

**MATHEMATICS ANXIETY AND ITS IMPACT ON STUDENTS' ACHIEVEMENT:
WITH SPECIFIC REFERENCE TO GRADE NINE STUDENTS OF EAST SHOA
ZONE IN OROMIA REGION**

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Master of Education (Med) thesis

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This thesis has been evaluated and approved by the examining board consisted of:

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Examiner

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Abbreviations/Acronyms

MARS: Mathematics Anxiety Rating Scale

Math: Mathematics

MAT: Mathematic Achievement Test

MOE: Ministry of Education

NCTM: National Council for Teachers of Mathematics

NDE: National Association for Developmental Education

TGE: Transitional Government of Ethiopia

SPSS: Statistical Package for Social Science

Abstracts

This study was aimed to examine the impact of mathematics anxiety on achievement. It was also focused on examining gender difference in mathematics anxiety as well as mathematics achievement. The study was conducted on five randomly selected public high schools of East Shoa zone. Subjects included 370 students, 184 male and 186 female. Math anxiety was measured using both the English version of Math Anxiety Rating Scale (MARS) and the Oromic version of math anxiety rating scale (MARS). The instrument used to measure achievement was the Mathematics Achievement Test (MAT), which was developed by the researcher. To accomplish the goal of this study, a quantitative study which was a survey study was used and a path analysis model was used to investigate the direct and indirect effect of each predictor variable on the criterion variable. The finding revealed that there was a significant negative correlation between mathematics anxiety and achievement ($r = -0.250, p < 0.01$). Revealing that students who have high mathematics anxiety tended to perform poorly on mathematics achievement. However, those who have low mathematics anxiety tended to score high in mathematics achievement. There was a significant gender difference in mathematics anxiety ($df = 368, t = -3.258, p < 0.01$); showing that female students' are more anxious about mathematics than male. There was also a significant gender difference in mathematics achievement ($df = 368, t = 5.151, p < 0.01$). Generally, the result of the study shows that male students are superior in all variables treated in the study. Moreover, the result of the study reveal that grade nine students' math anxiety level is at a moderate level. The result of path analysis shows that prior math achievement, sex, affective subscale and avoidance subscale were the most influential causes for mathematics achievement. While affective subscales, cognitive subscales and avoidance subscales were the causes of mathematics anxiety. Moreover, prior math achievement had a stronger direct effect on mathematics achievement than did any of the variables in the study, while affective subscale had a stronger direct effect on mathematics anxiety than did any of the other two subscales.

Chapter 1

Introduction

1.1. Back ground of The Study

Mathematics is one of the fundamental skills in which people of modern societies needs in sustaining their daily life. For instance, Neunzert (2000 cited in Sarah Boutwell Johnson, 2003) feels that mathematics is critical for people living in the 21st Century in order for them to be successful. But, still the idea that mathematics is a difficult subject manifests among students of Ethiopia. It is obvious that more and more professionals and specialists in technology will be required for our country in the future. And hence mathematics is truly the gateway to scientific and technological fields. Students with low mathematical ability may not be successful in those fields. The Ethiopian Education and Training Policy (TGE, 1994), indicates that students of grades 9 and 10 are expected to consider different areas (fields) in to account for identifying their interest for further education, specific training, and the world of work. However, it is at this stage that students heard of the blame of some subjects (for instance phobia of mathematics begins) and inclination to other subjects overtly depicted.

More importantly, the current educational and training policy of Ethiopia depicts that most of the students completing preparatory school can join science and engineering fields. So, students have to build confidence in their ability to do mathematics from the very beginning of their high school life, in such a way that they become an adequate talented individual for their country. Moreover, MOE (2009, p. iv) put its objectives of mathematics learning in the first cycle of the secondary education (Grades 9 and 10) as “mathematics learning at this cycle, should contribute towards educating students to be ready to take part in constructing the future society. At this level, everything has to be done to develop personalities characterized by a scientific view of life, high moral qualities and readiness to take part in social activities. Each student should acquire a solid, applicable and extendable mathematical knowledge and develop the appropriate

mathematical skills either to pursue with his/her study of preparatory school (Grades 11 and 12) mathematics or join the technical and vocational trainings after which he/she is able to participate in activities of shaping a new society”. But there are many constraints that hinder students’ mathematics ability at this stage. One of the major problem in which this study emphasize is mathematics anxiety.

In fact the NCTM (1989, cited in Joseph M. Furner & Barbara T. Berman, 2005) recognizes mathematics anxiety as a problem and has specifically included the detection of this phenomenon in its assessment practices. Moreover, the National Council for Teachers of Mathematics (NCTM, 2000) standards calls for a focus on the process, rather than the product of mathematics so that students can become better, persistent problem-solvers in their everyday lives. The NCTM (2000) states that students need to value mathematics and be able to manipulate, see, and communicate mathematics (both orally and in writing).

