate whether students feel nervous or confused with mathematics. Again, the responses across items were mixed. Although, at least one

can say that majority of students are not afraid or uncomfortable with mathematics. About 46.4% of the males and 47.7% of the females do not feel anxious or uncomfortable with mathematics. On the other hand, slightly more than half (52.2%) of the males and 47.7% of the females agreed or strongly agreed that they are calm and unafraid while studying mathematics. However, about 42% of the males and 38.5% of the females agreed or strongly agreed with the statement, "Mathematics makes me feel uneasy and confused." Also, 58.1% of the males and 63.4% of the females agreed or strongly agreed that mathematics do not make them worried when they are trying to understand it.

Items 5, 9, 13, and 20 illustrate if the students enjoy mathematics in and out of school. About 60% of the males and 59.5% of the females agreed or strongly agreed that they enjoy studying mathematics. On the other hand, about 43% of the males and 49.1% of the females agreed or strongly agreed with the statement, "I have seldom liked studying mathematics." Also, 45.7% of the males and 52.3% of the females agreed or strongly agreed that mathematics is enjoyable and stimulating to them. In addition, 34% of the males and 30% of the females agreed or strongly agreed with the statement, "Mathematics is one of my most dreaded subjects."

Items 21, 22, and 24 demonstrate how the students feel when they work on mathematics problems. Approximately 59% of the males and 62% of the females agreed or strongly agreed that they like to solve new mathematics problems. On the other hand, 28.1% of the males and 26.2% of the females agreed or strongly agreed that they were not motivated to work hard on mathematics problems. In addition,

55.5% of the males and 59.5% of the females agreed or strongly agreed with the statement, “I do not get upset when trying to work mathematics problems.”

Most Jordanian male students agreed in their opinion that mathematics helps to develop the mind and teaches a person to think; also, mathematics has contributed greatly to the progress of civilization. Most Jordanian female students thought that mathematics helps to develop the mind and teaches a person to think; also, mathematics has contributed greatly to the progress of civilization. Item 15, “Mathematics is not especially important to everyday life” received the least number of responses from both male and female Jordanian students (26.8% and 18.3%, respectively).

The results of the study are presented in detail in Chapter Four. In this section, the findings are summarized using the five research questions as the organizer. Research Question 1: What are Jordanian male students’ attitudes toward learning mathematics?

The interview questions (3, 7, 8, 12, and 13) and Table 5 (M = 81.52) in Chapter Four indicate that the Jordanian male students’ attitude toward learning mathematics is positive according to the interview questions and the students’ attitude maximum possible score, which was 120. Jordanian males’ responses to the attitudes scale indicate that out of 24 items, there were 10 items to which more than 50% of the male students agreed or strongly agreed. On four items out of 24 items more than 50% of male students disagreed or strongly disagreed. On only six of these 14 items did more than 60% of male students agree or strongly agree (see Appendix H).

Research Question 2: What are Jordanian female students' attitudes toward learning mathematics?

The interview questions (3, 7, 8, 12, and 13) and Table 4 (M = 80.23) in Chapter Four indicate that the Jordanian female students' attitude toward learning mathematics is positive according to the interview questions and the students' attitude maximum possible score, which was 120. Jordanian females' responses to the attitudes scale indicate that out of 24 items, there were 10 items to which more than 50% of female students agreed or strongly agreed. On six items out of 24 items, more than 50% of female students disagreed or strongly disagreed. On only seven of these 16 items did more than 60% of female students agreed or strongly agreed (see Appendix H).

Research Question 3: What are the differences and similarities between Jordanian males' students' attitudes and Jordanian females' students' attitudes toward learning mathematics?

The interview questions (3, 7, 8, 12, and 13) and Table 4 (male students M = 81.52 and female students M = 80.23) in Chapter Four indicate that the Jordanian male students' attitudes and Jordanian female students' attitudes toward learning mathematics are almost similar. But, according to their responses to interview questions 14 and 15, there are some differences, because Jordanian male students have more interests in studying mathematics related majors at colleges; therefore, male students have more colleges open to them than Jordanian female students. Also, according to their responses to the attitudes scale, there were differences between

Jordanian male and Jordanian female students in 3 items out of 24 items, which were 7, 10, and 15 (see Appendix H).

Research Question 4: Is there significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement?

By using the Pearson Correlation (0.167) Table 35 in Chapter Four, the results indicate there is significant correlation between the two dependent variables, which are attitudes toward learning mathematics and mathematics achievement.

Research Question 5: Are there significant differences between Jordanian males and females on a combination of student's attitude toward learning mathematics and mathematics achievement?

By using Wilks' Lambda Test Table 36 in Chapter Four, the overall results indicate that there are significant differences between male and female students in a combination of students' attitudes toward learning mathematics and mathematics achievement. The achievement scores and the attitude scores were used to test the research hypotheses. A multivariate analysis of variance (MANOVA) was used to test the hypotheses of the study. The descriptive statistics of this study revealed that students' attitude toward learning mathematics responses the mean for each item ranged from 1.87 to 4.37; however, the mean for all items for male students was M = 81.52, and for female students was M = 80.23. In addition, in the mathematics achievement test responses the mean for male students was M = 13.10 and for female students was M = 11.15. The result of the analysis indicates that there are significant

differences between male and female students in 10th grade in a combination of students' attitude toward learning mathematics and mathematics achievement.

The two research questions were restated as null hypotheses, which were tested to answer these questions. The following section summarizes the results of the statistical analysis, which are addressed in detail in Chapter Four.

The first null hypothesis is:

H01: There is no significant correlation between Jordanian male and female students' attitudes toward learning mathematics and mathematics achievement.

Overall, in regard to research question 1, the Pearson Correlation was used to test the hypothesis; descriptive and inferential statistics indicated that there was significant correlation (0.167) between the two dependent variables; the attitude toward learning mathematics and mathematics achievement. Therefore, the result is to reject the first null hypothesis (see Table 35).

The second null hypothesis is:

H02: There are no significant differences between Jordanian males and females on a combination of students' attitudes toward learning mathematics and mathematics achievement.

Generally, in regard to research question 2, the Wilks' Lambda Test was used to test the hypothesis; descriptive and inferential statistics indicated that there were significant differences between male and female students in 10th grade in a combination of students' attitude toward learning mathematics and mathematics achievement, where $F = 16.30$, $p = 0.000$. Therefore, the result is to reject the second null hypothesis (see Table 36).

Discussion and Conclusion

The goal of this study was to investigate if there are differences between students' attitude toward learning mathematics and mathematics achievement with respect to gender in 10^{th}-grade students in Amman, Jordan, in order to discuss the results of the study and differences between students' attitude toward learning mathematics and mathematics achievement. This section summarizes the descriptive statistics of the study.

Table 4 and 6 in Chapter Four illustrate that the mean of each item of students' attitude toward learning mathematics ranged from 1.87 to 4.37 and the mean of all items was 80.87. This indicates that the students' attitudes toward learning mathematics are slightly positive according to the maximum possible score of 120. Furthermore, the mean scores on Aiken's Attitude Scale indicate that there is no significant difference between males and females.

Table 31 in Chapter Four shows that the mathematics achievement test (M = 12.12) is comparatively low according to the maximum possible score of 20. The low score of mathematics achievement test was surprising to the researcher. These findings are consistent with findings from previous research in other countries. For example, Papanastasiou (2000) found that attitudes were positive for the majority of the students; achievement did not duplicate the pattern.

Based on the correlation matrix (see Table 35), the first null hypothesis is rejected. Table 35 and Figure 25 in Chapter Four indicate that there is significant correlation between male and female students' attitudes toward learning mathematics and mathematics achievement. Pearson Correlation was 0.167, which was significant

($p = 0.003$). This finding is supported by Hammori (2004); she also found a positive correlation between mathematics achievement and attitude towards mathematics among 8th-grade students in Jordan.

Table 32 shows that there are significant differences in the mean scores of males and females in mathematics achievement among 10th-grade students in Amman, Jordan. This finding is consistent with the findings of American Association of University Women (1999) and Weist (2001).

Based on the multivariate results, the second null hypothesis is rejected. Table 36 in Chapter Four demonstrates that there are significant differences between male and female 10th-grade students in a combination of students' attitudes toward learning mathematics and mathematics achievement.

From Tables 7 through 30 in Chapter Four, the researcher observed that the students selected from the Likert-Scale "Neutral" ranged between 5.9% and 30.7%. This might affect students' attitude results. Some researchers argue against including the neutral option along the agreement range in the Likert-Scale. They assert that no person is neutral in any given issue unless the person has not formed an opinion about the issue. Having not formed an opinion is different from being neutral. A person, in the new version of the scale without the neutral option, indicates the extent to which he or she agrees or disagrees with each statement (Ary, Jacobs, and Razavieh, 1990).

