# ADDIS ABABA UNIVERSITY
# SCHOOL OF GRADUATE STUDIES


## GENDER DIFFERENCES IN MATHEMATICS ACHIEVEMENT AS A FUNCTION OF MATH SELF-EFFICACY AND MATH ANXIETY AMONG BALE ZONE HIGH SCHOOL STUDENTS


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MAY, 2001

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# ABSTRACT

*The present study was conducted on 374 (188 females and 186 males) randomly selected high school students. The major purpose was to investigate the gender differences of 9th and 11th graders in mathematics achievement as a function of math self-efficacy and math anxiety.*

*To do this, mean difference tests and path analyses model were employed. Accordingly, in the four high school random samples of 9th and 11th grade boys and girls studied, the boys scored significantly higher than the girls did in math self-efficacy and in math achievement tests. The girls were significantly more anxious about math than the boys. However, no gender difference was found in math anxiety for 11th graders. The mean difference tests further suggest students with high math self-efficacy and low math anxiety scores were superior in their math achievement than those with low math self-efficacy and high math anxiety level. In addition, the correlational analyses indicate that math anxiety adversely affect the math self-efficacy and math achievement of high school students (grades 9 & 11). Thus, it is concluded that high school students who that they lack the confidence to do mathematical problems develop negative affect to the subject, which in turn results in negative attitude that culminates in poor math performance.*

*The path analyses model for the pooled subjects, except grade level, the other variables had revealed a statistically significant direct effect on math achievement. Math self-efficacy had strong direct and total effect on math achievement followed by math anxiety. Math self-efficacy had a mediational and predictive role in the academic arena. Regarding the gender sub-group path analyses model, for both genders math self-efficacy and math anxiety had statistically significant direct effects on math achievement, the predicting power being higher for males than females. For the pooled as well as the gender sub-group, the contribution of math self-efficacy to achievement was higher than the other variables considered in the study.*

# CHAPTER ONE

## 1. INTRODUCTION

### 1.1 Background of the Study

In the advancement of science and technology, in this rapidly changing world, the role of mathematics is highly pronounced. On a more fundamental level, according to Travers (1991) as cited in McCaul (1994), Mathematics is needed in every day life. Emphasizing the importance of mathematics, Meece, Wigfield, & Eccles (1990:430) noted that " a strong background in mathematics is critical for many career and job opportunities in today's increasingly technological society."

Similarly, Krutteskii (1976) as cited by Benbow and Arjmand (1990) posited that "the development of sciences has been recently characterized by a tendency for them to become more mathematical ... . Mathematical methods and mathematical style are penetrating every where." This is to mean, we cannot understand our computerized world without mathematics.

Moreover, Adeleke (1998) goes on confirming the above view points by saying that "mathematical techniques are constantly being developed to meet the changing requirements of Physics, Chemistry, Biology, Social and Behavioral Sciences, Engineering and Computer science. "In light of this, Setidisho (1961) as cited by Adeleke (1998) also indicates that no other subject forms a strong binding force among various branches of the sciences as mathematics.

Despite its importance, mathematics is a subject which many students experience difficulty with. Many students have mistaken impressions about mathematics and dislike mathematical activity; many seem to fear, even hate mathematics (Neale, 1969; cited in Yoseph, 1997).

More important, however, according to Wiloso & Boldizar (1994) as cited by Lopez et al (1997) is that many students shun mathematics courses in high school and that women continue to be underrepresented in many mathematics intensive academic majors and career fields. Although there have been significant increases in the enrollment of women in law, medicine, and business schools, women are still underrepresented in physical science and engineering programs and in all male dominated vocational education programs (Eccles, 1987).

Besides, NAEP (1988) as cited by Meece, Wigfield,& Eccles(1990) noted that students of both sexes, but particularly women do not attain a high level of competency, even if they have completed 4 years of high school math. In further support of the gender differences in 'mathematics, Lamb (1997) also expounded that, gender differences in many areas of participation in school are receding, but the gap favoring males in mathematics study in senior secondary school persists. Similarly, a considerable body of literature (e.g., Leder, 1986; Maccoby & Jacklin, 1974, 1978 ; Mills, Ablard, & Stumpf, 1993;Silkow, 1985) also report that males achieve higher mathematics scores than do females.

Regarding academic achievement of women, a research that analyzed O-Level (grades 11-12) examination results in Botswana, Zambia and Kenya revealed that girls performed poorer than boys in almost all subjects, specially in physical sciences, biology and mathematics. Nevertheless, girls did better in English literature in all the three countries (Duncan, 1989; cited in Genet, 1998).

Along with the previously mentioned findings, in the case of Ethiopia, girls who are enrolled in the school system show comparatively low school performance. In relation to this, Genet (1991) reports that in grades 6 and 8, girls have been performing poorly between the years 1978-1987 in mathematics and science. Furthermore, she states that girls have performed unsatisfactorily in mathematics in the Ethiopian School Leaving Certificate Examination (E.S.L.C.E).

Likewise, Sewnet (1995) on his part found significant gender differences in mathematics achievement in favor of boys while he was investigating factors affecting scholastic achievement of fifth graders in East Gojjam Zone. This was further confirmed by studies conducted on Junior and Secondary High Schools (Seleshi, 1995; Yoseph, 1997) regarding attitude towards mathematics. That is, the results of their study indicate gender differences in mathematics achievement in favor of boys.

In the same vein, Atsede's (1991) study vividly portrayed representational disparities of males and females in science and science related courses, although the causes for such discrepancies were not well discussed. The factors in her study were presented in their nutshell under one umbrella term: Traditional sex role stereotype.

It is, of course difficult to overlook the impinging effect of this factor on the academic behavior of both sexes. More specific factors that could bring about differences in academic achievement of male and female students must be further investigated to introduce the desired intervention programs. It is so because, scholars argue that non-cognitive factors constitute conditions that facilitate or hinder cognitive achievement (Makonnen, 1987).

From the local findings expressed thus far, it may be viewed that the exploration of gender differences in mathematics achievement as a function of self-efficacy and anxiety toward mathematics hasn't been given due attention.

Therefore, it is important to explore thoroughly whether math self-efficacy and math anxiety accounts for gender differences in mathematics achievement among high school students in the Ethiopian context.

## 1.2 Statement of the Problem

This study examines gender differences in mathematics achievement as a function of math self-efficacy and math anxiety. It aims at examining the following leading questions.

1. Are there statistically significant gender differences in the variables in the study?

2. Do students with high math self-efficacy scores and with low math anxiety scores differ, to a statistically significant extent, from students with low math self-efficacy scores and high math anxiety scores in their performance of mathematics?
3. Are there statistically significant differences between grade levels ($9^{th}$ & $11^{th}$) on the variables treated in the study?

4. Do gender, grade level, math self-efficacy, and math anxiety have direct and indirect effects on achievement of maths? If so, which one has the highest direct and indirect or total effects on math achievement? Which one is a statistically significant predictor of achievement?

5. Does math self-efficacy have a mediational role between gender and math achievement as well as a predictive role to math anxiety grade level and math achievement?

6. Do the effects of math self-efficacy, grade level, and math anxiety on math achievement have the same trend for the gender sub -groups?

## 1.3 Objectives of the Study

The major objective of this study was to undertake gender analyses with respect to the variables understudy, and to investigate the effects of the predictor variables on the criterion variable.

Having this major objective in mind, the study has the following specific objectives.

- To examine whether there is a statistically significant gender differences in the variables in the study.
- To investigate the direct and indirect or total effects of gender, grade level, math self-efficacy and math anxiety on achievement in mathematics.

- To determine the proportions of the joint and/or independent contribution of the predictor variables to the variability of the criterion variable (for the pooled as well as the gender sub-group subjects).

- To investigate whether students with high math self-efficacy and high math anxiety level differ, to a statistically significant extent from students with low math self-efficacy and low math anxiety in their performance of mathematics.

## 1.4 Significance of the Study

Gender differences in mathematics achievement as a function of math self-efficacy and math anxiety is a widely researched subject. Nonetheless, local research on the subject is scant. Therefore, examining the problem in the local context was timely and important. More specifically, the findings of this study might help:

1. to enhance and develop girls' level of confidence about mathematics so that to lift up their performance of math.

2. to encourage female students' participation in many male dominated subjects.

3. to initiate counseling intervention so that to increase students' perceptions of math self-efficacy and to reduce students' level of anxiety about mathematics.

4. to encourage educators, policy makers, curriculum designers, counselors, etc., to focus not only on the cognitive factors but also on the non-cognitive factors such as self-efficacy, anxiety, value perceptions, etc. in the teaching learning process.

5. to remind mathematics teachers to pay as much attention to students self-evaluations of competence as to actual performance.

## 1.5 Delimitation of the Study

A number of variables account for gender differences in mathematics achievement of high school students. This study, however, is focused only on math self-efficacy and math anxiety as a cause for gender differences in mathematics achievement of high school students. Furthermore, the study is delimited to two grade levels ($9^{th}$ and $11^{th}$) and four high schools of the Bale Zone. Grade 10 and 12 students were not included, because they were prepare for the Ethiopian General Secondary Education Certificate Examination (E.G.S.E.C.E) and the Ethiopian Secondary School Leaving Certificate Examination (E.S.L.C.E) respectively.

## 1.6 Operational Definition of Key Terms

**Achievement:** refers to students' mathematics performance as shown by their scores on a test prepared by the investigator on the basis of the mathematical syllabus and the contents of the textbooks of grades 9 and 11.

**Gender Differences:** refers to the differences between boys and girls in their mathematics achievement, math self-efficacy and math anxiety scores.

**Math Anxiety:** refers to feelings of tension, worrieness, helplessness, and mental disorganization when one is required to manipulate numbers or solve mathematical problems (Richardson and Suuin, 1972; Tobias, 1978; cited in Hunsley, 1987).

**Math Self-Efficacy:** refers to individuals' judgements of their capabilities to solve specific math problems, perform math-related tasks, or succeed in math related courses (Betz & Hackett, 1983; cited in Pajares & Miller, 1994).

**Path Analysis:** refers a statistical procedure, based on multiple regression that enables one to decompose correlations into direct and indirect effects (Feather, 1988).

**Self-efficacy:** refers to personal confidence in the ability to successfully perform a task at a given level (Shell, Murphy and Bruning, 1989).

# CHAPTER TWO

## 2. REVIEW OF RELATED LITERATURE

In this section of the study an effort is made to bring the works of different scholars and researchers on aspects of the gender disparities in mathematics achievement in relation to math self-efficacy and math anxiety. In so doing, the related literature is divided in five major parts: Gender Differences in mathematics achievement, The Role of self-efficacy in academic achievement, Gender Differences in math self- efficacy, The Role of math anxiety in academic achievement of math, and Gender Differences in math anxiety.

### *2.1.* Gender Differences in Mathematics Achievement

With regard to gender, Heyneman(1980) as cited by Yoseph(1997) beliefs that an individual's sex is one of the major factors associated with academic performance and a powerful predictor of achievement differences. Although much has been done in the field of gender differences, controversy remains unsolved.

In relation to mathematics,the existing gender variation in ability and achievement, mainly in mathematics, has been an important theme of research for quite many researchers.

Gender differences in mathematics achievement become more pronounced between the upper elementary school years and the last year of high school, and the size of differences shows a significant increase during this time span (Maccoby & Jacklin, 1974,1978). In this regard, studies of children's achievement (Douglas, 1964; Davie et al., 1972) as cited by Measor and Sikes(1992) show that girls consistently do better than boys academically through their primary education in all subjects with the possible exception of mathematics.

In contrast to the ongoing viewpoints, an examination of U.S., Australian, and British studies (Leder, 1990) reveals an inconsistency in the findings, with males performing better in some studies and females in others. Leder, however, notes that few consistent differences in performance in mathematics are found at early primary school level.

In the case of Junior schools, gender difference (Raymond & Benbow, 1986) is quite apparent in mathematics achievement. Another study by Murray (1977) that involved students from junior schools also revealed significant gender differences in ability favoring males. According to the study, controlling for IQ, this gender difference was found due to the superior achievement of boys in mathematics. In further support of this same position, Maccoby & Jacklin (1974) indicated almost all children labeled as exceptionally talented in mathematics by junior high schools are male.

Studies of mathematics ability and achievement (e.g., Carr & Jessup, 1997; Leder, 1986; Mokros & Koff, 1978; Silkow, 1985) have consistently found sex differences favoring males. In particular, at high school level, there is a substantial body of evidence to suggest that males frequently outperform females in mathematics (Lamb, 1997; Leder, 1990; Stipek & Gralinski, 1991).

From the standpoint of gender differences, Marshall (1984) also conducted a research that examined boy's and girl's performance on two types of mathematics items (computations and story problems). His findings revealed that girls are more likely than boys to be successful with story problems. On the other hand, according to Marshall & Smith (1987) and Johnson (1984) girls make different error than boys in their problem solving as a function of the ways in which they solve problems.

Although boys and girls don't differ in mathematics background or math performance in grade 8, significant sex differences were found in grade 11(Marshall, 1984). Likewise, in investigating the research question of male and female students' creative thinking ability and science achievement, Wey (1994) found that males got higher scores on fluency, originality, mathematics, and physics than females. The female students got high scores on flexibility and chemistry than male students. Englehard (1990) also examined the relation between gender and performance on a set of mathematics items. The study was conducted on 3924 adolescents (2040 girls and 1884 boys) in the United States and 3740 adolescents (1789 girls and 1951 boys) in Thailand. Accordingly, the result suggests that both levels of cognitive complexity and content category is related to gender differences. That is, gender differences tend to become more favorable toward boys as the level of cognitive complexity increases and also as the content changes from arithmetic through algebra to geometry.

To examine gender differences in mathematics achievement in general and the change in these differences across grade levels in particular, longitudinal studies seem to be more useful. One such study (Hilton & Bergland, 1974) uses data from Educational testing services on 1859 students from grades five, seven, nine, and eleven. His study reveals no significant gender differences in mathematics achievement at grade five levels though boys mean scores were higher than girls. However, the study discloses significant gender differences in favor of males at subsequent grade levels (7, 9 and 11). It should also be noted, however, that some investigator disclose substantial differences in favor of boys as early as the second grade (Mills, Ablard, & Stumpf, 1993 ).

A similar longitudinal study by Benbow & Stanely (1980) as cited by Yoseph (1997) also reports substantial gender differences in mathematical reasoning ability in favor of boys in intellectually gifted 9927 junior high school students. The investigators further reported that large gender differences in mathematical reasoning ability are observed between boys and girls with essentially identical formal educational experiences in mathematics. An other longitudinal study which includes over a thousand subjects (grade 3 & 6) also revealed that girls are more successful than boys in computations, where as boys are more likely to solve word problems in both grades (Marshall & Smith, 1987). Their study further revealed that females had fallen behind to a serious extent in word problems and geometry in grade 6.