According to students' responses in the qualitative part and the researcher's belief, most teachers disregard students' questions, and they are not grateful for the importance of their questions. Most teachers do not give opportunities for the students to articulate their ideas; this implies that our students' roles are very passive in the

classroom. Therefore, teachers through their instructional approaches, should encourage students' cognitive interactions in gaining mathematics concepts by providing them with opportunities that let them achieve these concepts.

Finally, high achievement in mathematics and a positive attitude toward learning mathematics are the most important goals of teaching mathematics. Consequently, it is important for teachers to consider and be aware of the relationship between these variables and the causes of the relationship between them.

Recommendations

Based upon the findings of the study, the following are recommendations for teaching mathematics in 10^{th}-grade in Jordan.

1. The Jordanian Ministry of Education's Curriculum Development Department should create some standardized tests for mathematics and encourage teachers to use them for exams and practice in schools.
2. Educators and teachers should not only think about content of curriculum when planning for instruction; they should also consider students' attitudes, perceptions, and capabilities in mathematics to help teachers be aware of their students' needs and interests when teaching mathematics.
3. The findings of this study show that students prefer teachers who had a positive attitude toward mathematics to teach them.
4. The findings of this study suggest that better understanding was achieved when students had teachers who provided help to them when they needed it and with teachers who made classes interesting.

5. School programs should be designed to teach mathematics in a way that students will enjoy. Parents should be involved in a school's programs to be able to influence their children.
6. Students' prior knowledge in mathematics influences their later success in mathematics. Students in the early grades should be helped to master essential knowledge and skills in mathematics.
7. Curriculum developers are strongly encouraged to consider students' interest when developing mathematics curricula.

Recommendations for further research.

1. This study was conducted in Amman, Jordan. The sample of this study was chosen from 10th-grade students in this city. It is recommended that this study be replicated and extended to other cities in Jordan.
2. This study focused on students' attitudes toward learning mathematics and mathematics achievement in 10th-grade students in Amman, Jordan. Other studies may be conducted to consider viewpoints of students in other grades.
3. The researcher did not interview teachers for this study. Interviewing teachers might be helpful to understand students' attitudes toward learning mathematics.
4. Similar studies should be conducted at elementary and middle school levels to give more valuable knowledge about mathematics education in Jordan.

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Appendix A

Mathematics Achievement Test

MATHEMATICS ACHIEVEMENT TEST

Name: Time: 60

Minutes

Circle the correct answer for each question

1. The table below contains the results of a biology experiment.

Record of Blooms

Week	1	2	3	4	5
Number of Blooms	3	9	27	81	*b*

Assuming the pattern shown in the table continues, what is the value of *b*?

A. 108

B. 130

C. 162

D. 243

2. Which equation is equivalent to $3(2x - 5) = 4(x + 3)$?

A. $2x = -27$

B. $2x = 27$

C. $10x = -27$

D. $10x = -3$

3. if A = 7 and b = -4, what is the value ab- 2b?

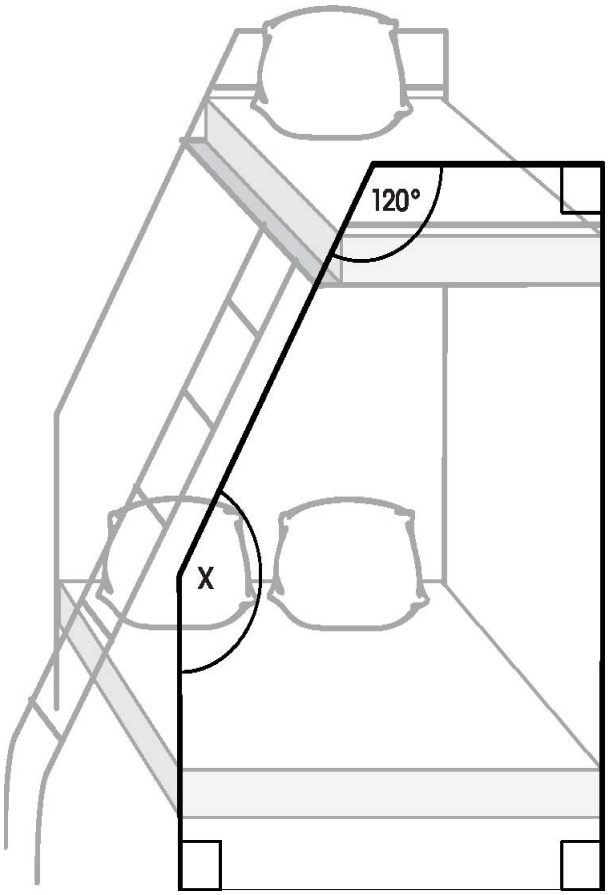
A. -36

B. -20

C. 20

D. 36

4. In the diagram below. What is the measure of angle X?



A. 540°

B. 390°

C. 150°

D. 120°

5. Three different opinion polls show different results for the proportion of voters

expected to vote for Candidate A in an election for mayor.

Poll 1: Nine of every 20 voters are expected to vote for Candidate A.

Poll 2: The percentage of voters expected to vote for Candidate A is 52%.

Poll 3: There are 130,000 people expected to vote, and of these, 55,000 are expected to vote for Candidate A. Determine which of these polls shows the greatest favorable result for Candidate A.

6. A set of data contains 10 negative numbers and 4 positive numbers. Which one of these statements must be true?

A. The mean is a negative number.

B. The median is a negative number.

C. The mode is a negative number.

D. The range is a negative number

7. Which expression represents 270,000 written in scientific notation?

A. 270×10^{3}

B. 27×10^{4}

C. 2.7×10^{5}

D. 0.27×10^{6}

8. The table below shows values for x and y.

x	Y
0	–1
1	0
2	3
3	8
4	15
5	24

Which of these equations represents the relationship between x and y?

A. $y = x - 1$

B. $y = x + 19$

C. $y = x^2 - 1$

D. $y = 2x^2 - 5$

9. Which number is irrational?

A. -2

B. $\sqrt{8}$

C. 3

D. $\frac{22}{8}$

10. Which of the following is a correct statement?

A $-\frac{4}{2} > \frac{2}{4}$

B. $-\frac{2}{4} > -\frac{4}{2}$

C. $-\frac{2}{4} < -\frac{4}{2}$

D. $\frac{4}{2} < \frac{2}{4}$

11. A system of equations is shown below.

$3x + 2y = 19$

$2x - y = 1$

What is the solution to the system of equations?

A. $x = 1, y = 1$

B. $x = 3, y = 5$

C. $x = 7, y = -1$

D. $x = 19, y = 1$

12. Ali bought two shirts, one priced at $ 5.99 and the other at $ 12.00. Sales tax on his purchase was 7%. How much change should he have received if he paid with $ 20.00 bill? .

A. $ .75

B. $ 1.49

C. $ 2.15

D. $ 7.41

13. Sam wants the mean of his 5 geometry test scores to be at least 90%. His scores on the first four tests are 85%, 83%, 96% and 91%. What is the minimum score Sam can earn on the fifth test to meet his goal?

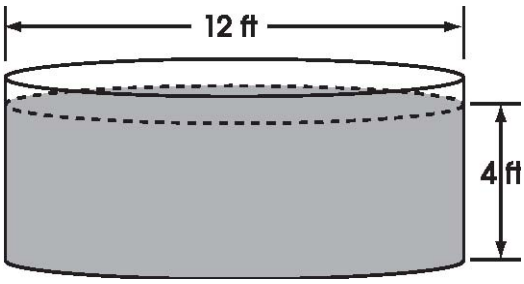
A. 89%

B. 90%

C. 95%

D. 100%

14. A circular pool has a diameter of 12 feet.



About how much water is needed to fill the pool to a depth of 4 feet?

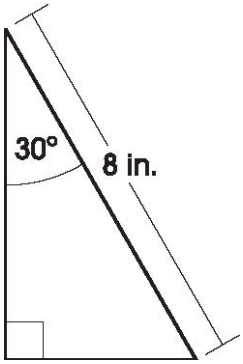
A. 75 cubic feet

B. 150 cubic feet

C. 450 cubic feet

D. 1,800 cubic feet

15. A right triangle has the dimensions as shown in the diagram below.



What is the approximate area of the triangle?

A. 8.0 square inches

B. 11.3 square inches

C. 13.9 square inches

D. 16.0 square inches

16. Which expression is not equivalent to 7?

A. -7

B. $\sqrt{49}$

C. 7^1

D. $\frac{7}{49}$

17. A TV is on sale for 15% off the regular price of $135. After the price reduction, a 5% sales tax is added. How much will a customer pay?

A. $141.75

B. $120.49

C. $114.75

D. $109.01

18. Ahmad knows that 3 liters of paints will cover an area of 200 square feet. He needs to paint an area of 800 square feets. Which of the following proportions could he use to find out how many litters of paints he should buy?

A. $\frac{200}{800} = \frac{?}{3}$

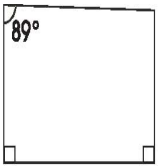
B. $\frac{800}{3} = \frac{200}{?}$

C. $\frac{3}{200} = \frac{?}{800}$

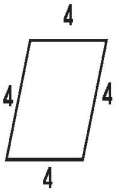
D. $\frac{3}{800} = \frac{200}{?}$

19. Which figure is not a parallelogram?

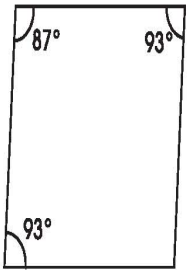
A.



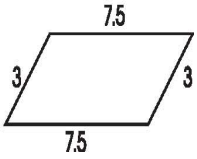
B.



C.

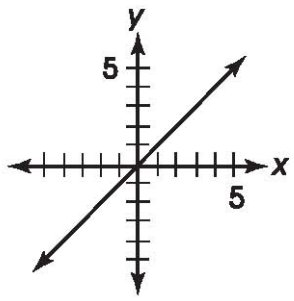


D.

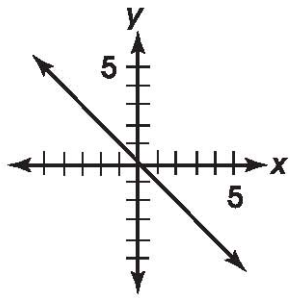


20. Which of these represents the graph of the equation $-3x + 4y = -12$?

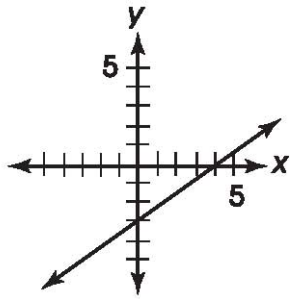
A.



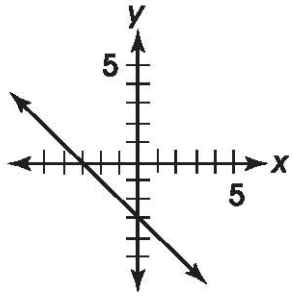
B.



C.



D.



Mathematics Achievement Test

(Arabic Version)

الزمن : دقيقة الاسم : .....

ضع دائرة حول رمز الاجابة الصحيحة

1) الجدول أدناه يبين نتائج تجربة في الأحياء

تسجيل زهرات نبات

الاسبوع	1	2	3	4	5
عدد زهرات النبات	3	9	27	81	س

1. افترض أن النمط الظاهر في الجدول مستمر، ما قيمة س ؟

أ) 108 ب) 130 جـ) 162 د) 243

2. أي المعاملات التالية تكافيء المعادلة 3(2س – 5) = 4(س+3)؟

أ. 2س = -27
ب. 2س = 27
ج. 10س = 27
د. 10س = -3

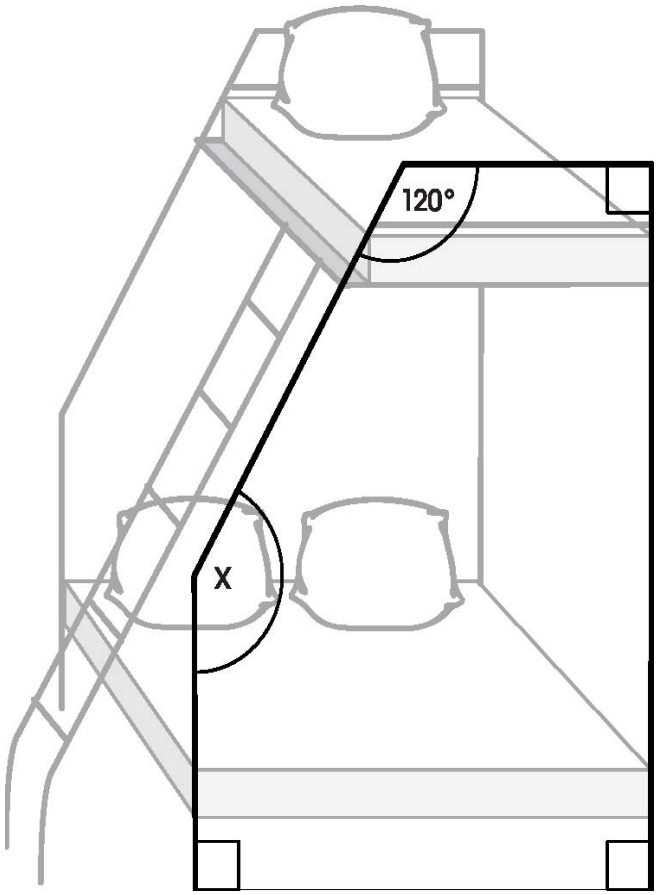
3. إذا كانت أ = 7 ، ب = -4 ، ما قيمة أب – 2ب؟

أ. -36

ب. -20
ج. 20
د. 36

4. في الشكل ادناه ما مياس الزاوية x؟

أ. 540˚
ب. 390˚
ج. 150˚
د. 120˚



5. أعطت ثلاثة استطلاعات للرأي نتائج مختلفة لنسب المقترعين الذين سيصوتون للمرشح أ في انتخابات رئيس البلدية

الاستطلاع "1" : 9 مقترعين من 20 يتوقع أن يصوتوا للمرشح أ.

الاستطلاع "2" : نسبة المقترعين الذين يتوقع أن يصوتوا للمرشح أ تساوي 52%.
الاستطلاع "3" : هناك 130000 شخص يتوقع أن يصوتوا، و 55000 منهم يتوقع أن يصوتوا للمرشح أ.

حدد أيّ الاستطلاعات الواردة أعلاه تعتبر نتيجة مفضلة للمرشح أ.

6. مجموعة من البيانات تحتوي (10) أعداد سالبة، وأربعة أعداد موجبة، أي الجمل التالية يجب أن تكون صحيحة؟

أ. الوسط الحسابي عدد سالب.
ب. الوسيط عدد سالب.
ج. المنوال عدد موجب.
د. المدى عدد سالب.

7. أي من التعبيرات التالية تمثل العدد 270000 مكتوباً بالصورة العلمية؟

أ. 270×10^{3}
ب. 27×10^{4}
ج. 2.7×10^{5}
د. 0.27×10^{6}

8. الجدول التالي يبين قيم س ، ص

ص	س
1-	0
0	1
3	2
8	3
15	4
24	5

أي هذه المعادلات تمثل العلاقة بين س & ص ؟

أ. ص = س – 1

ب. ص = س + 19
ج. ص = س² _ 1
د. ص = 2س – 5

9. أي الاعداد التالية غير نسبي؟

د) -8 جـ) 3 ب) $\sqrt{8}$ -2

10. أي الجمل التالية جملة صحيحة؟

أ. $-\frac{4}{2} \rangle \frac{2}{4}$
ب. $-\frac{2}{4} \rangle -\frac{4}{2}$
ج. $-\frac{2}{4} \rangle -\frac{4}{2}$
د. $\frac{4}{2} \rangle \frac{2}{4}$

11. لديك نظام المعادلات التالي:

3س + 2ص = 19
2س – ص = 1

ما هو حل هذا النظام؟

أ. س = 1 ، ص = 1
ب. س = 3 ، ص = 5
ج. س = 7 ، ص = -1
د. س = 19 ، ص = 1

12. اشترى علي قميصين، سعر الاول 5.99 ديناراً، وسعر الآخر 12.00 ديناراً. وكانت ضريبة المبيعات على مشترياته 7%، كم سيعيد البائع له إذا دفع (20) ديناراً؟

د) جـ) 2.15 ديناراً ب) 1.49 ديناراً أ)0.75 ديناراً
100%

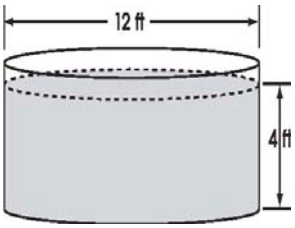
13. سامي يريد أن يكون الوسط الحسابي لعلاماته في خمسة اختبارات في الهندسة على الاقل 90%، علاماته في أول أربعة اختبارات 85% ، 83% ، 96%، 91% ، فما هي أقل علامة يجب أن يحصل عليها سامي ليحقق هدفه؟

د) 100% جـ) 95% ب) 90% أ) 80%

14. بركة دائرية يبلغ قطرها 12 متراً. انضر الشكل ادناه

كم من الماء تقريبا نحتاج لتعبئة البركة
الي عمق 4 امتار

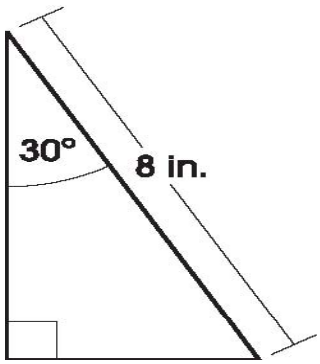
أ. 75 مترا مكعب.
ب. 150 مترا مكعب.
ج. 450 مترا مكعب.
د. 1800 مترا مكعب.