Furthermore, few cross-sectional studies employed subtests such as geometry, algebra, and measurement in examining gender differences in mathematics achievement. For example, Fennema & Carpenter (1981) as cited by Yoseph (1997) have analyzed data from a representative sample (over 70,000) of 9-, 13-, and 17- year olds that participated in the national Assessment of Educational progress (NAEP). In the study, the investigator objectives were to examine gender differences and to detect the significance of this difference. The result of their study indicated that no clear pattern of differences in achievement was observed at age nine or thirteen, where as at age seventeen males average performance exceeds that of females at every cognitive level (knowledge, understanding, and applications). That is, females scored higher on lower level number and numeration skills at ages nine and thirteen, where as males scored higher on multi-step word problems in this content area at all ages.

On the other hand, a study conducted by Byrnes & Takahira (1993) reported controversial issues of gender. In the study, high school students were given SAT.M items and measure of their prior knowledge and strategies. Results in this case showed that male students performed better than female students on the SAT items. Regression analysis, however, showed that where as prior knowledge and strategies explained nearly 50% of the variance in SAT scores, gender explained no unique variance. Therefore, their findings suggest that it is not one's gender that matters as much as one's prior knowledge and strategies.

In the Ethiopian context, a study that included students in grades 8 through 11 in Northern Shoa region, Seleshi (1995) has found significant gender differences in mathematics achievement in favor of boys in all grade levels. Similarly, a news broadcast by the Amharic program of the voice of Ethiopia National services reported that, a study conducted in 43 countries revealed that 13 year-old boys surpassed their same age girls in physics, maths, and chemistry (Ethiopian Radio, Wednesday, November 20, 1996; cited in Yalew, 1997).

Although it appears that gender differences in mathematics achievement favor males, some exceptions do exist. That is, the review of sex related differences in mathematics achievement do not always draw the conclusion of male superiority in the subject. They present evidence that contradicts the commonly held belief that boys are superior to girls in solving mathematics problems. For instance, males achieve higher than females as revealed in some studies (e.g., Lumis & Stevenson, 1990). While no significant differences are found in other studies (e.g , Hilton and Bergland ,1974). Besides, although gender differences in mathematics achievement typically favor boys in the continental united States, they favor girls in Hawii (Brandon, Newton & Hamond, 1987; cited in Sewnet, 1995).

Although many studies have explored gender difference in mathematics performance, most of the conclusions indicate that very little or no gender differences at primary grade levels and significant gender differences in favor males by the time learners reached upper elementary or junior high school (Hilton & Bergland, 1974; Maccoby & Jacklin,1974; Measor & Sikes,1992).

## 2.2 The Role of Self-efficacy in Academic Achievement

Many researchers and theorists have supported the significance of self-efficacy in academic settings. The forerunner in self-efficacy, Bandura (1984:1176) as cited by Yalew (1997) propounded that:

> *People's Perceptions of their self-efficacy influences the types of scenarios they construct and reiterate ... . Perceived self-efficacy and cognitive stimulation affect each other plays a preponderant role in performance accomplishment of tasks.*

Students with a strong sense of academic self efficacy have been proven expend greater effort for accomplishing a given task (Salomon, 1984; Schunk, 1983), persist longer in the presence of difficulties (Schunk, 1982), demonstrate lower level of anxiety (Meece, Wigfield, & Eccles, 1990; Pintrich & De Groot, 1990), use more effective learning strategies (Pintrich & De Groot, 1990), and self-regulate better than others (Zimmerman & Martinez-Pons, 1990).

In a similar fashion, according to Schunk & Gunn (1986), self-efficacy is hypothesized to influence one's choice of activities, effort expended, persistence, and task accomplishment. On top of this view points, Mone, Baker, & Jeffris(1995) noted that, the higher the capability and confidence levels the higher the subsequent personal goals, effort tasks persistence, and subsequently tasks performance.

Likewise, Weiner (1979) postulated that, in achievement related contexts the causes perceived as most responsible for success and failure are ability, effort, task difficulty and luck. That is, in attempting to explain the prior success or failure at an achievement, the individual assesses his or her level of ability. In a similar manner, future expectations of success and failure would then be based upon ones perceived level of ability in relation to the perceived difficulty of the task, as well as an estimation of the intended effort and anticipated task.

In agreement with the above view points, research on motivation suggests that students who have high expectancies for success and value the task are more likely to perform well (Atkinson, 1964; Covington & Omelih, 1979; Eccles, 1983; cited in Pokay & Blumenfeld, 1990). Thus, performance expectancies may be based on perceived ability, as well as perceptions of current and past performances, perceived task difficulty, and how hard the child expects to work. This is to mean children who attribute their failure to low ability are more likely to have negative future expectancies after experiencing failure than are children who attribute either insufficient effort or a very difficult task. In support of this same position, Feather (1988) states that a person's actions are assumed to bear some relations to the expectations that a person holds and to the subjective values (valences) of the outcomes that might occur after the action. In explicit terms, many researchers (e.g., Feather, 1988; Halvari, 1997; Nicholas, 1978; Pokay and Blumenfeld, 1990) concluded that, students who have high expectancies for success are more likely to perform well.

In general, Bandura (1989:1175) as cited by Yalew (1997) maintained that "Self-efficacy beliefs affect through patterns that may be self-aiding or self-hindering." Bandura, further argued that it influences the cognitive, motivational, and affective processes of individuals in the course of academic endeavor. Shunk (1987:233) as cited by Yalew (1997) also stated that "Self-efficacy could affect choice of activities. Students who have low sense of efficacy for learning cognitive skills may attempt to avoid tasks, where as those who judge themselves more efficacious should participate more eagerly." This pattern is consistent with Pajares & Miller (1994) who found that self-efficacy was a strong predictor of attitude (and other variables treated) on achievement. That is, when other variables were controlled, it was indicated that self-efficacy contributed significantly to the variance of performance. Bandura (1986) as cited by Yalew (1997), that more than any other variables further supported this, self-efficacy was found a reliable predictor of performance behavior.

Self-efficacy (Shell, Murphy, & Bruning, 1989), therefore is seen as the generative mechanism through which persons integrate and apply their cognitive, behavioral and social skills to the performance of the task. More specifically, according to Vrugt (1994), people whose perceived self-efficacy is positive will pursue a relatively high level of performance. They will not be put off easily, they will do their best, seek new solutions, and also persevere in the case of difficult task assignment. Vrugt (1994) further indicates, if a person's perceived self-efficacy is negative, he or she will pursue a lower level of performance. That is, doubts and uncertainty during the performance of a task undermine a person's concentration in the case of difficult task he or she will easily give up. In sum, Randhawa, Beamer, & Lundberg (1993) concur that, confidence in doing a task and the confidence in one's ability in an area of endeavor are critical factors for motivation and persistence.

As regards mathematics self-efficacy, Meyer & Schatzkoehler (1990) suggested that, confidence is one part of self-concept and has to do with how sure a student is of his or her ability to learn new mathematics and to do well in mathematical tasks. Research on mathematics self-efficacy beliefs, in particular has been sparked by the awareness that adequate preparation in mathematics serves as a "critical filter" affecting entry into a wide range of scientific and technical careers (Betz & Hackett, 1983; cited in Lopez et al., 1997).

Confidence in learning mathematics, conceptual forerunner to math self-efficacy, has consistently been found to predict math-related performances (Hackett, 1985; cited in Pajares & Miller, 1994). Contending this position, Collins (1982) as cited by Pajares & Miller (1994) found that, when prior performance was controlled, children with high self-efficacy out performed children with low level of self-efficacy in the completion of novel math problems.

Further more, experimental studies which manipulated the Level of perceived self-efficacy of children with arithmetic deficiencies revealed that as self- efficacy improved so did the mathematics performance (Shunk, 1982;Shunk & Gunn, 1986). Other studies, using path analysis, also demonstrated that a model that included self-efficacy accounted for a larger portion of the variance in mathematics performance than other variables such as mathematics self-concept, perceived usefulness of mathematics, prior experience with mathematics or gender for college students (Pajares & Miller, 1994).

According to Pajares & Miller (1994), most researchers investigating the relationship between math self-efficacy and performance have reported a strong correspondence. Randhawa, Beamer, & Lundberg (1993) found that self-efficacy mediated the effect of various math attitudes on math achievement. Moreover, Lopez et al (1997) suggested that students' self-efficacy beliefs might help to explain their choice (or avoidance) of science and mathematics intensive activities.

Contrary to the above findings, some empirical findings show that self-efficacy belief was not' predictor of academic performance. For example, Benson (1989) as cited by Parjares & Miller (1994) found that "mathematics self-efficacy was not predictive of mathematics performance." Using a regression model with mathematics anxiety, American College Test Quantitative (ACT-Q) scores and prior mathematics experience, Copper & Robinson (1991) as cited by Mulugeta (1998) found that self-efficacy did not account for a significant proportion in mathematics. A similar finding was noted by some studies among elementary school children. Accordingly, Norwhich (1987) reported that when the effect of mathematics self-concept and prior mathematics performance was controlled, self-efficacy did not predict mathematics performance.

On the whole, confidence (Fennem & Leder, 1990) in learning mathematics influences a student's willingness to approach new material and persist when the materials become difficult.

## 2.3 Gender Differences in Math Self-efficacy

In the course of schooling, there are many situations that affect successful accomplishment of male and female student careers' and the schools intended to ends. Of those variables that are responsible in bringing about such performance discrepancies among boys and girls, self-efficacy found to be the crucial one.

Self-efficacy is presumed to be pervasively influential in affecting academic achievement of boys and girls. From among various variables that could bring about differences between males and females, one prominent factor is found to be self-confidence (Maccoby & Jacklin, 1974; cited in Torberg, 1977). In this regard, Maccoby & Jacklin (1974) reported that self-confidence is a key factor that could create variation in achievement-related tasks between the two sexes.

In so far as gender differences in self-efficacy are concerned, Hackett & Betz (1981) as cited by Shaefers, Epperson, & Nauta (1997) argued that women compared with men, receive less self-efficacy information about their skills in engineering, the physical sciences, and mathematics and hence have lower levels of self-efficacy expectations in these fields.

Theorists have proposed that these gender differences in test performance and choices are cause in part by gender differences in achievement related beliefs. For example, researchers frequently report that female students have lower perception of competence and lower performances expectancies than male students in mathematics (Entwisle & Baker, 1983; Hanna & Sonnenaschein, 1985). In the intellectual sphere, men (Lent, Brown & Gore, 1997) tend to report somewhat higher self-efficacy in relation to mathematics courses and general academic requirements. In their conclusion, Randhawa et al (1993:47) also stated that "Girls as a group, because of their significantly lower perceptions of mathematics self-efficacy, are thus at a greater risk than boys." In other words, their low level of self-efficacy perceptions (Pajares and Miller,1994) accounted for the lower academic performance of girls. That is, the poorer performance of women was largely due to lower judgement of their capability.

On the other hand, Eccles (1987) as cited in Shaefers, Epperson, & Nauta (1997) applied the expectancy-valence theory to woman's career choices and suggested that women are less likely than men to aspire to careers with heavy mathematics concepts because women are less confident in their mathematics ability than men. In the studies conducted by Sherman (1979), at each grade level (grades 8 through 12), also indicates boys were significantly more confident than were girls. The multiple correlation coefficients (Sherman, 1979) further indicates girls' mathematics performance was more predictable from the affective variables (such as confidence in learning mathematics attitude toward success in mathematics) than was boys performance. Other studies focusing on mathematics have shown that females rate lack of ability and/or skills as a slightly more important causes of their math failure than males (Eccles (Persons), Adler, & Meece, 1984).

According to Stipek & Gralinski (1991), gender differences in self-efficacy shows a similar sort of results. The study was conducted on a sample of 194 $3^{rd}$ grades and 279 junior high school students completed questionnaires measuring achievement related to beliefs before and after they took a regularly schedules of mathematics exam. Accordingly, as expected, girls' achievement-related beliefs were generally more negative than boys achievement related beliefs. On the average, girls rated their ability lower and expected to do less well on the examination than did boys.

After a comprehensive review of literature on sex differences, Maccoby & Jacklin (1970) as cited by Brabender & Boardman (1977) concluded that, although men and women perform comparably in most intellectual task, women evaluate their performance more negatively than do men. Similarly, Lenney (1977) as cited by Torberg (1977) summarized that women evince lower performance expectancies and self-evaluations of their abilities than men, which will have long lasting effects on their career choice.

Fennema & Sherman (1976) as cited in Meyer & Schatzkoehler (1990) reported that, when gender difference in mathematics achievement in favor of males was found, it was accompanied by a gender differences in confidence, also in favor of males. Interestingly enough, gender differences in confidence were also found even when there were no differences in achievement. Furthermore, the study revealed, at both the middle school and high school levels, females reported lower levels of confidence in their ability to learn mathematics than did males.

In connection to the above view points, Sherman (1979) found at each grade level (grades 8 through 12) that boys were significantly more confident in their mathematical ability than were girls. In support of this, the study conducted on high school students (Yalew, 1996) showed that males had higher self-efficacy compared to females.

On the other hand, in such a similar domain, few exceptions do exist. For instance, especially among high school subjects, some studies reported that girls and boys did not differ in their mathematics self-efficacy (Pajares & Miller,1994).

Considering the gender difference problems, Genet (1998) underscored some possible reasons for the low confidence of women in education. She elucidated that, while boys are encouraged in ways that will enable them to achieve, compete and win, girls are discouraged to develop such traits because, they are not necessary for the stereotyped roles of housewives and mothers. Such an encouragement, which the girls are denied, is an essential factor that helps boys to develop the sense of competitiveness in their educational endeavor.

## 2.4. The Role of Math Anxiety on Students' Performance

Achievement and attitude are both commonly identified as important areas for student growth in the school curriculum. For example, in reviewing affective factors of mathematics learning (Suydam & Weaver, 1975:45) as cited by Quinn & Jadav (1987) wrote:

> *Teachers and other mathematics educator generally believe that children learn more effectively when they are interested in what*

*they learn and that they will achieve better in mathematics if they like mathematics. Therefore, continual attention should be directed towards creating developing, maintaining and reinforcing positive attitudes.*

When students become preoccupied with their own self-evaluation and with negative possibilities involved in the situation, performance suffers because of the misdirection of attention away from the task at hand (Houston, 1977; Morris & Engle, 1981; cited in Morris, Davis, & Hutchings, 1981). Consistently, the traditional test anxiety theory (Wein, 1971) as cited by Benjamin, Mckeachies and Lin (1987) stated that, a high anxiety level produces task-irrelevant responses, for example error tendencies and worry that interfere with task-relevant responses necessary for good performance. In the same domain, Meyer & Schatzkoehler(1990) on their part also noted that, fear of success is the fear of the negative consequences that accompany success.