15. مثلث قائم الزاوية له الابعاد المبينة في الشكل ادناه.

ما المساحة التقريبية لهذا المثلث؟

أ. 8.0 إنش مربع.
ب. 11.3 إنش مربع.
ج. 13.9 إنش مربع.
د. 16.0 إنش مربع



16. أي التعبيرات التالية لا يساوي 7؟

أ. |-7|
ب. $\sqrt{49}$
ج. (7)
د. 7/49

17.جهاز تلفاز عليه تنزيلات 25% وسعره العادي 200 دينار. وبعد تخفيض السعر تضاف ضريبة مبيعات مقدارها 10%.

فكم سيدفع المشتري؟

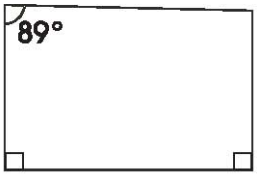
أ. 141.75 ديناراً.
ب. 120.49 ديناراً.
ج. 114.75 ديناراً.
د. 165.00 ديناراً.

18. يعلم أحمد أن 3 لترات من الدهان يمكن أن تدهن مساحة 200 قدم مربع، وهو يحتاج لدهان 800 قدم مربع، أي التناسبات التالية يمكن أن تستخدم لإيجاد كمية اللترات من الدهان التي يجب أن يشتريها؟

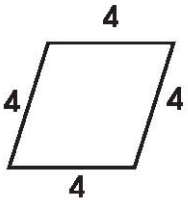
أ) $\frac{200}{800} = \frac{x}{3}$ ب) $\frac{800}{3} = \frac{200}{x}$ جـ) $\frac{3}{200} = \frac{x}{800}$ د) $\frac{3}{800} = \frac{200}{x}$

19.أي الأشكال التالية ليست متوازي أضلاع؟

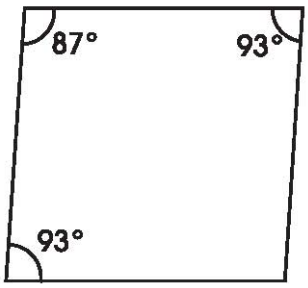
A.



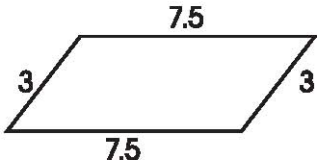
B.



C.

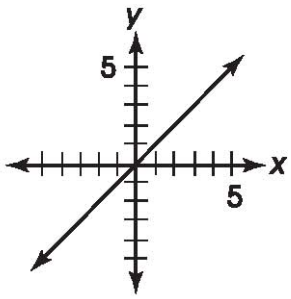


D.

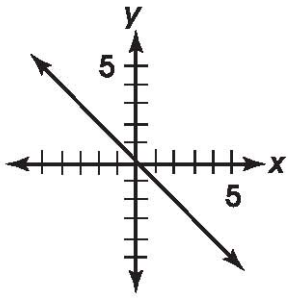


20. أي الرسومات التالية تمثل المعادلة -3س + 4ص = 12-؟

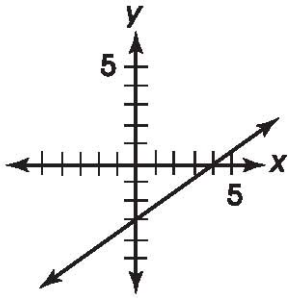
A.



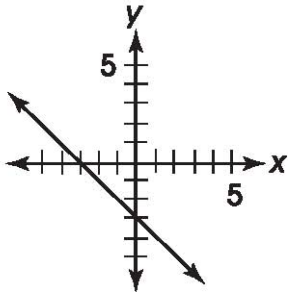
B.



C.



D.



Appendix B

Aiken Attitude to Mathematics Scale

SA= Strongly Agree
A= Agree
U=Undecided
D= Disagree
SD= Strongly Disagree

****

Participant Name:

Please check X in one answer that describe your opinion

No	Scale	SA	A	U	D	SD
1	Mathematics is not a very interesting subject.					
2	I want to develop mathematics skills and study this subject more					
3	Mathematics is a very worthwhile and necessary subject					
4	Mathematics makes me feel nervous and uncomfortable					
5	I have usually enjoyed studying mathematics at school					
6	I do not want to take any more mathematics than I Absolutely have to					
7	Other subjects are more important to people than Mathematics					
8	I am very calm and unafraid when studying mathematics					
9	I have seldom liked studying mathematics					
10	I am interested in acquiring further knowledge of Mathematics					

11	Mathematics helps to develop the mind and teaches a person to think					
12	Mathematics makes me feel uneasy and confused					
13	Mathematics is enjoyable and stimulating to me					
14	I am not willing to take more than the required amount of mathematics					
15	Mathematics is not especially important to everyday life					
16	Trying to understand mathematics does not make me anxious					
17	Mathematics is dull and boring					
18	I plan to take as much mathematics as I possibly can during my education					
19	Mathematics has contributed greatly to the progress of Civilization					
20	Mathematics is one of my most dreaded subjects					
21	I like trying to solve new problems in mathematics					
22	I am not motivated to work very hard on mathematics Problems					
23	Mathematics is not one of the most important subjects for people to study					
24	I do not get upset when trying to work mathematic problems					

Aiken Attitude to Mathematics Scale

(Arabic Version)

****

الاسم :---------- الزمن:

من فضلك اقرا العباره جيدا ثم اختار واحدا من الخيارات الخمسه التى تمثل رايك تماما بوضع X في المكان المناسب	اوافق بدرجه كبيره	اوافـق	غير متاكد	اعارض	اعارض بدرجه كبيره
1- الرياضيات ليست ماده مسليه جدا					
2. انا اريد تطوير مهاراتي في الرياضيات اكثر ولاستمرار في دراسه الرياضيات					
3. الرياضيات ماده قيمه جدا وضروريه					
4. الرياضيات تجعلني اشعر بالنرفزه وعدم الارتياح					
5. انا عاده استمتع بدراسه الرياضيات في المدرسه					
6. انا لا احب ان ادرس زياده في الرياضيات اكثر مما هو مطلوب منى					
7. المواد الاخري اهم للناس من الرياضيات					
8. انا هادئ جدا وغير خائف عند دراسه الرياضيات					
9. انا نادرا ما احب دراسه الرياضيات					
10. انا مهتم لادراك اكثر عمقا في في معرفه ه الرياضيات					
11. الرياضيات عامل مساعد في تطوير الذهن وتعليم الشخص كيف يفكر					
12. الرياضيات تجعلنى اشعر بعدم السهوله والارتباك					
13. الرياضيات ممتعه وجذابه لى					

من فضلك اقرا العباره جيدا ثم اختار واحدا من الخيارات الخمسه التى تمثل رايك تماما بوضع X في المكان	اوافق بدرجه كبيره	اوافـق	غير متاكد	اعارض	اعارض بدرجه كبيره
14. انا لست مهتم لاخذ اكثر من المقدار المطلوب في الرياضيات					
15. الرياضيات ليست ذات اهميه خاصه في الحياه اليوميه					
16. المحاوله لفهم الرياضيات لا تجعلنى اشعر بالقلق					
17. الرياضيات مملة وتشعرني بالضجر					
18.انا اخطط لدراسه اكبر قدر من مواد الرياضيات التى ستتاحU لUي خلال تعليمي					
19. الرياضيات تسهم بشكل رائع في تطوير الحضاره					
20. الرياضيات واحده من اكثر المواد التى اتخوف منها					
21. انا احب محاوله حل مساله رياضيات جديده علي					
22. انا غير متشجع للعمل بجديه عاليه في مسائل الرياضيات					
23. الرياضيات ليست واحده من اهم المواد التى ينبغي للناس دراستها					
24. لا اغضب عندما احاول الحصول علي الجواب الصحيح في مساله رياضيات					

Appendix C

Interview Questions

1-When did you start studying mathematics? Before entering school, did you know how to count or anything related to math?

2-Did anyone change your thinking about mathematics, for example, your teacher, dad, and friend? Why or why not?

3-Do you like mathematics? Why or why not?

4-What subjects of math do you like (Geometry, Algebra, Statistics, etc) Why?

5-Do you think to be good in math you have to do all mathematics homework correctly without any mistakes? Why or why not

6-Which of the following statements would you choose and why?

- a- Math is a fun subject
- b- Math is not a fun subject

7-Do you think mathematics is an important subject for your future life? Why or why not?

8-Do you think mathematics is more difficult than other subjects? Why or why not?

9- Do you like to study mathematics without taking examinations? Why or why not?

10-how do you feel about mathematic and do you know how other students feeling about mathematics? Why?

11- How do you feel about mathematics and do you know how other students feeling about mathematics? Why?

12- Do you like to learn mathematics and what do you think about other students' attitudes toward learning mathematics? Why?

13- Did any math teacher influence your attitude toward learning mathematics, and how do you think mathematics, teachers influence students' attitudes toward learning mathematics?

14- Did any math teacher affect your mathematics achievement, and how do you think mathematics teachers affect the students' achievement? Why?

15- Who do you think does better in mathematics, males or females? Why?

Interview Questions

(Arabic Version)

اسئله المقابلـــــه

1. متى بدات دراسه الرياضيات ؟ هل كنت تعرف ان تعد او اي شيء قريب للرياضيات قبل دخولك المدرسه ؟
2. هل اثر احد ما في تغيير مفهومك للرياضيات ؟ علي سبيل المثال مدرسك؛ والدك؛صديقك؛ لماذا؛ او لماذا لا ؟
3. هل تحب ماده الرياضيات ؟ لماذا؛ او لماذا لا ؟
4. اي فرع من فروع الرياضيات تفضل ؟ على سبييل المثال الاحصاء؛ الجبر؛ الهندسه؛ ولماذا ؟
5. هل تعتقد انه لتكون جيدا في الرياضيات؛ لابد ان تكون جيدا وسريعا في حل الالغاز ؟ لماذا؛ او لماذا لا ؟
6. هل تعتقد انه لتكون جيدا في الرياضيات؛ لا بد ان تجيب علي جميع الواجبات المنزليه بشكل صحيح ؟ماذا؛ او لماذا لا ؟
7. اى من الجمل التاليه التاليه تفضل ولماذا ؟

ا- الرياضيات ماده مسليه

ب- الرياضيات ماده غير مسليه

8 . هل تعتقد ان الرياضيات ماده مهمه في حياتك المستقبليه ؟ لماذا؛ او لماذا لا ؟

9. هل تعتقد ان الرياضيات اصعب من المواد الاخري ؟ لماذا؛ او لماذا لا ؟

10 هل تحب ان تدرس ماده الرياضيات بدون اخذ اي امتحان في ذلك ؟ لماذا؛ او لماذا لا ؟

11 ما هو شعورك لماده الرياضيات ؟ وهل تعرف كيف يشعر زملاءك الطلاب تجاه ماده الرياضيات؛ ولماذا ؟

12 هل تحب ماده الرياضيات ؟ وما رايك في رغبه الاخرين في تعلم ماده الرياضيات ؟ ولماذ

13 هل اثر مدرس ما في تغير مفهومك للرياضيات ؟ ؛ وكيف تعتقد ان معلم الرياضيات يؤثر في مفهوم الطلبه الاخرين لتعلم الرياضيات ؟

14 هل اثر احد مدرسي الرياضيات في تحصيلك في هذه الماده ؟ وكيف تعتقد ان معلم الرياضيات يؤثر في تحصيل الطلاب للماده نفسها ؟

15 من هو في اعتقادك افضل في تحصيل الرياضيات الاولاد ام البنات ؟ لماذا ؟

Appendix D

Reliability

RELIABILITY ANALYSIS - SCALE (ALPHA)

MALES AND FEMALES ATTITUDE

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
P1	77.9186	371.5716	.5768	.9197
P2	77.4576	383.8681	.4196	.9223
P3	77.3322	374.9709	.5719	.9199
P4	78.1898	369.2019	.5837	.9196
P5	77.7661	388.6016	.3139	.9240
P6	78.4780	375.1143	.5379	.9204
P7	78.4136	380.0121	.4752	.9215
P8	78.0644	374.2986	.5379	.9204
P9	78.3864	368.2651	.6735	.9180
P10	77.7119	375.5732	.5975	.9195
P11	76.9153	390.0030	.3736	.9228
P12	78.1932	366.0884	.6483	.9184
P13	78.0373	362.7775	.7332	.9168
P14	78.4000	379.9959	.4489	.9220
P15	77.5898	379.8958	.4615	.9217
P16	77.8000	380.6027	.4444	.9220
P17	78.0780	361.3646	.7390	.9166
P18	78.1288	373.5208	.5557	.9201
P19	77.1898	382.5761	.4768	.9214
P20	77.8508	356.8416	.7792	.9157
P21	77.7085	372.2753	.5966	.9194
P22	77.9356	373.0469	.6099	.9192
P23	77.8373	377.6469	.4715	.9216
P24	77.8542	371.2338	.6056	.9192

Reliability Coefficients

N of Cases = 295.0 N of Items = 24

Alpha = .9232

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

MALES AND FEMALES ACHIEVEMENT

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1	11.1741	9.4319	.2570	.6244
Q2	11.3174	9.0119	.2958	.6163
Q3	11.3857	9.3336	.1371	.6352
Q4	11.4334	8.8149	.3136	.6127
Q5	11.3686	9.1582	.2091	.6263
Q6	11.7884	9.3112	.1386	.6353
Q7	12.0102	9.9828	-.0809	.6494
Q8	11.3652	9.2258	.1846	.6293
Q9	11.6075	9.4310	.0769	.6447
Q10	11.4027	8.8030	.3303	.6107
Q11	11.2321	9.1857	.2990	.6182
Q12	11.4471	8.8508	.2958	.6150
Q13	11.5529	8.5905	.3691	.6042
Q14	11.7270	8.8019	.3070	.6133
Q15	11.7782	9.2006	.1759	.6307
Q16	11.2321	9.0761	.3543	.6129
Q17	11.3413	8.7119	.4034	.6027
Q18	11.5734	8.9783	.2301	.6239
Q19	11.3925	9.2324	.1724	.6309
Q20	11.7509	9.3179	.0916	.6448

Reliability Coefficients

N of Cases = 293.0 N of Items = 20

Alpha = .6364

Appendix E

Permission To Use Ohio Graduation Practice Test

From: Heffner, Stan" <Stan.Heffner@ode.state.oh.us

To: sam'" <mrayyan1@yahoo.com

RE: Permission Granted

Date: Mon, 8 Nov 2004 07:31:07 -0500

Hello Sam:

After reviewing your request I am happy to grant you permission to use the practice form of the Ohio Graduation Test in mathematics as part of your academic studies. I wish you the very best as you seek to measure the mathematics achievement of students in Amman, Jordan.

Stan W. Heffner
Associate State Superintendent
Center for Curriculum and Assessment
Ohio Department of Education
25 South Front Street, Mail Drop 601
Columbus, Ohio 43215-4183

Appendix F

IRB Approval

The University of Oklahoma

OFFICE FOR HUMAN RESEARCH PARTICIPANT PROTECTION

March 10, 2005

Professor Jon Pedersen
Instructional Leadership and Academic Curriculum
820 Van Vleet Oval, Rm. 114
CAMPUS MAIL

Dear Professor Pedersen:

The Institutional Review Board-Norman campus has reviewed your proposal, "An Investigation of the Relationship Between Students' Attitude Toward Learning Mathematic and Mathematics Achievement with Respect to Gender among 10th Grade Students in Amman, Jordan," under the University's expedited review procedures, Categories:

6. *Collection of data from voice, video, digital, or image recordings made for research purposes.*

7. *Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.*

The Board found that this research would not constitute a risk to participants beyond those of normal, everyday life, except in the area of privacy, which is adequately protected by the confidentiality procedures. Therefore, the Board has approved the use of human subjects in this research.

This approval is for a period of twelve months from March 10, 2005, provided that the research procedures are not changed from those described in your approved protocol and attachments. Should you wish to deviate from the described subject protocol, you must notify this office, in writing, noting any changes or revisions in the protocol and/or informed consent document and obtain prior approval from the Board for the changes. A copy of the approved informed consent documents is attached for your use.

At the end of the research, you must submit a short report describing your use of human subjects in the research and the results obtained. Should the research extend beyond 12 months, a progress report must be submitted with the request for continuation, and a final report must be submitted at the end of the research.

If data are still being collected after five years, resubmission of the protocol is required.

Should you have any questions, please contact me at 325-8110 or irb@ou.edu.