The phenomenon of "math anxiety" – extreme lack of confidence in one's ability to cop with mathematics is familiar virtually in all highly educated society (Resnick, 1989). In particular, Richardson & Suinn (1972) as cited in Adams & Holcomb (1986) reported that many people who do not suffer from general anxiety do suffer from anxiety about mathematics. They also reported that over one third of the students requesting help for anxiety in a university counseling program indicate that anxiety about mathematics was the main concern. That is, anxiety about mathematics appears to be something more or different than general anxiety.

As has been noted by Pajares & Miller (1994) in many cases inaccurate perception of mathematical capability and not poor preparation or lack of skills are responsible for avoidance of math-related courses and careers. In this regard, Tobias (1978), three years of work in a math clinic at the Wesleyen University, in middle town, Connecticut, have prompted the conclusion that math avoidance is both a cause and a result of "mathematics anxiety", and that the cures for this problem are complex and far reaching.

According to Hunsley (1987), math anxiety was strongly related to frequent negative thoughts. Furthermore, studies (Meece, Wigfield, & Eccles, 1990) found that math anxiety relates negatively to students' performance on standardized tests of mathematics achievement. Low achievers, regardless of sex, reported a significantly greater level of anxiety on problem solving, test anxiety and application than did high achievers (Satake & Amato,1995). Likewise, Hunsley (1987) noted that math anxiety was related to lower expected grades, greater pre-exam anxiety and lower ratings of preparedness. That is, math anxious students who reported more anxiety would receive lower grades and felt less satisfied with their exam performance. As early as 1957, Dreger and Aiken as cited by Pajares & Miller (1994) also suggested that individuals suffered from "number of anxiety" and various studies have since demonstrated a negative correlation between math anxiety and math performance. More specifically, Fennema & Sherma (1976) as cited by Wigfield & Meece (1988), using their attitude scale, found that math anxiety and math ability concepts were highly correlated(r=-.89) in a sample of high school students.

However, it should be noted that no differences were found in the cognition of math anxious and non-math anxious students working on mathematical problems (Fulkeson et al.,1984;cited in Husley,1987).

The research (Tobias, 1978) as cited in Broadbooks et al (1981) suggests that in view of their anxiety about mathematics many individuals tend to avoid it. Thus, many academically capable students prematurely restrict their educational career options by discontinuing their mathematical training early in high schools (Meece, Wigfield, & Eccles, 1990). More over, they indicated that students in secondary schools seem to have unfavorable attitude toward mathematics. Contending the ongoing viewpoints, Pajares & Miller (1994) also indicated avoidance of math courses has its roots in elementary or junior school and generally begins in high school.

By and large, research on test anxiety has shown that highly anxious students are overly concerned with the possible consequences of failure (Sarason, 1986; Wine, 1980; cited in Wigfield & Meece, 1988). On the basis of studies reviewed thus far, it seems likely that mathematics anxiety contribute to poor performance and avoidance of mathematics.

## 2.5. Gender Differences in Math Anxiety

Mathematics anxiety has received much attention as an explanatory variable for gender related differences in mathematics performance and enrollment in mathematics curriculum (Ailly & Bergering, 1992; Meece, Wigfield, & Eccles, 1990).

Several researches (e.g., Fennema, 1977; Fox, 1977; Tobias & Weissbord, 1980; cited in Wigfield & Meece, 1988) have also proposed that math anxiety contributes to observed sex differences in mathematics achievement and course enrollment plans. In relation to this point, Reilly's et al (1992) study that examined the relationship between math anxiety and selected demographic characteristics found gender differences in math anxiety. The investigators indicate, female students did not have higher levels of math anxiety than males until the late junior high school/early high school period, at which time females begin exhibiting more math anxiety than their male counterparts.

Along with the above mentioned findings, Wigfield & Meece (1988) elucidated that during high school and college years, female students report more anxiety about math than do male students. Consistent with their prior findings, Pajares & Miller (1994) also found that women expressed higher levels of math anxiety.

Somewhat differently, in one study that examined the feeling of math in students of single parents and non traditional career preparation programs (Bernstein et al., 1992) also show gender differences in math anxiety. According to the result of their study, at age 12, males felt slightly more math anxiety than females did. By age 14, however, females were more anxious about math than males were. Furthermore, they indicated that the feelings of math anxiety expressed by females were consistently higher than those of males until age 19. As they aged, students of both sexes become significantly less anxious about their math ability.

As' regard to gender differences in math anxiety, the results of the study (Wigfield & Meece, 1988) on math anxiety (worry & negative affective reaction) in $6^{th}$ through $12^{th}$ grade children, revealed that girls' negative affective reaction to math were stronger than those of boys at each grade level; the gender differences were significant for $6^{th}$, $7^{th}$, and $11^{th}$ grade students. It has also generally been found female students generally have less positive attitude towards mathematics than do male students.

The results of the study by Satake & Amato (1995), that have been done among Japanese elementary school children indicated there are significant gender, class, and achievement differences in math anxiety. In deed, the inverse relationship between math anxiety and achievement found in the study of Satake & Amato (1995) was consistent with the relationships observed in studies of American students regardless of grade levels (Betz, 1978; Rounds & Hendel, 1980; Suinn et al., 1988; Tobias & Weissbord, 1980; cited in Satake & Amato, 1995).

As discussed earlier, it appears that the major reasons for such low rate of performance for females in mathematics could probably be their lowered perception of self-efficacy and high level of anxiety toward mathematics.

In summary, anxiety and self-efficacy appear to account for variation in mathematics achievement in general and male-female differences in mathematics performance in particular.

In the course of schooling, several factors may impinge gender differences in math achievement. Treating all the possible variables that would influence male-female differences in math achievement are beyond the scope of this research. Based on the above viewpoints, this study attempts to examine the effects of self-efficacy and math anxiety on male-female students' mathematics achievement. Studies in this area are very scant or not available in the assigned zone, even in the country. On top of the above view points an attempt, in the next section, was made on the treatment producers of the problems under consideration.

# CHAPTER THREE

## 3. DESIGN OF THE STUDY

This chapter discusses the sampling procedures, the data collecting techniques and the statistical procedures employed to analyze the data.

### 3.1 Subjects

A pilot study, the objectives of which were to assess and improve the contents of the instruments, was administered to a random sample of 72 Ayer - Tena high school students of grades 9 and 11. Of the total samples (36 females and 36 males), eight students from the three instruments and one from the math achievement scale were excluded from the try out analysis. This was so because, they didn't provide complete information to the scale(s). Thus, the sample in the pilot study comprised of 64 students in the case of math anxiety and math self efficacy scales and 63 students in the case of math achievement scale.

The main study was conducted in the Bale zone high schools of grades 9 and 11 students. From among the high schools found in the zone four high schools (Batu-Terara, Robe, Goro and Agarfa) were selected randomly for this study. The target population of this study were both male and female regular students who were attending grades nine and eleven of the four high schools.

Although the instruments were administered to a sample of 410 students (50% from each sex), 32 students (15 females and 17 males) did not provide complete information to the instruments under study. Besides, four students (2 from each sex group) did not return either of the instruments. Thus, a total of 36 students (17 females and 19 males) were deleted from the study and this made the number of the two sexes a bit different. Hence, the main study comprised of 374 subjects (188 females and 186 males). Of these, 179 were eleventh graders and 195 were ninth graders.

To obtain the sample schools, the names of the 12 high schools of the zone under consideration were put into alphabetical order. Thereby, consecutive numbers 1 to 12 were assigned. Thereafter, using random number table, four high schools were selected (see Appendix A).

Sections and subjects were also selected in the same way except that males and females were separately listed and a random selection was made on the bases of the proportions of boys and girls from each school.

The number of sample sizes for the study was determined based on a table developed by Krejcie & Morgan (1970) for determining sample size from a given population.

## 3.2 Instruments

### 3.2.1. Mathematics achievement tests

Achievement tests were used to assess students' achievement level in Mathematics.

To this effect, based on the mathematics textbooks of grades 9 and 11, specific objectives were formulated and tables of specifications were prepared for both grade levels separately. Accordingly, two achievement tests (each with 30 items) were constructed from both grade levels based on the table of specifications. All the items for both grade levels were objective type each item having four alternatives. The tests were then administered to the pilot samples from both grade levels and item analysis was carried out. More specifically, indices of item discrimination and the effectiveness of each distracter were analysed on the subjects whose total scores fall in the upper 27% and the lower 27% (Ebel, 1979; Mehrens & Lehman, 1984). Furthermore, to select good items that measured the "true" ability of students, all the 30 items from each grade level were used for the analysis of item total correlation.

As a result, from a total of 60 items 40 items with point biserial correlation ($r_{pb} > 0.31$, $t > 1.76$, $p < 0.05$) were retained for the final study. However, based on the item analysis,9 of the items (with zero and negative discrimination indices) were discarded and substituted by other items that were taken from locally prepared tests with alpha coefficients ranging from .82 to .90 (Seleshi, 1995). This was done to keep the number of items in the final tests as planned in the table of specifications.

Besides, 6 items with discrimination indices below 0.19 (Ebel, 1979) and 5 items with point biserial correlation ($r_{pb} < .31$) were revised and improved for the final study.

The internal consistency reliability of the tests as estimated by KR–20 were 0.77 and 0.73 for grade 9 & 11respectively.

### 3.2.2. The math self-efficacy scale

In this regard, Pajares and Miller (1994:194) noted that "self-efficacy must be specifically rather than globally assessed, must correspond directly to the criterial performance task, and must be measured as closely as possible time interval to that task."

Thus, the instrument for assessing the students' math self-efficacy was constructed in the same way as developed by Dowling (1978) and used by Pajares and Miller (1994) to measure math self-efficacy of college students. The items involved in the scale were all those items (30 from each grade level) which were used for the achievement tests without their alternatives. In this case, the students were asked to rate their level of confidence in solving or providing the correct answer for each item on a five point scales that ranged from 1 (not at all confident) to 5 (completely confident).

Coefficient of split-half reliability revealed that the instrument had strong internal consistency (.90 overall, .93 for girls, .86 for boys in the case of grade 11 and .91 overall, .92 for girls, .90 for boys in the case of grade 9).

### 3.2.3. The math anxiety scale

Initially the scale consisted of 25 items of which 22 were selected from Plake & Parker (1982), Wigfield & Meece (1988), and Taylor (1997). Others were developed by the investigator. The main criterion for selection was the statement should be unambiguous with respect to the local condition. The instruments were designed to assess students' level of anxiety about mathematics. In this case, students reacted to each item (statement) of the math anxiety whether they are strongly disagreed, disagreed, agreed, or strongly agreed. Some (about half) of the items in the scale were phrased negatively and scored in a reversed direction. The rest were worded positively and scored in straight forward. That is, when students indicate "strongly disagree" to a negatively worded item (statement), they get a weight of 1 (which is the least), if the statement was positive they get highest score of 4.

Finally, item analysis was carried out and mean score of the upper 27% and lower 27% groups on each of the 25 items were compared using the mean score tests as suggested by Ebel (1979) and Nachmias & Nachmias (1987). To this end, 23 of the items were found to discriminate the two groups to a statistically significant extent ($t > 1.69$, $p < .05$). Even though 23 of the items were found to discriminate the two groups to a statistically significant extent ($t > 1.69$, $p < .05$), three were deleted from the scale because of their overlap with ability and value constructs.

Consequently, five of the items were discarded and the rest 20 items were retained for the main study and this was in agreement with Nachmias & Nachmias (1987) suggestion that the investigator can select the 20 to 25 items with the largest t-values for the final scale.

The scale, as estimated by split-half reliability coefficient was .83 and .77 for grades 9 and 11 respectively. As a whole, the reliability of the instrument using split-half as well as alpha coefficient was.79.

## 3.3 Variables

In this study, gender, grade level, math self-efficacy and math anxiety served as independent variables and math achievement score as dependent variable. In the gender difference analyses, math self-efficacy, math anxiety and math achievement score served as dependent variable where as gender served as an independent variable.

## 3.4 Procedure of Data Collection

In the pilot as well as in the main study, first the math anxiety and math self-efficacy scales were administered in one session. After the students completed the two scales, the achievement test was handed out to those students to work on it. It is so because, Bandura (1986) cited Pajares and Miller (1994) suggested that efficacy and performance be assessed within a close time period as possible and that efficacy assessment precede performance assessment.

Before working on the scales, students were oriented how to fill the scales and illustration was provided to them. Furthermore, they were instructed to read instructions carefully, to answer all questions, and to give their authentic responses and to work on all the scales independently.

During the main study, to avoid cheating among students while taking the test, the classroom subject teachers were assigned as invigilators (supervisors).

## 3.5 Method 0f Data Analyses

As a preliminary step in the analysis, descriptive statistics were computed. Based on this, mean difference tests between males and females, grade 9 & 11, and zero-order correlations for the pooled samples as well as the gender subgroup among the variables treated in the study were computed. Besides, mean difference tests for the upper 25% and the lower 25% of math self-efficacy and math anxiety scorers with respect to their mathematics achievement scores were computed. This was simply because, to examine differences in achievement of mathematics between low-high math self-efficacious students and low-high math anxious students. Finally, path analyses model (using multiple regression) for the pooled subjects as well as the gender sub-group were used to investigate the direct and indirect effect of each predictor variable on the criterion variable.

The path model was constructed in the same way as Pajares and Miller (1994) used. They proved the models appropriateness in investigating this type of problem.

Test of significance was performed using $\alpha$ = 5% level of significance.

The multiple regression models used in the study was:

$$Y = \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4$$

Where Y = criterion variable

$\beta_{i's}$ = Standardized beta coefficients (path coefficients)

$Z_{i's}$ = Predictor variables

# CHAPTER FOUR

## 4. RESULTS OF THE STUDY

This section presents the results of statistical analyses carried out to answer the basic questions raised in the present study. First, descriptive statistics is presented. This is followed by the gender difference analyses in the variables in the study. Then, individuals' math achievement scores with respect to high/low math self-efficacy & high/low math anxiety scores as well as correlational analyses were presented. Finally, path analyses were undertaken to see the direct and indirect effects of the independent variables on the dependent variable (for the pooled as well as the gender sub- groups).