Cordially,

Grayson Noley, Ph.D.
Vice Chair
Institutional Review Board-Norman Campus (FWA #00003191)

FY2005-270

Cc: Mr. Sam Mriano, Instructional Leadership & Academic Curriculum
Graduate College

660 Parrington Oval, Suite 316, Norman, Oklahoma 73019-3085 PHONE: (405) 325-8110 FAX: (405) 325-2373

Appendix G

Frequency and Percentage of Mathematics Achievement Test Score

Score	Frequency	Percent
2	1	.3 %
4	3	1.0 %
5	3	1.0 %
6	5	1.6 %
7	10	3.3 %
8	15	4.9 %
9	28	9.2 %
10	24	7.8 %
11	36	11.8 %
12	38	12.4 %
13	44	14.4 %
14	23	7.5 %
15	27	8.8 %
16	22	7.2 %
17	20	6.5 %
18	6	2.0 %
19	1	.3 %
Total	306	100.0 %

Appendix H

Likert-Scale Total Percentage of

(A+SA and D+SD)

Item	Male		Female	
	A + SA	D+ SD	A + SA	D+ SD
1	32.7	55.6	34	59.5
2	66.7	18.3	66	17.6
3	73.2	17.0	77.8	17.0
4	39.2	46.4	39.9	47.7
5	60.1	23.5	59.5	27.5
6	47.7	35.9	45.8	39.2
7	35.9	33.3	43.8	30.1
8	52.3	29.4	47.7	39.9
9	43.8	37.9	49	43.1
10	66.7	17.0	56.9	27.5
11	84.3	9.8	85.6	5.9
12	41.8	46.4	38.6	47.1
13	45.8	37.9	52.3	35.9
14	46.4	34.6	48.4	43.1
15	26.8	61.4	18.3	68.6
16	58.2	26.1	63.4	29.4
17	35.3	48.4	39.2	50.3
18	45.8	28.8	45.8	39.9
19	79.1	9.2	74.5	13.7
20	34	54.9	30.1	59.5
21	59.5	22.2	62.1	30.1
22	28.1	47.1	26.1	57.5
23	30.1	54.9	30.7	58.8
24	55.6	26.8	59.5	30.7

Appendix I

2004 Ohio Graduation Practice Test

Student Name

OHIO GRADUATION TESTS

Mathematics

Test

Spring 2004

This test was originally administered to students in March 2004. This publicly released material is appropriate for use by Ohio teachers in instructional settings. The test is aligned with Ohio's Academic Content Standards.

MATHEMATICS TEST

Directions: For multiple-choice items, solve each problem, choose the correct answer, and then blacken the corresponding space on your answer document. *Located on the inside cover of the answer document is grid paper that may be used for multiple-choice questions.* When you respond to the short-answer and extended-response items, you do not have to use *the entire area of the grid* space provided. Be sure that your answers are complete *and all of your work is in your answer document.*

1. The table below contains the results of a biology experiment.

Record of Blooms

Week	1	2	3	4	5
Number of Blooms	3	9	27	81	*b*

Assuming the pattern shown in the table continues, what is the value of *b*?

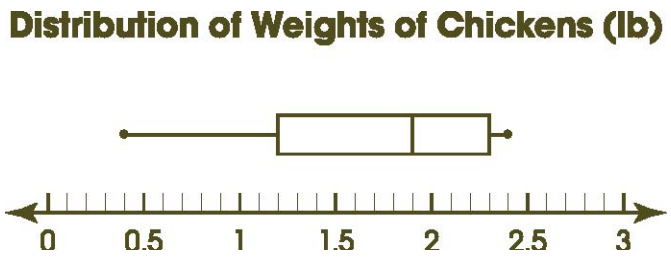
A. 108

B. 130

C. 162

D. 243

2. The box-and-whisker plot below describes the weights of a sample of 100 chickens.



What statement can be made about the data, using the graph alone?

A. The range of the weights is 3 lb.

B. The median weight is less than 2 lb.

C. Twenty-five percent of the chickens weigh less than 1 lb.

D. Fifty percent of the chickens weigh more than 2 lb.

3. Which equation is equivalent to $3(2x - 5) = 4(x + 3)$?

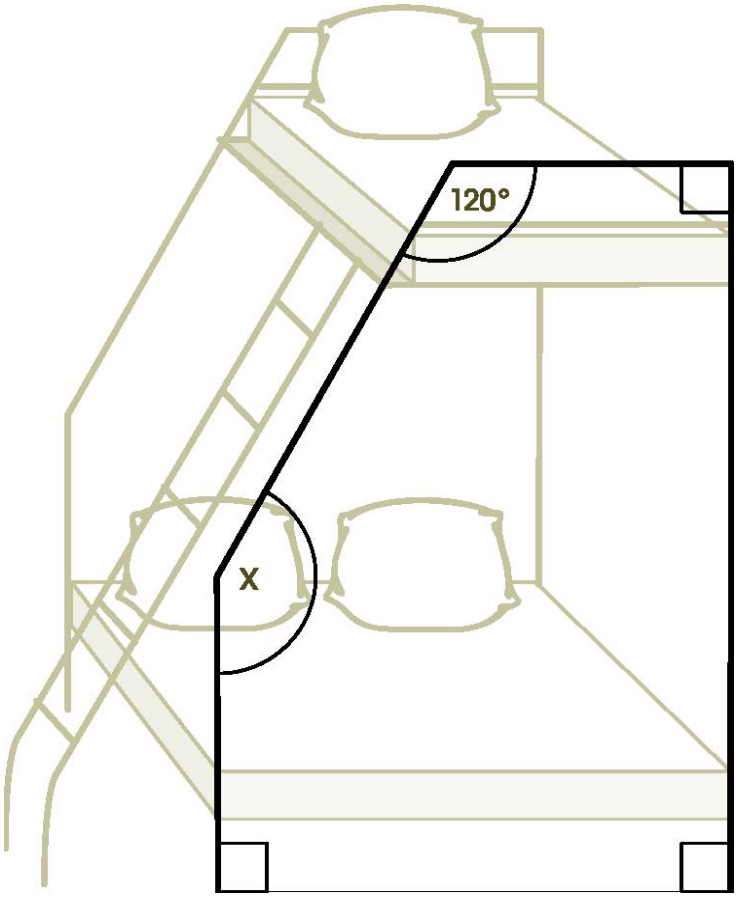
A. $2x = -27$

B. $2x = 27$

C. $10x = -27$

D. $10x = -3$

4. Darius and his father are constructing a set of bunk beds as shown in the diagram below.



What is the measure of angle X?

A. 540°

B. 390°

C. 150°

D. 120°

5. Three different opinion polls show different results for the proportion of voters expected to vote for Candidate A in an election for mayor.

   Poll 1: Nine of every 20 voters are expected to vote for Candidate A.

   Poll 2: The percentage of voters expected to vote for Candidate A is 52%.

   Poll 3: There are 130,000 people expected to vote, and of these, 55,000 are expected to vote for Candidate A.

   In your Answer Document, determine which of these polls shows the greatest favorable result for Candidate A. Show your work or provide an explanation for your answer.

6. A set of data contains 10 negative numbers and 4 positive numbers. Which one of these statements must be true?

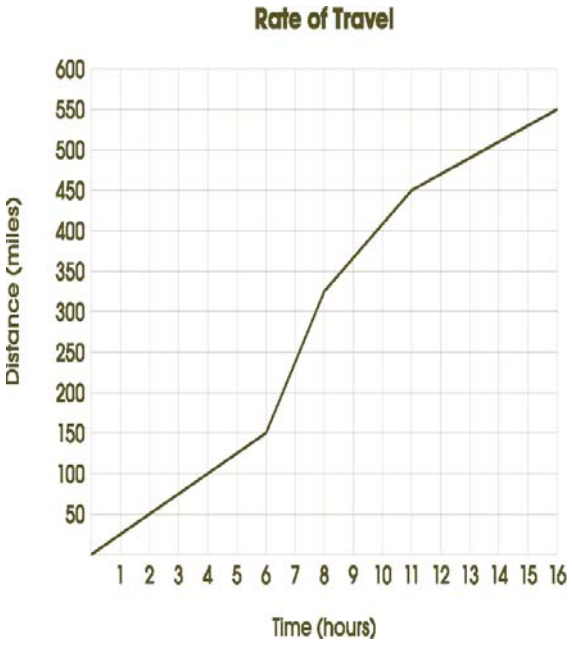
   A. The mean is a negative number.

   B. The median is a negative number.

   C. The mode is a negative number.

   D. The range is a negative number.

7. Travis went on a long trip. The graph below represents the relationship between distance and time.



During what interval was Travis' average rate of travel the fastest?

A. 0 to 6

B. 6 to 8

C. 8 to 11

D. 11 to 16

8. Which expression represents 270,000 written in scientific notation?

A. 270×10^{3}

B. 27×10^{4}

C. 2.7×10^{5}

D. 0.27×10^{6}

9. The table below shows values for x and y.

x	y
0	–1
1	0
2	3
3	8
4	15
5	24

Which of these equations represents the relationship between x and y?

A. $y = x - 1$

B. $y = x + 19$

C. $y = x - 1$

D. $y = 2x^2 - 5$

10. Triangle DEF has vertices with coordinates D (–2, 1), E(1, 5) and F(2, 3). In your Answer Document, draw and label triangle DEF on the grid provided. Draw the triangle D′E′F′ by translating each vertex of triangle DEF three units to the right and two units down. Appropriately label D″E″F″. Describe the movements necessary to perform a single translation of each vertex from triangle DEF to triangle D″E″F″.

11. Which number is irrational?

A. −2

B. $\sqrt{8}$

C. 3

D. 22/8

12. Julie does not want to spend more than $300 on ice skating. Her skates will cost $42, her lessons will cost a total of $56, and the practice time will cost $7.50 per hour.

Which inequality should Julie use to determine the maximum number of hours, h, she can practice without spending more than $300?

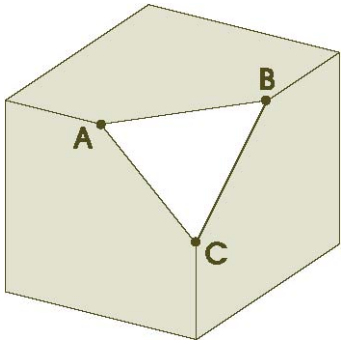
A. $56 + 7.50\,h < 300$

B. $42 + 7.50\,h < 300$

C. $7.50\,h - 42 - 56 \leq 300$

D. $42 + 56 + 7.50\,h \leq 300$

13. Daniel cut the corner off a cube as shown in the diagram below.



Points A, B and C are the midpoints of the edges of the cube. What type of three-dimensional figure has been cut off?

A. cone

B. cube

C. triangular prism

D. triangular pyramid

14. Pippi calculates her total earnings for the month with the equation

$$E = 15m + 5b,$$

where E is the total number of dollars she earns, m is the number of lawns she mows, and b is the number of hours she baby-sits. If Pippi mows 6 lawns, how many hours must she baby-sit to earn a total of $200?

A. 20

B. 22

C. 40

D. 45

15.The population density of a state, in people per square mile, is found by dividing the population of the state by its area in square miles. Florida has an area of 53,936 square miles. In 1998, Florida had a population of 14,915,980 and a population density of 276.5 people per square mile. For question 15, respond In your Answer Document, describe the completely in your Answer conditions under which a different state could Document. (2 points) have a smaller population than Florida but have a greater population density.

16. George wants to conduct a survey to determine the types of music that the students want at a school dance. Which sample population should George survey to represent the entire student body?

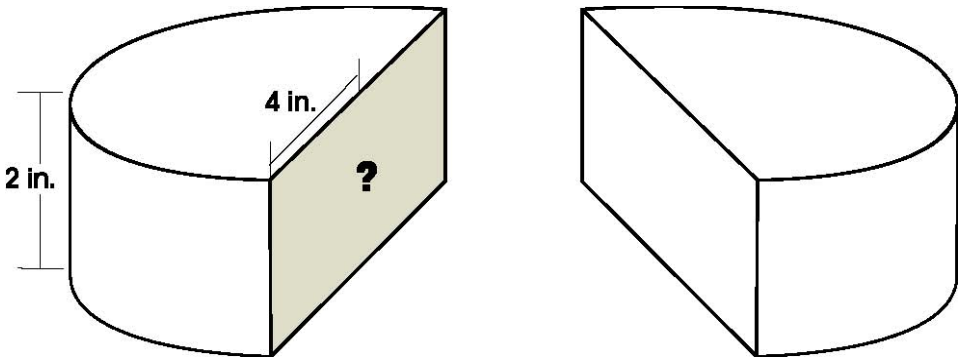
A. survey the teachers

B. survey the captain from each sports team

C. randomly survey two people from each homeroom class

D. randomly survey 50 people from the freshman class

17. Gene has a cylinder with radius 4 inches and height 2 inches. He cut the cylinder in half along the length of the diameter, as shown in the diagram below.



What is the area of the shaded cross-section?

A. 48 π square inches

B. 24 π square inches

C. 16 square inches

D. 8 square inches

18. A system of equations is shown below.

$3x + 2y = 19$ $2x - y = 1$

What is the solution to the system of equations?

A. $x = 1, y = 1$

B. $x = 3, y = 5$

C. $x = 7, y = -1$

D. $x = 19, y = 1$

19. Carlos and Tiesha empty a bag of 100 colored candies and count the number of each color, as shown in the following chart.

Number of Candies of Each Color

Color	Number
Orange	20
Red	10
Brown	30
Green	10
Yellow	15
Blue	15

They return all the candies to the bag and shake the bag. Carlos removes 5 candies, 2 of which are blue. Tiesha then pulls out one candy. What is the probability that Tiesha pulls out a blue candy?

A. 6.67%

B. 13.68%

C. 15.00%

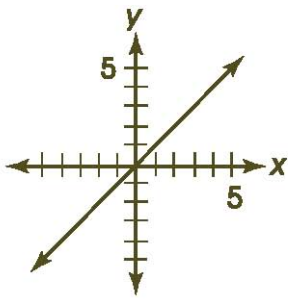
D. 15.79%

On the March 2004 Mathematics Ohio Graduation Test, questions 20–25 are field test items that are not released.

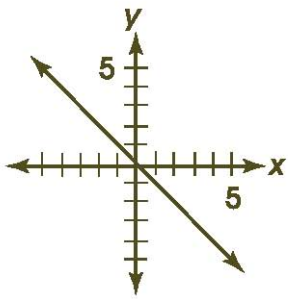
26. The floor plan of one room in a bookstore is a square with an area of 576 square feet. Part of this room is taken up by a café. The border of the café runs from the midpoints of two adjacent walls. In your Answer Document, find the area, in square feet, of the café. Show your work or explain how you found your answer.

27. Which of these represents the graph of the equation $-3x + 4y = -12$?

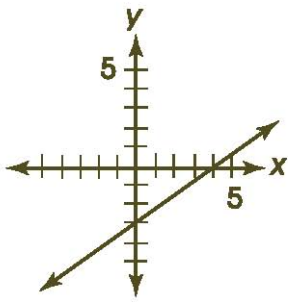
A.



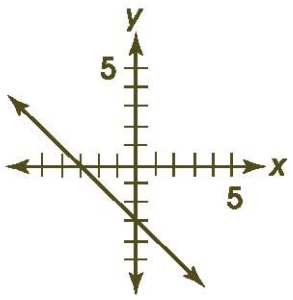
B.



C.



D.



28. What should be the minimum length of the box to hold the smaller mirror?

A. 2 inches

B. 6 inches

C. 9 inches

D.10 inches

29. The table shows the number of people who speak each of the six most common languages of the world.

Number of People (in millions)

Mandarin	English	Hindi	Spanish	Russian	Arabic
900	430	320	310	280	185

Which type of graph is appropriate to display the data in the table?

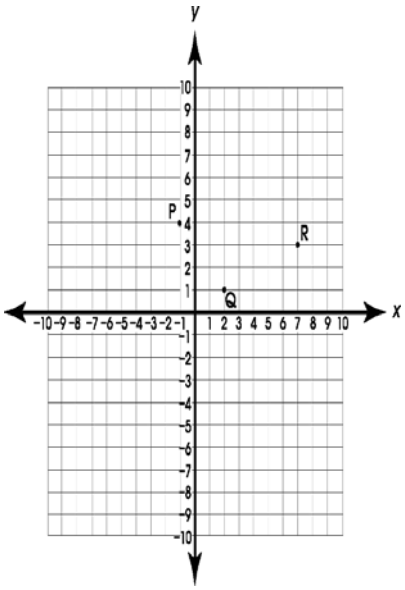
A. bar graph

B. box-and-whisker plot

C. line graph

D. scatter plot

30. Points P, Q and R are shown below.



These points are three vertices of a parallelogram. What are the coordinates of the fourth vertex of parallelogram PQRS?

A. (4, 6)

B. (5, 2)

C. (8, –1)

D. (9, 1)

31. Aaron wants the mean of his 5 geometry test scores to be at least 90%. His scores on the first four tests are 85%, 83%, 96% and 91%. What is the minimum score Aaron can earn on the fifth test to meet his goal?

A. 89%

B. 90%

C. 95%

D.100%

32. Cameron had $500 in savings on January 1. Quinn had $800 in savings on January 1. Cameron deposits $20 per week into his savings account. Quinn withdraws $15 per week from his savings account. In your Answer Document, write two equations:

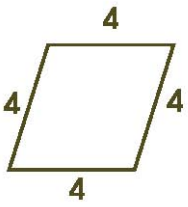
For question 32, respond completely in your Answer Document. (2 points)

one for the amount of money in Cameron's savings *x* weeks after January 1st, and one for the amount of money in Quinn's savings *x* weeks after January 1st. Determine the number of weeks until Cameron will have more money in his savings account than Quinn. Show your work or provide an explanation for your answer.