### 4.1 Descriptive Statistics

Table 1. Descriptive statistics of the variables treated in the study (N = 374)

| Variable | **Statistics** | | | |
|---|---|---|---|---|
| | M | SD | **Range of Scores** | |
| | | | Minimum | Maximum |
| Gender | . 50 | . 50 | 0 | 1 |
| Grade L. | 1.48 | .50 | 1 | 2 |
| MSE | 97.75 | 27.54 | 30 | 149 |
| MAS | 44.98 | 9.71 | 20 | 72 |
| PERF | 10.08 | 4.39 | 1 | 27 |

**Note:** M = means ; SD = Standard Deviations

MSE = Math self-efficacy; MAS = Math anxiety;

PERF = Performance of math; Grade L. = Grade Level

## 4.2 Gender Differences on MSE, MAS & PERF

Table 2. Means and Standard Deviation for males' and females' on MSE, MAS and PERF (Regardless of grade level)

| Variable | Male (n = 186) | | Female (n=188) | | t | p |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | | |
| MSE | 104.00 | 27.97 | 91.57 | 25.73 | -4.474 | .000 |
| MAS | 43.65 | 10.20 | 46.30 | 9.03 | 2.664 | .008 |
| PERF | 11.24 | 4.89 | 8.93 | 3.49 | -5.245 | .000 |

*df = 372

**Note**: MSE = Math self-efficacy ; PERF = Performance of math

MAS = Math anxiety

The gender differences, regardless of grade levels, were evident in all the variables treated in the study. Accordingly, as can be seen from Table 2, mean scores for male and female high school students of grades 9 and 11 on the math self-efficacy were significantly different ($t_{(372)}$ = -4.474, P<.000), indicating that males had reported high math self-efficacy than females. Likewise, mean scores for male and female high school students of grade 9 and 11 on the math anxiety differ to a statistically significant extent ($t_{(372)}$ = 2.664, P < .008), showing that females were more anxious about mathematics than males. Besides, mean scores for males and females on math achievement were significantly different ($t_{(372)}$ = -5.245, P < .000), revealing that males were superior in mathematics performance than females.

But, when the two grade levels were treated separately, a statistically significant difference was not found between the two genders for 11th graders in the case of math anxiety ($t_{(177)} = 0.577$, $P > .05$). Although the two grade levels were treated separately on each of the variable, mean scores for boys and girls were significantly different for math self-efficacy and math achievement scores (see Appendix G).

The result reveals that, whether the two grade levels are treated jointly or separately, boys had more confidence in their performance of mathematics and superior in math achievement than girls.

## 4.3 Achievement Differences of Students' having Low/High Math Self-efficacy and Low/High Math Anxiety Scores

Table 3. Means and Standard Deviations of math achievement test scores for students having Low/High math self-efficacy and Low/High math anxiety scores.

| Variable | Group | N | Mathematics Achievement Scores | | t | p |
|---|---|---|---|---|---|---|
| | | | M | SD | | |
| MSE | L | 93* | 8.85 | 3.13 | | .000 |
| | H | 93* | 13.59 | 5.48 | -7.252 | |
| MAS | L | 93* | 12.44 | 5.66 | | .000 |
| | H | 93* | 8.76 | 2.83 | 5.604 | |

*The upper 25% and the lower 25% of math self-efficacy and math anxiety with respect to achievement scores were considered.

As could be seen from Table 3 above, mean scores of achievement for high self-efficacious students and low self-efficacious students differ to a statistically significant extent ($t_{(184)} = -7.252$, $P < .000$).

This shows that, students who had more confidence to solve math problems were superior in math performance than those who had low confidence to solve math problems.

Similarly, mean achievement scores between high and low math anxious students were also differ to a statistically significant extent ($t_{(184)} = 5.604$, $P < .000$).
This result reveals that, those who had high anxiety about math performed poorly in math achievement than those who had less anxiety. Conversely, high math achievers had demonstrated high math self-efficacy and low anxiety about math than low achievers. Generally, students who rated themselves as more confident in solving math problems reported less math anxiety scores and performed the test better than their less able counter parts.

## 4.4 Grade Level Differences on MSE, MAS & PERF

Table 4. Means and Standard Deviations for grade 9 and grade 11 students on MSE, MAS & PERF

| Variable | Grade 9 (n = 195) | | Grade 11 (n = 179) | | t | P |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | | |
| MSE | 100.81 | 25.53 | 94.42 | 29.29 | 2.254 | .025 |
| MAS | 45.31 | 8.98 | 44.61 | 10.46 | .695 | .488 |
| PERF | 10.05 | 4.35 | 10.11 | 4.45 | -.144 | .886 |

*p<.05

As could be observed from Table 4 above, compared with 11th graders, 9th graders were more confident in their mathematical ability ($t_{(372)} = 2.54$, $P < .025$). With respect to math anxiety and math achievement, 9th graders and 11th graders did not differ to a statistically significant extent ($t_{(372)} = .695$, $P > .05$ and $t_{(372)} = -.144$, $P > .05$ respectively).

## 4.5 Correlational Analysis of the Variables in the Study for the Pooled Subjects

Table 5. Means, Standard Deviations, and Zero-Order correlation coefficients of the variables treated in the study for the pooled sample (N = 374) [sex codes were 0 = female, 1 = male and grade codes were 1 = grade 9, 2 = grade 11].

| Variable | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 1. Gender | .50 | .50 | - | | | | |
| 2. Grade L. | 1.48 | .50 | .06(ns) | - | | | |
| 3. MSE | 97.75 | 27.54 | .23* | -.12* | -- | | |
| 4. MAS | 44.98 | 9.71 | -.14* | -.04(ns) | -.43* | -- | |
| 5. PERF | 10.08 | 4.39 | .26* | .01(ns) | . 42* | -.38* | - |

* = Correlation is significant at the 0.05 level

ns = correlation is not significant at the 0.05 level

Table 5 portrayed that, gender was positively and significantly related to PERF ($r = .26$, $P < .05$) and MSE ($r = .23$, $P < .05$). PERF was also negatively and significantly correlated with MAS (r = -.38, P < .05), indicating that students who performed poorly in mathematics showed high anxiety about math than those who performed better on the tests under consideration.

In addition, MSE was positively and significantly correlated with PERF (r = .42, P <. 05) and negatively and significantly correlated with MAS (r = -.43, P < .05). This indicates that as the students confidence level about math increases, their performance in math also increases but their level of anxiety about math decreases and vice versa.

Gender was negatively and significantly correlated with MAS (r = -. 14), P < .05). That is, the sex of students had adverse relationships with math anxiety. The Table further revealed that, the correlations of grade level with gender (r = .064, P > .05), MAS (r = -.04, P > 05), and with PERF (r = .01, P >.05) were not statistically significant.

## 4.6 Correlational Analysis of the Variables in the Study for the Gender Sub-groups

Table 6. Correlation Matrix of the variables treated for the gender sub-groups (boys=186; girls = 188)

| Variable | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. Grade Level | _ | -0.152* | 0.055(ns) | -0.05(ns) |
| 2. MSE | -0.115(ns) | | -0.531** | 0.447** |
| 3. MAS | -0.120(ns) | -0.270** | | -0.445** |
| 4. PERF | 0.046(ns) | 0.288** | -0.224** | |

** = correlation is significant at the 0.01 level.

* = correlation is significant at the 0.05 level

ns = correlation is not significant

Correlations above the main diagonal are for boys and correlations below the main diagonal are for girls.

As it could be seen from Table 6, PERF was positively and significantly related to MSE for boys and for girls ($r = .45$ $p < .01$ and $r = .29$, $p < .01$ respectively). On the other hand, PERF was negatively and significantly related to MAS for boys as well as for girls ($r = -.53$, $p < 01$ and $r = -.22$, $p < .01$ respectively). For both genders, the trends of correlation of PERF with MSE and MAS as well as MSE with MAS were the same. But, in all cases, the magnitudes of correlation were found stronger in the case of boys than the girls. In the case of boys the correlation of grade level with MSE was negative and significant (r = -. 152, p<.05), where as in the case of girls, the correlation of grade level with any of the variables was not significant.

## 4.7. Causal relationships of the variables treated in the study for the pooled subjects

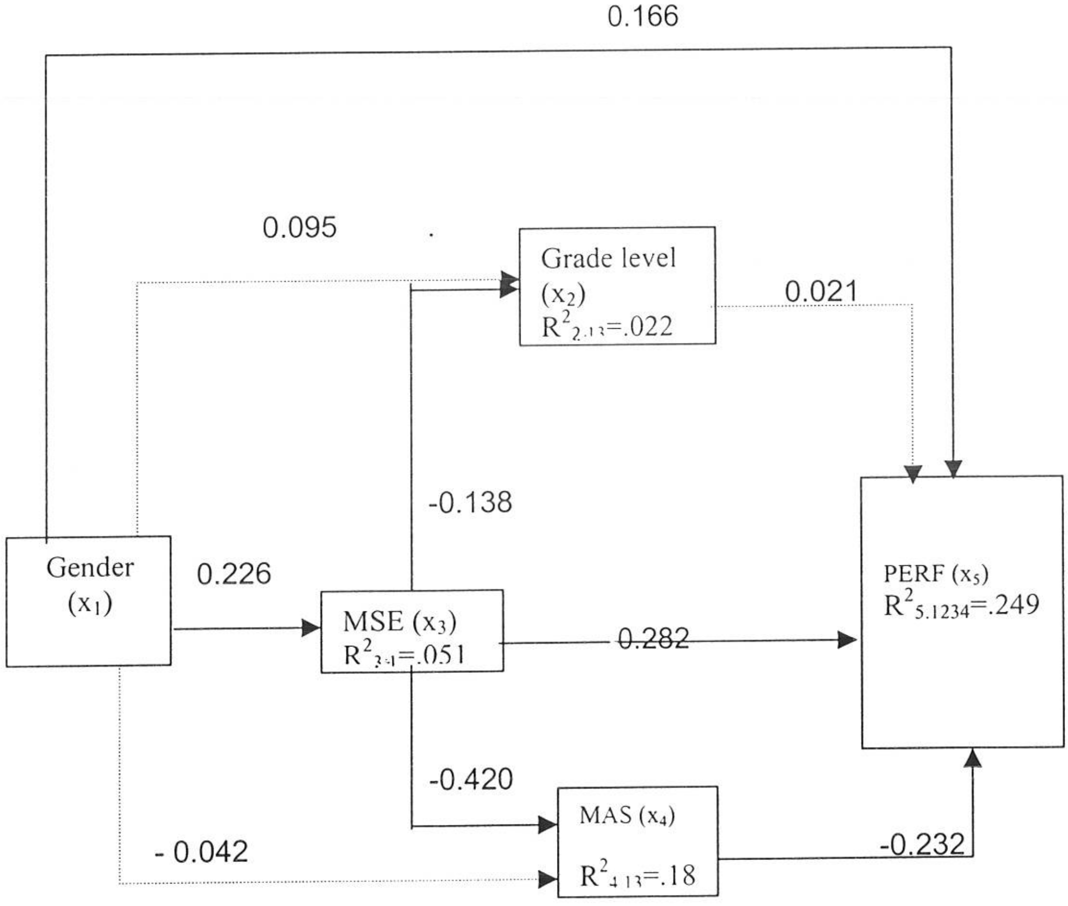



**Fig.1** A Path model portraying causal relationships of gender, grade level ,MSE,MAS and PERF for the pooled sample (N=374)

**Note:** Path coefficients are standardized betas(β's)

Dotted lines indicate non-significant path coefficients.

As could be indicated in figure 1 above, the effects on performance of gender ($\beta$ = .166, t = 3.564, p < .000), and math self-efficacy ($\beta$ = .282, t = 5.483, p < .000), were both positive and statistically significant. On the other hand, the effect on performance of math anxiety ($\beta$= -. 232, t= -4.631, p<. 000) was negative and statistically significant. Concerning prediction, the statistically significant path coefficients (standardized betas) in figure 1 show positive linkages between two of the predictor variables and the criterion variable and negative linkages between math anxiety and performance. The effect of grade level on achievement was not significant ($\beta$=.021, t=.464, p>.643), indicating that grade level was not a statistically significant predictor of math achievement. The path from MSE to grade level and MAS were negative and statistically significant ($\beta$= -.138 & $\beta$= -.420), indicating that MSE has adversely a predicting role to high school students' grade level and MAS. On the other hand, the effect of gender on grade level and MAS were not statistically significant ($\beta$= .095 & $\beta$= -.042), revealing that the sex of students' has no direct effect on high school students' grade level and MAS.

The path further revealed that math self-efficacy was the strongest predictor of math achievement followed by math anxiety. The effect of gender on performance was modest. Generally, the path revealed that sex of students, math anxiety and math self-efficacy were reliable predictors of achievement in math.

## 4.8. Effects of the predictor variables on the criterion variable for the pooled subjects

Table 7. Decomposition of Effects from the path analysis

| Effect | Standardized coefficients (Beta) | $R^2$ | t | P |
|---|---|---|---|---|
| On PERF | - | .249 | - | - |
| of Gender | 0.166 | | 3.564 | 0.000 |
| of Grade L. | 0.021 | | 0.464 | 0.643 |
| of MSE | 0.282 | | 5.483 | 0.000 |
| of MAS | -0.232 | | -4.631 | 0.000 |

**Note:** N = 374

The results in Table 7 above show the decomposition of effects from the path analyses model. Of all the path coefficients from the independent variables to math achievement, math self-efficacy ($\beta$=.282, t=5.483, p<.000), math anxiety ($\beta$=-.232, t=-4.631, p<.000) and gender ($\beta$=.166, t=3.564, p<.000) were statistically significant

The combined effects of gender, grade level, math self-efficacy and math anxiety explained 24.9% of the total variability in achievement of mathematics ($F_{(4,369)}$ = 30.621, p<.000). Thus, variables other than those studied in this study accounted for by 75.1% of the variability in students' math achievement.

A stepwise multiple regression analyses was performed to determine the contribution of gender, grade level, math self-efficacy and math anxiety as independent predictor of performance in mathematics. Accordingly, math self-efficacy added significantly to the prediction of achievement in math ($F_{(1,372)}$=78.366, p<.000), accounting for 17.4% of the variance. The addition of math anxiety to the original equation (math self- efficacy) added significantly to the prediction of math achievement ($F_{(2,371)}$=52.965, p<.000), accounting for 22.2% of the variance (math anxiety independently contributed 4.8% to the model). A regression model that included math self-efficacy, math anxiety and gender contributed significantly to the prediction of performance in math ($F_{(3,370)}$ = 40.843, p<.000), accounting for 24.9% of the variance (gender was noted to independently contribute 2.7% of the variance). From this one can assume that, grade level independently has no significant contribution to performance in math.

## 4.9 Direct and indirect effects of the predictor variables on the criterion variable

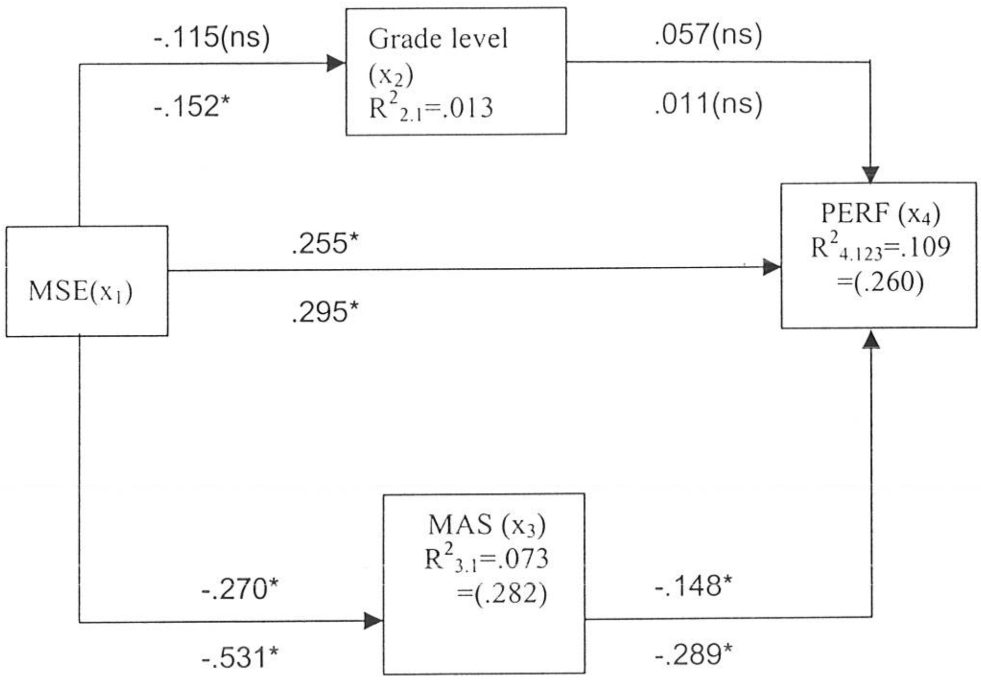
Table 8. Direct and Indirect effects of the Variables on math achievement

| Effect | r | Direct | One-way indirect | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | Via $X_2$ | Via $X_3$ | Via $X_4$ | Via $X_3X_2$ | Via $X_3X_4$ | |
| On PERF | - | - | - | - | - | - | - | - |
| of Gender | .26* | .166* | .002 | .064 | .01 | -.001 | .022 | .263* |
| of Grade L. | .01(ns) | .021(ns) | - | - | - | - | - | .021(ns) |
| of MSE | .42* | .282* | -.003 | - | .097 | - | - | .376* |
| of MAS | -.38* | -.232* | - | - | - | - | - | -.232* |

*p <.05; ns =non significant

The results of Table 8 above depict that the direct and total effects of math self-efficacy were stronger than the other variables followed by gender. Much of the indirect effect of gender on PERF was accounted through math self-efficacy. Math self-efficacy has a statistically significant direct effect on each of the variable. The direct effect of gender on grade level ($\beta$=0.095, t=1.804, p>.05) and on math anxiety ($\beta$=-.042, t=-.873, p>.05) was not statistically significant. The direct and total effects of math self-efficacy and gender on math achievement were statistically significant.

## 4.10. Causal relationships of the variables treated in the study for the gender sub- groups




*p<.05

**Fig. 2.** A path model portraying causal relationships of grade level, MSE,MAS and PERF for the gender sub -groups.

Note: Path Coefficients (β's) above the path lines are for girls and coefficients below the path lines are for boys. (n=188 for females & n=186 for males)

Coefficients of determination ($R^2$) in the brackets are for males and outside the brackets are for females

As shown in figure 2 above, the direct effect of math self-efficacy on achievement for boys and girls were $\beta$ = .295, t=3.877, $p<.000$ and $\beta$ =.255, t=3.487, $p<.000$ respectively. For both the gender subgroups, the effect of math self-efficacy on math achievement was stronger than the effect of math anxiety ($\beta$ = -.289, t=-3.844,$p<.000$ and $\beta$ = -.148, t=-2.026, $p<.044$ for boys and girls respectively). For both the gender subgroup, the effect of grade level on math achievement was not statistically significant

($\beta$ =.011, t=.171, p>.05 and $\beta$=.057, t=.806, p>.05 for boys and girls respectively). The path further portrays that math self-efficacy had a significant direct effect on grade level for boys but not for girls.

The coefficient of determination associated with the model for boys indicated that, math self-efficacy, math anxiety and grade level combined together accounted for 26% ($F_{(3,182)}$=21.316, p<.000) of the explained variance in math achievement.

A stepwise multiple regression indicates that, 20% of boys' math achievement was contributed by math self-efficacy and 6% by math anxiety. Regarding girls, the coefficient of determination for their math achievement accounted for by math self-efficacy, math anxiety and grade level combined together was 10.9%. ($F_{(3,184)}$ = 7.529, p<.000). Of this explained variance, 8.3% was contributed by math self-efficacy, 2.3% by math anxiety and 0.3% by grade level. For both the gender sub-groups, math self-efficacy had important contribution for students' math achievement. That is, math self-efficacy was strong predictor of math achievement.

## 4.11. Effects of the predictor variables on the criterion variable for the gender sub- groups

Table 9. Decomposition of Effects from the path analysis

| Effect | Standardized coefficients (β) | $R^2$ | t | p |
|---|---|---|---|---|
| On PERF | - | .109(.260) | - | - |
| of MSE | .255(.295) | | 3.487(3.877) | .001(.000) |
| of MAS | -.148(-.289) | | -2.026(-3.844) | .044(.000) |
| of Grade L. | .057(.011) | | .806(.171) | .421(.864) |

*Note: Figures in the brackets are for males.

As could be seen from Table 9, the trends of the effects of each predictor variable on the criterion variable was the same for the gender sub-group. For both the gender sub-groups, the effects of MSE and MAS on PERF were statistically significant. In a similar manner, the effect on performance of grade level was not statistically significant for boys as well as for girls.

# CHAPTER FIVE

## 5. DISCUSSION

The purpose of the present study was two folds: The first and the major one was to examine gender differences in the variables treated in the study. To study this problem, comparisons of mean scores of math self-efficacy, math anxiety and math achievement of both males and females were undertaken. The second purpose of this study was to investigate the effects of gender, grade level, math self-efficacy and math anxiety on math performance. Here, the mediational and predictive role of math self-efficacy between gender and math performance, as well as math anxiety and grade level were also studied. To do this, path models were constructed from the presumed causes to the presumed effects.

## 5.1 Gender Differences in math Self-efficacy, in math anxiety and in math performance

### 5.1.1 Gender Differences in math self-efficacy

Tests of mean differences for the pooled sample as well as the grade sub-group show that gender differences in math self-efficacy were evident. That is, boys were more confident in solving math problems than girls ($t_{(372)}$=-4.474, p<.000).

Separate correlational analysis carried out for boys and girls also reveal that, self-efficacy was significantly and positively related to math performance in both cases (r=.477, p<.01; r=.288, p<.o1 for boys and girls respectively). Although a similar trend was observed for boys and girls, the magnitude for girls was not as strong as their boy counter parts indicating that boys surpassed girls in their rate of math self-efficacy.

This finding is in consonant with many research findings that confirmed males had high math self-efficacy in solving math problems than their females' counter parts. Accordingly, one early studies by Fennema & Sharma (1987) suggested that boys were more confident in their math skills than girls. Some other investigators reported similar findings. For instance, Sherma (1976) as cited by Schofield (1982:283), in a study of 6th to 12th grade boys and girls found that "children of both sexes tended to view math as a male domain and girls of all grade levels exhibited less confidence in their mathematical competence than boys." The findings by Pintrich & DeGroot (1990) suggest that boys and girls report equal confidence during the elementary years but, by middle and high school, boys were grown more confident about their math ability. The result of the present study was further evidenced by the existing literatures (Hackett & Betz, 1981; cited Shaefers, Epperson, & Nauta, 1997) as indicated in the literature section. Interestingly enough, gender differences in confidence were also found when there were no differences in achievement (Meyer & Schatzkoehler, 1990).

Even though data which reveal differences between males and females in math self-efficacy in high schools of Ethiopia are not available, the study conducted on high school (Physics) students also showed that males had higher self-efficacy compared to females (Yalew, 1997). So, the present finding that showed gender differences in math self-efficacy in favor of boys is not the first of its kind.

There are some plausible explanations to this gender discrepancy. For one thing, the gender differences in math self-efficacy could be attributed to a reflection of the differential socialization process in achievement behavior (Almaz, 1991; Astede, 1991; Yalew, 1997). On top of this, Genet (1998) on her part noted that, most parents in patriarchal society treat their sons and daughters differently in regard to their future roles, aspirations, expectations, and education. While boys are encouraged in ways that enable them to achieve, compete and win, girls are discouraged to develop such traits because, they are not necessary for the stereotyped roles of housewives and mothers. Such an encouragement, which girls are denied, is a key factor that helps boys to develop the sense of competitiveness in their educational endeavors (Mocaby, 1963;cited in Genet,1998). Furthermore, Fennema and Sherma (1976) as cited in Schofield (1982) argue that Stereotyping mathematics as a male subject may be a mediating variable affecting sex differences (favoring males) on a variety of relevant attitudes, for example confidence in learning mathematics or perception of its usefulness. Though females may have competent skills as males they probably undermined their percepts of self-efficacy in performing academic tasks due to the aforementioned factors.

Another explanation for such discrepancies between gender may be attributable to expectations of mathematics teachers on male/female students. That is, math teachers do not expect girls to do better than boys in mathematics. Personal communications with some mathematics teachers and students of both sexes in the study area have confirmed this conclusion.

### 5.1.2 Gender Differences in Math Anxiety

When pooled subjects are considered, the results of the study show that girls (M = 46.30) were more anxious about math than boys (M = 43.65), $t_{(372)}=2.664$, $p<.008$. This result was in agreement with the result reported by Meece, Wigfield, and Eccles (1990) that demonstrate the gender differences in math anxiety. Their findings through grades $7^{th} - 9^{th}$, using one way analysis of variance (ANOVAs), revealed that girls (M = 3.80) express more anxiety about math than boys (M = 3.27), $F_{(1,248)} = 12.56$, Mse=1.39, $p<.01$. In a similar fashion, Pajares and Miller (1994) also note that women expressed higher level of math anxiety than men. As has been noted in the literature section, the feelings of math anxiety expressed by females were consistently higher than those of males until age 19 (Bernstein et.al., 1992). Along with the present finding, Wigfield & Meece(1988) elucidated that during high school and college years, female students report more anxiety about math than do male students.

However, when the grade levels were treated independently (separately), a statistically significant gender difference in math anxiety was not found for $11^{th}$ graders ($t_{(177)}$ = 0.577, $p>.05$). Contrary to this finding, one early study by Wigfield and Meece (1988) in $6^{th}$ to $12^{th}$ grade children, revealed that girls' negative affective reaction to math were stronger than those of boys at each grade level; the gender differences were significant for $6^{th}$, $7^{th}$ and $11^{th}$ grade students. On top of these view points, one possible reason for the gender difference in math anxiety, may be attributed to girls' perceptions of its (math) usefulness. It is simply because in many cases (Pajares & Miller, 1994), inaccurate perceptions of mathematics, and not poor preparation or lack of skills, are responsible for avoidance of math-related courses and careers. Viewed from the stand point of gender, it is found that, high school and college women generally rate them selves as more math anxious than men(Wigfield & Meece,1988).

Therefore, it is likely that children's judgements of their competence and potential are largely responsible for this avoidance (Pintrich and De Groot, 1990).

### 5.1.3 Gender Difference in Mathematics Achievement

Similar with math self-efficacy, a statistically significant gender difference in mathematics achievement was found for the pooled sample as well as the grade sub-groups. The difference in both cases were found in favor of boys ($t_{(372)}$=-5.245, p<.000, for the pooled subjects, t(193)=-4.531, p<.000 for grade 9; $t_{(177)}$=-2.897, p<.004 for grade 11). Besides, as score for females coded = 0 and males coded = 1, the positive relationship between gender and math achievement of the whole sample studied implies that males had better academic performance than females. The result is inline with a number of studies undertaken on gender differences in academic achievement of males/females in the Ethiopian context and had reported superior academic performance of males compared with their females counter parts (Genet, 1991; Yalew, 1997). Gender difference studies in mathematics achievement for high school students revealed that academic achievement of females in mathematics were inferior to that of males (Genet, 1991; Seleshi, 1995).

More specifically, examinations of the results of female students in Government Schools (Genet, 1998) indicated that, girls perform poorly in all high school academic subjects especially in mathematics. Females' inferior academic performance in mathematics to that of their male counterparts was, likewise, noted in the gender difference studies in mathematics performance of prospective primary and junior high schools (Sewnet, 1995; Yoseph, 1997). Thus, the observed differences between the two genders is not surprising because most of the earlier studies in the area have reported similar general results at high school level ( e.g., Byrnes & Takahira, 1993; Hilton & Berglund, 1974; Lamb, 1997; Pajares & Miller, 1994). Therefore, the finding that males had superior academic performance in mathematics compared to females for high school students was not uncommon.

One reason for girls to perform poorly in mathematics as compared to boys may be their lack of confidence in solving math problems. This was evidenced by one local study done by Kinfe (1998) on an educational intervention model for secondary school female students. The results of his study revealed that, 88% of the students undertaken agreed that mathematics is a subject that can be done well by males but not by females. Besides, lack of confidence on the part of girls and stereotyping math, as a male domain was attributable to their inferiority in mathematics achievement. That is, the poorer performances of the female students were largely due to lower judgements of their capability (Pajares & Miller, 1994).In the same vein, Heyneman(1980) on his part as cited by Yoseph(1997) also extended in saying that higher performance among boys could not be explained by chance and that the difference must have some deep-rooted reasons from society.