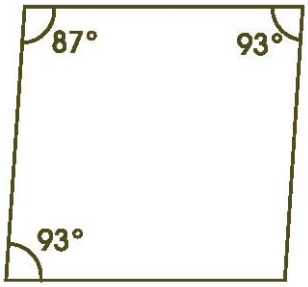
33. Which figure is not a parallelogram?

A.

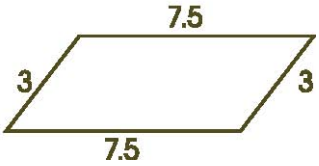
B.



C.



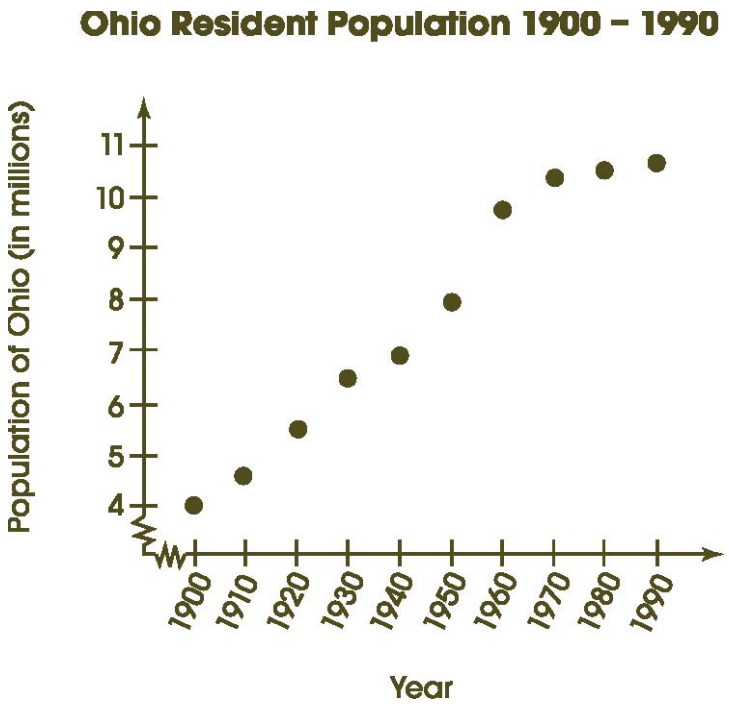
D.



34. The graph shows the population of Ohio from

1900 to 1990. Based on the data, in which decade did the population of Ohio increase the most?

A.	1910	to	1920
B.	1940	to	1950
C.	1950	to	1960
D.	1960	to	1970



35. The table below shows the number of fish caught each day last week.

Number of Fish Caught Each Day

Day	Number of Fish Caught
Monday	4
Tuesday	0
Wednesday	3
Thursday	2
Friday	0
Saturday	0
Sunday	5

If one day of that week is chosen at random, what is the probability that a minimum of one fish was caught that day?

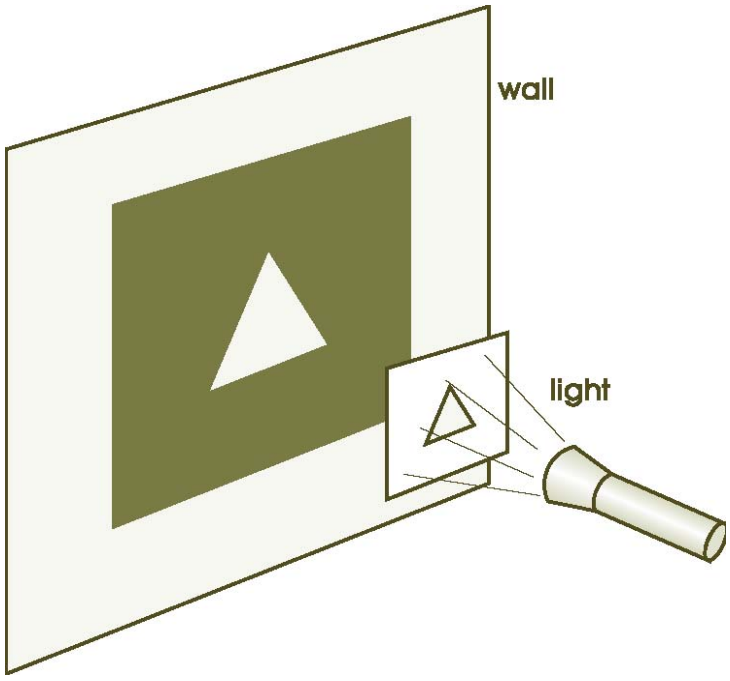
A. 3/7

B. 1/2

C. 4/7

D. 2/1

36. A student shines a light through a cutout of a triangle held parallel to a wall several feet straight in front of him, producing a similar image on the wall.



What must the two triangles have in common?

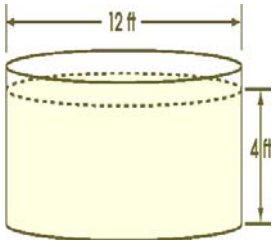
A. equal areas

B. equal heights

C. corresponding sides that are congruent

D. corresponding angles that are congruent

37. A circular pool has a diameter of 12 feet.



About how much water is needed to fill the pool to a depth of 4 feet?

A. 75 cubic feet

B. 150 cubic feet

C. 450 cubic feet

D. 1,800 cubic feet

38. Maria is making a quilt. She has a large piece of fabric that is 0.02 millimeters thick. The fabric is cut in half and one piece is placed on top of the other to make a pile. The pile is cut in half, and then one half is placed on top of the other to make a higher pile. Continuing this process, what would the thickness of the pile be after the 4th cut and piling?

A. 0.0016 millimeters

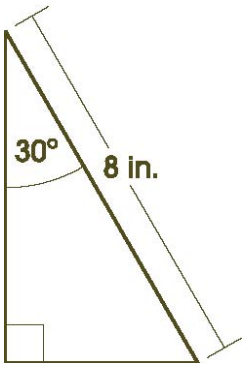
B. 0.08 millimeters

C. 0.32 millimeters

D. 16 millimeters

39. A town is conducting a survey to determine if the residents would use a new recreation facility. The survey must represent all different types of people who live within the town. Three different survey locations were proposed: a golf course, a day care center and a shopping mall. Every fifth person at the location would be asked to take part in the survey. In your Answer Document, determine which of the three proposed survey locations would provide the least amount of bias. Show your work or provide an explanation for your answer.

40. A right triangle has the dimensions as shown in the diagram below.



What is the approximate area of the triangle?

A. 8.0 square inches

B. 11.3 square inches

C. 13.9 square inches

D. 16.0 square inches

41. Which expression is not equivalent to 7?

A. $|-7|$

B. $\sqrt{49}$

C. 7^{1}

D. 7/49

42. A DVD player is on sale for 15% off the regular price of $135. After the price reduction, a 5% sales tax is added. How much will a customer pay?

A. $141.75

B. $120.49

C. $114.75

D. $109.01

43. Rene is selecting a menu for a party. He plans to select a meal that includes one main dish, one vegetable and one dessert from the following list of choices.

Party Menu		
Main Dish	Vegetables	Desserts
Stuffed chicken breast	Italian green beans	Peach cobbler
Grilled salmon	Corn on the cob	German chocolate cake
Beef tips	Glazed carrots	Banana pudding
	Baked potato	Ice cream with cookies
		Strawberry shortcake

How many different meals can Rene select?

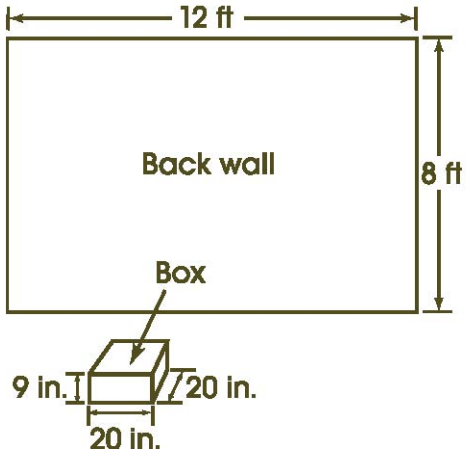
A. 12

B. 32

C. 35

D. 60

44. Identical boxes are to be stacked along the back wall of a storage room from floor to ceiling. The diagram shows the dimensions of the back wall and the dimensions of one of the boxes, which has a square base.



Which of these is the best estimate of the maximum number of boxes that can be stacked against the entire back wall?

A. 200

B. 70

C. 50

D. 1