Another explanation for the gender differences in mathematics achievement in favor of boys probably lies in the local cultures that generally discourage the education of girls (Genet, 1991). This means that girls lower performance in mathematics could probably be related to their life style since most of them are dedicated to home activities such as cooking, taking care of their younger siblings or generally helping their mothers. In addition, getting training for their future roles as wives and mothers at home would take some of their time. This leaves them with very little time for their study. The widely held belief that men are superior to women particularly in intellectual activities coupled with the cultural inhibitions against a woman's achievement (Almaz & Barbara, 1990; cited in Mulugeta, 1998) probably influenced female/male students self-evaluation interms of the academic achievement.

Besides, the reason for such poor academic performance of girls in different level of education may be attributed to the values and attitudes that the Ethiopian society attaches toward education of women. In most part of Ethiopia, patriarchal thinking dominates the culture (Allasebu,1988; cited in Genet,1998). That is, patriarchal thinking enhances the beliefs that men are superior to women and it also institutes division of labor by gender.

## 5.2 Differences in academic achievement of mathematics between low/high math self-efficacious and between low/high math anxious students.

The results of mean difference tests for the upper 25% (M=13.59) and the lower 25% (M=8.85) on math self-efficacy scores with respect to math achievement revealed that, individuals' who had high math self-efficacy scores seem to achieve better than their low confidence peers. This result was depicted in Table 3. Results obtained from the correlational analyses also indicate that gender and math self-efficacy had significant positive relationships with performance. This means that in both gender group, students who scored high in math self-efficacy obtained higher scores on the achievement tests than those who showed low level of confidence on solving math problems. Besides, the correlational analyses formed for the gender subgroup portrayed that math self-efficacy and math achievement have significant positive relationships. This means that as one's math self-efficacy increases so does his/her math achievement and vice versa. In agreement with this finding, confidence was more strongly correlated with achievement (r=.40) than was any other variable measured in the study (Meyer & Schatzkoehler, 1990). Zohar (1998) also evidenced the positive relationship between math self-efficacy and math achievement. This result was also in accord with the reports of many researchers (e.g., Pajares and Miller, 1994; Randhawa et al., 1993) who maintained that the level of self-efficacy students possess will either enhance or stunt their academic motivation and thereby their by their performance.

Similar to the findings of the present study, it has been postulated that people with greater perceived self-efficacy actually do better on many kinds of tasks (Bandura, 1977, 1986; cited in Mulugeta, 1998). It should come as no surprise that what people believe they can do predicts what they can actually do and affect how they feel about themselves as does of the task (Pajares & Miller, 1994). Hence, it seems reasonable to assume that individual's with low math self-efficacy seem to be disadvantaged in performance of mathematics.

Likewise, the mean scores for the upper 25% and the lower 25% of math anxiety scores with respect to math achievement revealed that low math anxious students surpassed to their high math anxious peers in their achievement of mathematics ($t_{(184)} = 5.609$, $P < .000$). The upper 25% and the lower 25% of math anxiety scores were considered, simply because the effects of anxiety were assumed to be linear. In further support of this position, test anxiety researchers (Henrich & Spielberger, 1982; Wine, 1980; cited in Meece, Wigfield & Eccless, 1990) suggest that its effects may depend on the amount of anxiety experienced. That is, moderate levels of math anxiety may facilitate achievement striving, where as more extreme levels appear to be more disruptive of cognitive and attentional processes, especially on tasks involving higher order thinking skills.

In agreement with the present finding, Satake & Amato (1995) indicated that low-achievers, regardless of sex, reported a significantly greater level of anxiety on problem solving, test anxiety and application than did high achievers. Hunsley (1987) also noted that math anxiety was related to lower expected grades, greater pre-exam anxiety and lower ratings of preparedness. This means math anxious students who reported more anxiety would receive lower grades and felt less satisfied with their pre-exam performance. In addition, the correlation matrix revealed that math anxiety and math achievement had significant negative relationship. Consequently, it is possible to say that being more math anxious could easily lead to poor performance on math achievement. This also implies that math anxiety appears to have adverse effects on math achievement. Wigfield & Meece (1988) and Zohar (1998) evidenced the negative relation between math anxiety and math achievement.

One reason for students' poor math achievement may be attributed to inaccurate perceptions of mathematics capability (Profound lack of confidence in mathematics). In consistent with this suggestion, Meece, wigfield & Eccles (1990) noted that, students who have low perceptions of their math abilities and do not value mathematics might not report as much math anxiety as students who have low perceptions of their math abilities. As long as students feel that they are incompetent and helpless in doing the given task, they will eschew those tasks as much as possible. Thus, it is concluded students who think that they have low confidence to do mathematical problems develop negative affect to the subject which in turn result in negative attitude that culminates in low math performance.

### 5.3 Differences between grade levels in the variables in the study

The result of the study revealed that, $9^{th}$ graders and $11^{th}$ graders differ to a statistically significant extent with respect to their math self-efficacy scores ($t_{(372)}=2.254$, $p<.025$). Nonetheless, the differences do not appear to increase with grade levels and the path model portrayed in figure 1 confirmed this. Because the effect of MSE on grade level was negative and significant ($\beta$ = -. 138). On the other hand, $9^{th}$ & $11^{th}$ graders did not differ to a statistically significant extent with respect to math anxiety and math achievement scores.

The finding indicating a non-statistically significant differences between $9^{th}$ and $11^{th}$ graders on achievement is generally inconsistent with that of other studies (e.g., Fennema and Sherma, 1977; cited in Seleshi, 1995). The mean scores in other studies increased with grade level because of students' maturity and increased knowledge (Fennema & Sherma, 1977,1978; cited in Seleshi, 1995). Such a pattern was not observed in the present study. One possible explanation for the inconsistency of the present results with that of the previous studies could be the differences in the tests employed. That is, the mathematics tests employed in other studies, although designed for each grade level were statistically equated (the same test in series) and the results were treated as if the same tests were administered at all levels. The tests used in the present study, on the other hand, may be viewed as somewhat grade specific rather than similar to each other.

In other words, the tests were developed on the bases of the contents taught at each grade level and no attempt was made to develop similar items. Thus, mean scores were not expected to increase with grade levels in the present study as opposed to the results in others studies.

The finding with respect to math anxiety is not in agreement with the one indicated in the literature section (Satake & Amato, 1995). The non-significant difference between the two grade levels with respect to math anxiety may be attributable to the nature of the scale. That is, due to social desirability students could respond to the item in the scale not on the bases of what they really feel but on the bases of what they think are socially acceptable or desirable answers.

### 5.4 The effects of gender, grade level, math self-efficacy and math anxiety on math achievement and the mediational and predictive role of math self-efficacy between gender and on performance, and other variables respectively

The results of the path analysis explaining math achievement as a function of gender, grade level, math self-efficacy are displayed in figure 1. Regarding the effects of gender, grade level, math self-efficacy and math anxiety on math achievement, the path model portrayed that, except grade level which was not significant ($\beta$=0.021, t=.464, p>0.05), other variables had a statistically significant direct effect, the effect of math self-efficacy being the preeminent one. This showed that grade level did not have a substantial effect on students' mathematics achievement. Thus, It is evident that their level of math anxiety and math self-efficacy can mainly account for high school male-female students' failure and/or success in mathematics achievement.

Table 7 provides a decomposition of effects from the path analyses. Of all path coefficients from the independent variables to achievement, math self efficacy (β=. 282, t=5.483, p<. 000), gender (β=.166, t=3.564, p<.000) and math anxiety (β=-.232, t=-4.631, p<.000) were statistically significant.

As could be seen from figure 1, the direct effects of gender either on grade level or on math anxiety were not statistically significant rather the effect of gender on math anxiety was indirect (via math self-efficacy). This suggests that, gender does not differentially predict math anxiety for girls and boys, even though girls and boys differed in the amount of anxiety they report. Thus, it does appear that it may be misleading to examine the influence of gender on math anxiety with out looking at ones math self-efficacy.

On the other hand, the direct effects of math self-efficacy both on grade levels and math anxiety were negative and statistically significant (β = -. 138 & β = -. 420 respectively). This result suggest that as the grade level increases from $9^{th}$ to $11^{th}$, one's math self-efficacy decreases and vice versa. Interestingly enough, the mean difference tests between grade levels in Table 4 also strengthen this result. The adverse effect between math self-efficacy and math anxiety, which was portrayed in figure 1, also confirmed by the correlation analyses performed for the pooled subject as well as the gender subgroup. It could therefore, be possible to conclude that students will develop negative attitude towards the subjects when they have low confidence to solve mathematical problems which intern result in poor math performance.

A similar finding was reported by Pajares and Miller (1994) that math self-efficacy had stronger direct positive effect on achievement than any of the variables in the study. The finding is also in accord with local research findings that confirmed self-efficacy, among any other variables, had strong direct effect on performance (Mulugeta, 1998; Yalew, 1997).

Although much of the effects of gender on performance were direct, greater portion of its indirect effect was contributed through math self-efficacy. This suggests that math self-efficacy had a mediational role between gender and achievement. Generally, the direct and total effects of math self-efficacy were significantly stronger than gender and math anxiety suggesting its predictive and mediational role between these two variables in the realm of academic arena. This condition may also suggest that girls may conceive math as a male dominated subject, or may not be encouraged to get into those fields related to mathematics. Concerning such variation, as cited by Yalew (1997), what Bandura (1986) contended seems viably logical. Bandura indicated that one source of feeling of competence is observations of similar others.

In the present study, it was found that, gender, math self-efficacy, math anxiety and grade level combined together accounted for 24.9% of the explained variance in math achievement. That is, gender, math self-efficacy, math anxiety, and grade level combined together was significantly explained with the variability in math achievement of high school students ($9^{th}$ & $11^{th}$ graders). Of this total variance, math self-efficacy contributed 17.4%. Thus, math self-efficacy was an important predictor of students' math achievement. Regarding the gender sub- group path analyses model, the path coefficient in figure 2 portrayed that, although similar trend was observed for boys and girls the case was not true for the effect of MSE on grade level. That is, the effect of

MSE on grade level was statistically significant in the case of boys but not in the case of girls. The path further revealed that both MSE and MAS were strong predictors of boys' math achievement than girls. Besides, the stepwise multiple regression for the pooled sample as well as the gender sub-group indicated, of all the variables included in the study, it was math self-efficacy that contributed significantly to the variance of performance. That is, the poorer performance of girls were largely, due to their lower judgements of their capability. This finding, as cited by Pajares and Miller (1994) strengthen Bandura's (1986) claim that self-efficacy beliefs are key arbiters of human agency and also lend support to researchers who counted that student motivation may be better explained by these beliefs than by other cognitive or affective processes.

Thus, among the non-cognitive factors, self-efficacy seems more crucial for accurate prediction of academic performance of males than females, particularly concerning mathematics achievement.

# CHAPTER SIX

## 6. SUMMARY, CONCLUSION AND RECOMMENDATION

In the present study attempts were made to examine gender differences in mathematics achievement as a function of math self-efficacy and math anxiety including gender and grade level.

To collect necessary data, three types of instruments namely, math anxiety scale, math self-efficacy scale and math achievement tests were used.

In so doing, the following specific questions were entertained.

1. Are there statistically significant gender differences in the variables in the study?

2. Do students with high math self-efficacy scores and low math anxiety scores differ, to a statistically extent, from those students having low math self-efficacy and high math anxiety scores in their performance of math?

3. Are there statistically significant differences between the two grade levels (9$^{th}$ & 11$^{th}$) on the variables treated in the study?
4. Do gender, grade level, math self-efficacy, and math anxiety have direct and indirect effects on achievement of math? If so, which one has the highest direct and indirect or total effects on math achievement? Which one is a statistically significant predictor of achievement?

5. Does math self-efficacy have a mediational role between gender and math achievement, as well as a predictive role to math anxiety, grade level, and math achievement?

6. Do the effects of math self-efficacy, grade level, and math anxiety on math achievement have the same trend for the gender sub-group?

Accordingly, Mean difference tests indicated that in all the variables in the study, gender differences were statistically significant. This result, however, seems to be true when pooled subjects are considered. A non-significant gender differences, however, was found in mean math anxiety scores for 11$^{th}$ graders. Significance differences were also noted in math achievement of high school students (9$^{th}$ & 11$^{th}$) having high/low math self-efficacy and high/low math anxiety scores. The correlations among math self-efficacy, math anxiety and math achievement were statistically significant for the pooled as well as the gender subgroup samples. The path model portrayed that, except grade level, the other variables had statistically direct significant effect on performance. For both the pooled and the gender sub-group path analyses models, math self-efficacy was the strongest determinant of math achievement.

Therefore, from the aforementioned discussions one may arrive at the following conclusions.

1. There was gender disparity in all the variables in the study for the pooled subjects. That is, boys of high school students (9$^{th}$ & 11$^{th}$) reported high math

self-efficacy, low math anxiety and better performance on math achievement than their female counterparts.

2. Students with high math self-efficacy and low math anxiety level performed better on math achievement than students with low math self-efficacy and high math anxiety levels. That is, students with low math self-efficacy and high math anxiety levels associated with poor performance on math achievement.

3. Gender, math self-efficacy and math anxiety add significantly (jointly and / or independently) to the changes in variance of high school students' math achievement. Grade level adds no significant contribution to high school students' mathematics achievement.

4. Math self-efficacy had a mediational and predictive role between gender and achievement and other variables in the study respectively.

In a nutshell, the present findings do not provide a novel evidence when seen from the point of view of the available theoretical and empirical evidences. Viewed from the Ethiopian context, the investigations of the contribution of non-cognitive factors on academic performance of math have received scant attention. Thus, the results of the present study seem to have some practical implications to high school students in particular and in all grade levels in general.

The present study, however, was not without some limitations. One potential problem is that the study is partly based on self-reported data. This is particularly true of the data gathered through math anxiety scale. Due to social desirability, students could respond to the item in the scale not on the bases of what they really feel but on the bases of what they think are socially acceptable or desirable. Secondly the sample contains only high school students of $9^{th}$ and $11^{th}$ graders, and so results found may be representative of these two grade levels rather than other segments of high school students.

Based on the aforementioned discussions and conclusions, the following recommendations are made.

1. It would be advisable for educators, curriculum designers, counselors, etc., to focus not only on cognitive factors but also on non-cognitive factors such as self-efficacy, math anxiety, academic achievement motivation, etc. in the teaching learning process.

2. Individuals with low math self-efficacy and high math anxiety seem to be disadvantaged in performance of mathematics tests. Thus, teachers and school practitioners should be looking to students' beliefs about their capabilities as important mediators and predictors of performance. Inaccurate perceptions could also be identified early and appropriate interventions are undertaken by arranging special programs such as educational enrichment programs. Furthermore, rendering individual centered counseling services by counselors and educators could be adopted to change their beliefs.

3. Mathematics teachers should give due attention to the non-cognitive factors such as those examined in this study. Within the teaching-learning process, they have to scrutinize the beliefs of their students. In so doing, they should devote

much of their time and energy to promote high math self-efficacy of their students ingeneral and female students in particular so as to make them successful in their math achievement.

4. Treatment programs (counseling interventions) for math anxious students (particularly for females) should be involved so as to help students manage their emotional stress and reduce their fear and dread doing of math. Guidance and counselors should help them in giving "the true picture" of their own abilities so that they may utilize their endowed potentials in constructive ways.

5. Parents should also encouraged their children (especially female students) by providing incentives or rewards to develop internal, stable and controllable attribution (effort) whenever they are involved in difficult and complex tasks.

6. Future researches should examine whether math self-efficacy and math anxiety constructs on math achievement are generalizable to other segments of high school students. In addition, it would be fruitful to conduct research on math self-efficacy and math anxiety with different methodologies to give a richer description of the relationships of these constructs with math achievement concerning gender.

7. Future research should also include a large sample including elementary, junior and secondary school students to examine the root causes of the gender differences in math achievement and other variables examined in the study.

8. Finally, it is important to note that future studies should focus on the impinging effects of sex-role stereotypes on self-efficacy so that prompt measures would be taken to reduce, if not avoid, gender differences in performance of math and enrollment in math and related subjects.

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# APPENDIX A

A list of secondary schools ($9^{th}$ – $12^{th}$) in the area of the study.

1. Adaba Senior Secondary School
*2. Agarfa Senior Secondary School
*3. Batu Terara Comprehensive Secondary School
4. Dodola Senior Secondary School
5. Gasera High School
6. Ghinnir Senior Secondary School
*7. Goro High School
8. Jara Senior Secondary School
9. Kokaso High School
10. Mena Senior Secondary School
*11 Robe Senior Secondary School
12. Worka High School

* School numbered 2, 3, 7 and 11 were the sample high schools.

APPENDIX B

# ADDIS ABABA UNIVERSITY
## EDUCATION FACULTY GRADUATE STUDIES PROGRAM
## DEPARTMENT OF PSYCHOLOGY

**General:** This questionnaire is prepared to collect data that will be used for writing my Master's Thesis as a partial fulfillment of the program of graduate studies in the Addis Ababa University. This questionnaire has two parts (Math anxiety & Math Self-efficacy Scales). Thus, you are kindly requested to complete the questionnaires carefully and honestly for your responses are the only way to reach a reliable research results.

**Direction 1:** Below are items (statements) which have been designed to assess your opinion (feelings) about mathematics. Mark (x) under the points which best indicates how closely you agree or disagree with the math anxiety expressed in each statement as it concerns you.

The four points are:

Strongly Disagree (SD), Disagree (D), Agree (A), and Strongly Agree (SA).

| | | SD | D | A | SA |
|---|---|---|---|---|---|
| *1 | Mathematics is one of my most dreaded subject | | | | |
| *2 | My mind goes blank, and I am unable to think clearly when doing math | | | | |
| 3 | I am very calm and unafraid when studying math | | | | |
| 4 | I do not get upset when working with numbers | | | | |
| 5 | I do not feel scared of taking math tests | | | | |
| 6 | Mathematics does not make me uneasy and confused | | | | |
| *7 | I feel a sense of insecurity when doing math | | | | |
| 8 | Looking through the pages on a math text does not make me worry | | | | |
| *9 | I feel scared of mathematics activity | | | | |
| *10 | I cannot predict the type of questions on math tests and exams | | | | |
| *11 | Compared to other subjects, I feel worry about how well I am doing in math | | | | |

| | | SD | D | A | SA |
|---|---|---|---|---|---|
| 12 | I do not feel worry during math class | | | | |
| 13 | Mathematics does not make me restless, irritable, and impatient | | | | |
| *14 | If I could, I prefer to avoid mathematics | | | | |
| 15 | Watching a teacher work on mathematics problem on the blackboard does not make me worry | | | | |
| *16 | As compared to others, I am concerned that the teacher may think I am a poor student in mathematics | | | | |
| 17 | Trying to understand mathematics does not make me anxious | | | | |
| *18 | I feel worry that other students might understand mathematical problems better than me | | | | |
| *19 | I approach mathematics with a feeling of hesitation resulting from a fear or not being able to do math | | | | |
| *20 | Picking up a math textbook to begin working a homework assignment makes me worry | | | | |

*Represents negatively worded statements.

**N.B.** High score indicates higher anxiety

APPENDIX C.

**Direction**: Below is a scale that expresses problems on grade 9 mathematics. Your are to estimate, on a five point scale, the extent of your ability to solve or to provide answers to the problems. The five points are:

1. Not at all confident  2.very little confidence  3. Uncertain
4. Much confident  5.completely confident

Mark (x) under the point, which best indicates how closely you are confident or not to solve each of the following 30 items.

| | | Not at all confident | Very little confidence | Uncertain | Much confident | completely confident |
|---|---|---|---|---|---|---|
| 1 | What is the symbol for disjunction? | | | | | |
| 2 | If the truth value of a compound statement is true for all possible truth values of its components, then it is called | | | | | |
| 3 | What is the additive inverse of 2/3? | | | | | |
| 4 | How many members of elements are there in the set {{ 6,7 },{1,2,3}}? | | | | | |
| 5 | The number of proper subsets of the set{ p, q ,r} is equal to | | | | | |
| 6 | If A x B = {(a,m),(b,s),(c,t)} then Set B = ? | | | | | |
| 7 | Let R = The set of integers between –5 and 5<br>S = The set of natural numbers less than 10<br>T = The set of Teff in a sack.,<br>Among the three sets given above, which one is an infinite set ? | | | | | |
| 8 | If (3x + 2, 9 = 5, 4y + 1), then what are the values of x & y respectively ? | | | | | |
| 9 | If A = {1,2,3}, B = {4,5}, and C = {1,2,5}, then A n(B/C) = ? | | | | | |
| 10 | What is the place value of the digit 2 in $(30201)_{four}$ ? | | | | | |
| 11 | What is the decimal notation for $2 + \frac{3}{10} + \frac{7}{1000}$ ? | | | | | |
| 12 | What is the number that immediately follows $(88)_{nine}$ | | | | | |
| 13 | If A = {-1,0,1}, then under what ordinary operation A is closed? | | | | | |
| 14 | If $a\Delta b = \frac{a-b}{4}$, then what is the value of 1 Δ5 ? | | | | | |
| 15 | If S = {1,2,3} and * is a binary Operation on S, then what is the inverse of 3 using the table to the right.<br>\| * \| 1 \| 2 \| 3 \|<br>\| 1 \| 3 \| 1 \| 2 \|<br>\| 2 \| 1 \| 2 \| 3 \|<br>\| 3 \| 2 \| 3 \| 1 \| | | | | | |

| | | Not at all confident | Very little confidence | Uncertain | Much confident | completely confident |
|---|---|---|---|---|---|---|
| 16 | Out of a group of 100 students, 35 are member of mathematics club, 50 are members of physics club, and 20 are members of both clubs. How many are members of neither the mathematics nor the physics club? | | | | | |
| 17 | What is the sum of $(342)_{seven}$ and $(1232)_{seven}$? | | | | | |
| 18 | Arrange 5, -9,1 & 0 in their increasing order | | | | | |
| 19 | If $1.5 - 0.01 = x$, then what is the value of x ? | | | | | |
| 20 | Changing 0.7333... to a fractional form and simplifying what do you get (obtain ) ? | | | | | |
| 21 | If $x = 2.0333...$ and $y = 3.4333...$ then $x + y = ?$ | | | | | |
| 22 | What is the standard notation for 0.0324? | | | | | |
| 23 | Change $(11.11)_{two}$ into base ten | | | | | |
| 24 | Simplify $7\sqrt{5} - \sqrt{45}$ and write it using single radical | | | | | |
| 25 | Simplify $\sqrt{2}\sqrt{32}$ | | | | | |
| 26 | What is the simplified form of $\frac{15 \times \sqrt{27}}{5 \times \sqrt{3}}$ ? | | | | | |
| 27 | Rationalize the denominator of $2/(3+\sqrt{6})$ | | | | | |
| 28 | Divide $(313)_{four}$ by $(23)_{four}$ and put the result in base four . | | | | | |
| 29 | If $n(A)=8$, $n(B) = 6$, and $n(A \cap B) = 4$, then determine the value of $n(A \cup B)$ | | | | | |
| 30 | Of the numbers 3.1046111111---, $\sqrt{2}\sqrt{8}$ , and 0, which one is <u>IRRATIONAL</u> number ? | | | | | |

Appendix - D

# MATHEMATICS ACHIEVEMENT TEST FOR GRADE NINE

Name____________________ Section ____________ Roll. No.__________

Sex______________________ Age ______________ School____________

**Direction**: This test booklet contains 30 multiple-choice items. Read each statement carefully. Each item is followed by four possible answers. There is only one best answer for each question. Choose the one that best answers the question and blacken the circle corresponding to your choice on the answer sheet provided.

**Time:one hour**

1. What is the symbol for disjunction?
   A. V
   B. ∧
   C. ⇒
   D. ¬
2. If the truth value of a compound statement is true for all possible truth values of its components, then it is called __________
   A. Tautology
   B. Contradiction
   C. Equivalents
   D. Logically true
3. The additive inverse of 2/3 is _________
   A –3/2
   B. 3/2
   C. -2/ 3
   D. 0
4. How many members of elements are there in the set {{6,7}, {1,2,3,}}?
   A. 2
   B. 3
   C. 4
   D. 5
5. The number of proper subsets of the set {p,q,r} is equal to _____
   A. 8
   B. 7
   C. 4
   D. 3
6. If AxB={(a,m),(b,s),(c,t)}, then set B=?
   A. {a,m,s}
   B. {a,b,c}
   C. {m,s,t}
   D. {c,t}
7. Let R = the set of integers between –5 and 5
   S = the set of natural number less than 10.
   T = the set of teff in a sack
   Among the three sets given above, which one is infinite set?
   A. R
   B. S
   C. T
   D. none of them are infinite

8. If (3x + 2, 9= 5, 4y + 1), then the value of x and y respectively are:-

   A. 2,1
   B. 7/3, 5/2
   C. 0,2
   D. 1,2

9. If A={1,2,3}, B={4,5}, and C={1,2,5}, then the set A∩(B/C)= ?

   A. {1,2,3,}
   B. {}
   C. {1,2,5}
   D. None

10. What is the place value of the digit 2 in $(30201)_{four}$?

   A. 16
   B. 8
   C. .4
   D. 2

11. The decimal notation for $2 + \frac{3}{10} + \frac{7}{1000}$ is________

   A. 0.237
   B. 0.2307
   C. 2.37
   D. 2.307

12. The number that immediately follows $(88)_{nine}$ is_______

   A. 1000
   B. 100
   C. 99
   D. 89

13. If A ={-1,0,1}, then under what ordinary operation set A is closed?

   A. Multiplication
   B. Division
   C. Subtraction
   D. Addition

14. If $a \Delta b = \frac{a-b}{4}$, then the value of $1 \Delta 5$ =?

   A. −3
   B. −1
   C. 0
   D. 1

15. If S={1,2,3} and ∗ is a binary operation on S, then what is the inverse of 3 using the table below

| ∗ | 1 | 2 | 3 |
|---|---|---|---|
| 1 | 3 | 1 | 2 |
| 2 | 1 | 2 | 3 |
| 3 | 2 | 3 | 1 |

   A. 1
   B. 2
   C. it self
   D. has no inverse

16. Out of a group of 100 students, 35 are members of mathematics club, 50 are member of physics club, and 20 are member of both clubs. How many are members of neither the mathematics nor the physics club?

A. 15
B. 30
C. 35
D. 65

17. The sum of $(342)_{seven}$ and $(1232)_{seven}$ in base seven is ________

A. $(1604)_{seven}$
B. $(650)_{seven}$
C. $(1560)_{seven}$
D. $(1650)_{seven}$

18. Which one of the following numbers are arranged in their increasing order?

A. 9,5,1,0
B. 5,1,-9,0
C. 0,-9,1,5
D. -9,0,1,5

19. If 1.5 – 0.01 = X, then the value of X is _______

A. 0.49
B. 1.44
C. 1.49
D. None of them

20. Changing 0.7333 ----- to a fractional form and simplifying gives ____________

A. 11/14
B. 11/15
C. 22/29
D. 73/100

21. IF X = 2.033333---- and Y= 3.43333----, then X +Y = ?

A. $5.\overline{46}$
B. $5.4\dot{6}$
C. $5.4\dot{3}$
D. $5.\dot{4}\dot{3}$

22. What is the standard notation for 0.0324?

A. $3.24 \times 10^{2}$
B. $3.24 \times 10^{-2}$
C. $32.4 \times 10^{2}$
D. $32.4 \times 10^{-2}$

23. When $(11.11)_{two}$ is changed is base ten, its value is __________

A. 2.25
B. 2.75
C. 3.25
D. 3.75

24. When $7\sqrt{5} - \sqrt{45}$ is simplified and written using single radical, it is the same as _____

A. $3\sqrt{5}$
B. $4\sqrt{5}$
C. $-\sqrt{10}$
D. $5\sqrt{3}$

25. Simplifying $\sqrt{2} \times \sqrt{32}$ we get ____

A. $\sqrt{34}$
B. 6
C. $6\sqrt{2}$
D. 8

26. The simplified form of $\frac{15 \times \sqrt{27}}{5 \times \sqrt{3}}$ is ____

A. $5\sqrt{3}$
B. 9
C. 15
D. 27

27. When we rationalize the denominator of $\frac{21}{3 + \sqrt{6}}$, we obtain:-

A. $21\sqrt{3} - 6$
B. $7(6 - \sqrt{6})$
C. $7(3 - \sqrt{6})$
D. 1

28. If we divide $(313)_{four}$ by $(23)_{four}$, we get ________

A. $(13)_{four}$
B. $(12)_{four}$
C. $(11)_{four}$
D. None of these

29. If $n(A \cap B) = 4$, $n(B) = 6$, and $n(A) = 8$, then $n(A \cup B) = ?$

A. 18
B. 14
C. 12
D. 10

30. Which one of the following is IRRATIONAL number?

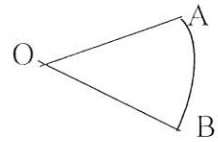
A. 3.10406111111-----
B. $\sqrt{2}\sqrt{8}$
C. 0
D. None of them

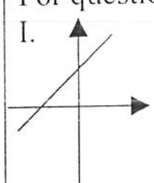
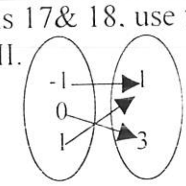
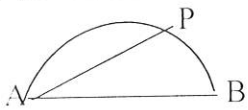
Appendix E

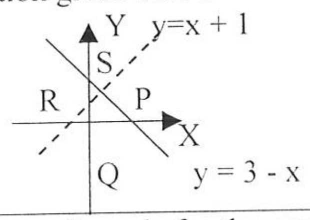
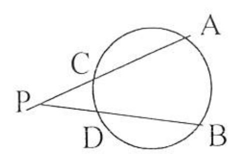
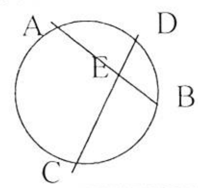
**Direction**: Below is a scale that expresses problems on grade 11 mathematics. Your are to estimate, on a five-point scale, the extent of your ability to solve or to provide answers to the problems. The five points are:

1. Not at all confident 2.very little confidence 3. Uncertain
4. Much confident 5.compltely confident

Mark (x) under the point, which best indicates how closely you are confident or not to solve or provide answers for each of the following 30 items.

| | | Not at all confident | Very little confidence | Uncertain | Much confident | Completely confident |
|---|---|---|---|---|---|---|
| 1 | A straight line having only one common point with the circle is called | | | | | |
| 2 | A quadrilateral in which a circle can not inscribed in is | | | | | |
| 3 | If $\angle$ POQ is a central angle of $60^0$ in a circle with center O, then the degree measure of the major arc QP is equal to | | | | | |
| 4 | What is the degree measure of the angle with radian measure $\frac{7\pi}{4}$? | | | | | |
| 5 | What is the smallest measure of the angle with degree measure $460^0$? | | | | | |
| 6 | What is the perimeter of the shape below. if O is center and AB is an arc of a circle with AO=BO=6cm & $\angle AOB = 60^0$   | | | | | |
| 7 | If R={(x,y)/ y $\leq$ - x}, then among the ordered pairs (-1,1),(6,-3), and (5,5) which one belong to R? | | | | | |
| 8 | What is the inverse of the relation R={(x,y)/ y = 1/2x + 2}? | | | | | |
| 9 | A quadrilateral which is equilateral But not equiangular is called | | | | | |
| 10 | Let A= {1,2,5},B={6,7}and R= {(x,y) $\in$ Bx A and y=x-2} what is the domain of R | | | | | |
| 11 | For the relation R= {(x,y)/y=3-2x; x =-1/2,0,2}, what are the corresponding ranges of R? | | | | | |
| 12 | If f={(2,5),(3,4)}and g={(2,15),(3,0)}, then find g-f | | | | | |

| | | Not at all confident | Very little confidence | Uncertain | Much confident | Completely confident |
|---|---|---|---|---|---|---|
| 13 | Let h(x)= $4x^2$ and g(x)= $3-2x^2$ If f= h x g. find f for x = ½ | | | | | |
| 14 | Let f = {(1.1).(2.3).(3.4)} and g = {(2.3).(3.1).(4.2)}.what is the value of g(f(3))=? | | | | | |
| 15 | How many sides have a regular polygon if the sum of its interior angles is equal to $1080^0$? | | | | | |
| 16 | Given A={a.b.c.d}.How many members of AxA have the form (x.x)? | | | | | |
| | For questions 17& 18. use the following information I.  II.  III. {(0.0).(1.1).(0,4)} | | | | | |
| 17 | Of the above three information, which one <u>does</u> <u>not</u> represent a function? | | | | | |
| 18 | Of the three information given above, which one represents a one – to – one function? | | | | | |
| 19 | In the figure below. AB is diameter of a semi-circle APB and m(∠ABP)=$55^0$ What is the measure of arc PB?  | | | | | |
| 20 | Given a circle with center O. radius R. and any arbitrary point P. If R>OP. then where is the position of the point P? | | | | | |
| 21 | Two circles are externally tangent If the radius of the lager is R and the radius of the smaller is r, and the distance between their centers is d. then express d in terms of R& r? | | | | | |
| 22 | If the circumference of the circle is 12∏ cm, then determine its area | | | | | |

| | | Not at all confident | Very little confidence | Uncertain | Much confident | Completely confident |
|---|---|---|---|---|---|---|
| | To answer questions 23, 24, and 25 use the graph of the relation given below  | | | | | |
| 23 | Set up a formula for the graph of the region R given above | | | | | |
| 24 | Find the domain of the region R from the graph given above | | | | | |
| 25 | The range of the region R from the graph above is | | | | | |
| 26 | If in the figure to the right m(arc AB)= $100^0$, and m(P)= $15^0$, then find m(arc DC)  | | | | | |
| 27 | On a given circle there are two distinct points A and B . If the ratio of the minor arc AB to the major arc AB is 2:7, then determine the angle circumscribed by the major arc. | | | | | |
| 28 | In the figure to the right is a circle with two intersecting chords AB and DC at point E. If AE=EB, DE= 4cm, and DC=9, then determine the length of chord AB.  | | | | | |
| 29 | In a circle, drawn on different sides of the center are parallel chords equal to 36cm and 48cm. If the distance between them is 42cm, then determine the radius of the circle. | | | | | |
| 30 | The plane of a small circle of a sphere of radius 6cm bisects the radius of the sphere perpendicular to it. What is the radius of the small circle? | | | | | |

APPENDIX F

# MATHEMATICS ACHIEVEMENT TEST FOR GRADE ELEVEN

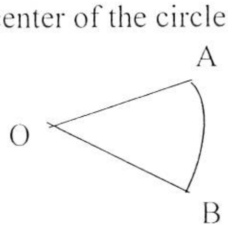
Name ______________________ Section ____________ Roll. No.____________

Sex_________________________ Age______________ School_____________

**Direction:** This test booklet contains 30 multiple-choice items. Read each statement carefully. Each item is followed by four possible answers. There is only one best answer for each question. Choose the one that best answer the question and blacken the circle corresponding to your choice on the answer sheet.

**Time:one hour**

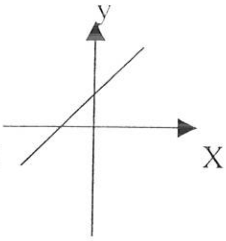
1. A straight line having only one common point with a circle is called ___________
   A. secant line
   B. tangent line
   C. chord
   D. diameter
2. A quadrilateral in which a circle <u>can not</u> be inscribed in is
   A. Square
   B. Rhombus
   C. rectangle
   D. trapezium
3. If $\angle POQ$ is a central angle of $60^0$ in a circle with center O, then the degree measure of the major arc QP is
   A. $30^0$
   B. $60^0$
   C. $120^0$
   D. $300^0$
4. What is the degree measure of the angle with radian measure $7\Pi/4$?
   A. $45^0$
   B. $90^0$
   C. $135^0$
   D. $315^0$
5. The smallest measure of the angle with degree measure $460^0$ is
   A. $0^0$
   B. $60^0$
   C. $80^0$
   D. none
6. What is the perimeter of the shape to the right, if 0 is center of the circle, AB an arc of the circle with AO=BO=6cm and $\angle AOB=60^0$

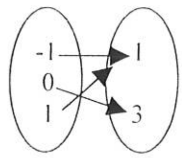
   
   

   A. $\Pi$ cm
   B. $2\Pi$cm
   C. $2(\Pi+3)$cm
   D. $2(\Pi+6)$ cm
7. If $R=\{(x,y):y \leq -x\}$, which one of the following ordered pairs belong to R?
   A. (−1,1)
   B. (6, −3)
   C. (5,5)
   D. All

8. What is the inverse of the relation R={(x,y) :y= ½x+2}?
   A. $R^{-1}$= {(x,y):y=2x-4}
   B. $R^{-1}$={(y,x):x=2y-2}
   C. $R^{-1}$={(x,y):y=½x+2}
   D. $R^{-1}$={(y,x):x= ½y+2}
9. A quadrilateral, which is equilateral but not equiangular, is ________
   A. Rhombus
   B. Square
   C. Rectangle
   D. Trapezium
10. Let A={1,2,5}, B ={6,7}, and R={(x,y) ∈BxA and Y=x-2} what is the domain of $D_R$?
   A. {6}
   B. {7}
   C. {6,7}
   D. {1,3,4}
11. For the relation R={(x,y):y=3-2x;x=-½,0,2}, what are the corresponding ranges of R?
   A. {-1,3,4}
   B. {1,2,3}
   C. {2,3,4}
   D. {2,3,5}
12. If f={(2,5),(3,4)} and g={(2,15),(3,0)} then g-f=?
   A. {(2,10), (3,-4)}
   B. {(2,-10),(3,4)}
   C. {(0,10),(0,-4)}
   D. None
13. Let h(x)=$4x^2$ and g(x)=3-$2x^2$.If f=gxh, find f for x=½
   A. 7/2
   B. 5/2
   C. 3/2
   D. 1
14. Let f={(1,1),(2,3),(3,4)} and g={(2,3),(3,1),(4,2)}, what is the value of g(f(3)?
   A. 1
   B. 2
   C. 3
   D. 4
15. How many sides have a regular polygon if the sum of its interior angles is equal to $1080^0$?
   A. 6
   B. 7
   C. 8
   D. such a polygon doesn`t exist?
16. Given A={a,b,c,d}. How may members of AxA have the form (x,x)?
   A. 4
   B. 8
   C. 12
   D. 16

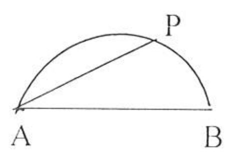
For questions 17 and 18, use the following information

I 


II. 

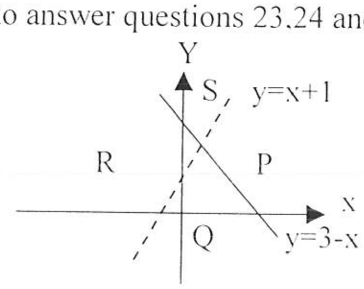

III. {(0,0), (1,1), (0,4)}

17. Which one of the above information doesn`t represent a function?
    A. I
    B. II
    C. III
    D. II &III
18. Of the above information,which one represents a one-to-one function?
    A. I
    B. II
    C. III
    D. All
19. In the figure below, AB is diameter of a semi- circle APB and $m(\angle ABP)=55^0$, then measure of arc PB=?
    A. $55^0$
    B. $70^0$
    C. $90^0$
    D. $110^0$

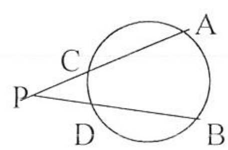



20. Given a circle with center o, radius r, and any arbitrary point p. If r>op, then where is the position of the point p?
    A. out side the circle
    B. inside the circle
    C. on the circle
    D. cannot be determined
21. Two circles are externally tangent. If the radii of the larger is R, the smaller is r, and the distance between their center is d, then what is the expression of d interms of R & r?
    A. d=R+r
    B. d=R-r
    C. R-r<d<R+r
    D. d= 2(R-r)
22. If the circumference of the circle is 12∏cm, then what its area?
    A. 3∏$cm^2$
    B. 6∏$cm^2$
    C. 9∏$cm^2$
    D. none of these

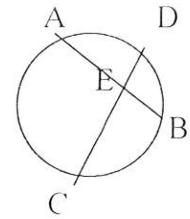
Use the graph below to answer questions 23,24 and 25



23. The formula for the graph of the region R is
   A. R={(x,y):y≤x+1 and y≥3-x}
   B. R={(x,y):y≥x+1 and y≤3-x}
   C. R={(x,y):y>x+1 and y≤3-x}
   D. R={(x,y):y<x+1 and y≥3-x}
24. The domain of the region R from the above graph is
   A. {x:x≤1}
   B. {x: x>1}
   C. {x:x<1}
   D. All real numbers
25. The range of the region R is
   A. {y:y≤2}
   B. {y:y>2}
   C. {y:y<2}
   D. All real numbers
26. If in the figure to the right, m(arc AB)=$100^0$ and measure of angle P=$15^0$, then m(arcDC)=?
   A. $30^0$
   B. $35^0$
   C. $70^0$
   D. None of them




27. On a given circle there are two points A and B. If the ratio of the minor arc AB to the major arc AB is 2:7, then the measure of the angle circumscribed by the major arc is ____
   A. $280^0$
   B. $80^0$
   C. $40^0$
   D. none
28. In the figure to the right is a circle with two intersecting chords AB and DC. If AE=EB, DE=4cm and DC=13 cm, then chord AB is equal to?
   A. 6
   B. 9cm
   C. 12cm
   D. $\sqrt{52}$




29. In a circle, drawn on different sides of the center are parallel chords equal to 36cm and 48cm. If the distance between them is 42cm, then determine the radius of the circle.
   A. 18cm
   B. 24cm
   C. 30cm
   D. none of them
30. The plane of a small circle of a sphere of radius 6cm bisects the radius of the sphere per perpendicular to it. What is the radius of the small circle?
   A. $\sqrt{3}$
   B. 3 cm
   C. $2\sqrt{3}$
   D. $3\sqrt{3}$ cm

# APPENDIX G.

**Table 10:** Means and Standard Deviation for males' and females' in the variables treated in the study (by grade level)

| Grade | Sex | VARIABLES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | MSE | | | MAS | | | PERF | | |
| | | N | M | SD | N | M | SD | N | M | SD |
| 9 | F | 104 | 94.23 | 25.27 | 104 | 47.27 | 7.23 | 104 | 8.79 | 3.53 |
| | M | 91 | 108.33 | 23.81 | 91 | 43.08 | 10.22 | 91 | 11.48 | 4.75 |
| | | t = -3.993,.P=.000 | | | t=3.338,P=.001 | | | t=-4.531,P=.000 | | |
| 11 | F | 84 | 88.27 | 26.05 | 84 | 45.10 | 10.78 | 84 | 9.11 | 3.45 |
| | M | 95 | 99.85 | 31.01 | 95 | 44.19 | 10.20 | 95 | 11.00 | 5.03 |
| | | t=-2.685,P=.008 | | | t=.577,P=.564 | | | t=-2.897,P=.004 | | |

*P < .05

# DECLARATION

I, the undersigned, hereby declare that this thesis is my original work done under the guidance of Dr. Daniel Desta. All relevant sources used in this thesis are duly acknowledged.

Name: Eshetie Abebe

Department: Educational Psychology

Signature: ______

Date: June 5, 2001

Advisor: Daniel Desta (Ph.D)

Signature ______

Date: ______