Adeleke (1998, as cited in Eshetie, 2001) suggests that mathematical techniques are constantly being developed to meet the changing requirement of physics, chemistry, biology, social and behavioral science, engineering and computer science. In light of this Stedisho (1961, cited in Eshetie, 2001) indicates that no other subject forms a strong binding force among various branches of sciences as mathematics.

Despite its importance, mathematics is a subject which many students experience difficulty with it. Many students have a mistaken impression about mathematics and hence dislike mathematics. Many seem to fear even hate mathematics (Neale, 1969, cited in Eshetie, 2001).

Mathematics anxiety is a feeling of tension and anxiety that interfere with the manipulation of mathematical problems in varied situations in ordinary as well as academic life (Richardson & Suinn, 1972). It can also be explained as a sense of discomfort observed while working on mathematical problems (Hadfield & Trujillo, 1999; Ma, 2003) and is associated with fear and uneasiness to specific math related

situations (D'Ailly & Bergering, 1992). According to (Kogelman, S, Nigro, E., & Warren, J., (1978) math anxiety is a conditioned fear that develops into a passive attitude, which becomes a self-fulfilling insight that reinforces one's beliefs about an inability to perform mathematically and it is often the result of repeated negative experiences related to mathematics.

Often students who are anxious, bored, and fearful towards math or who do not comprehend the importance of math in professional and personal life are the once that likely avoid the study of mathematics. One notable consequences of math anxiousness are the inability to do math, the decline in mathematics achievement, the avoidance of mathematics courses, the limitation in selecting college majors and future careers and the negative feelings of guilt and shame, (Betz, 1978; Rechardson & Suinn, 1972).

The consequence of avoiding mathematics in turn has serious implications (Sells, 1972; Tobias, 1980; Hembree, 1990, cited in M.Marie, 2009). For example, Hembree (1990, as cited in Sarah Boutwell Johnson, 2003) suggests that when students avoid the study of mathematics, it erodes the country's resources base in science and technology. It is thought that the avoidance of mathematics especially applies to females. Having math anxiety may not of course, mean a person cannot understand nor do certain mathematical tasks, but it is to mean that it can inhibit the ability to learn or successfully demonstrate that learning.

According to (K. Yenilmez, N. Girginer & Aozlem Uzun, 2007, para. 6) the symptoms of math anxiety are;

- o **Panic:** Students have a feeling of helplessness. They feel that a brick wall has come down and they will never do better and have reached their limit in math.
- o **Paranoia:** Students have a feeling that everyone knows the answer except them. They feel that they have been faking math for years and everyone knows it.

- o **Passive:** They have an attitude that either they have a math mind or they don't. There is nothing they can do to become better in math. They sit back and don't take action.
- o **Lack of confidence:** They don't trust their intuition. They rely on memorizing rules instead of understanding the concepts (Le Moyne 2003, cited in K. Yenilmez et al 2007, para.6).

Generally, students who have encountered math anxiety have the perception that their difficulties are unique that no other person understands them or has similar problems. K. Yenilmez et al., (2007) suggests that math anxiety is a common problem, and many students learn math anxiety even at home, before starting school and one way to better understand math anxiety and its effects is to hear the stories of others, how they became anxious, and what they have done about it. In line to this, (Shields, 2006; Alci, 2001; He, 2007, cited in Erden & Akgul, 2008) argues that although math anxiety is not hereditary, the confidence of parents on their own mathematical skills and their attitudes affects the feelings of children towards math. Besides parents, views of the teachers and peers are also influential in the increase or decrease of students' confidence in their mathematical skills.

This study is concerned with the investigation of the relationship between mathematics anxiety and mathematics achievement as well as the relationship between gender difference and mathematics anxiety with specific reference to grade nine (9) students.

1.2. Statement of the Problem

Most of the time, anxiety is observed to be a behavior which appears in particular stimulating conditions instead of being a general feature that is measurable by tests. However, after accepting that anxiety was a characteristic of human and that personality was a different dimension, a requirement has appeared to evaluate this feature. And hence math anxiety is measured in two ways (see sec 2.5). Students who view mathematics as a difficult and boring subject tend to avoid mathematics whenever or wherever possible

(Daane and Tina, 1986). This avoidance intern has a negative effect on students' academic achievement, because the knowledge of mathematics is used to understand not only mathematics but also other subjects such as physics and chemistry. That is why mathematics anxiety is regarded as a problem. Moreover, math anxiety may influence students' everyday life, academic careers, and even contribute to stress, which is well known to cause many other problems.

1.3. Objectives of the Study

The purpose of this survey study was to identify the extent of mathematics anxiety and its relation to mathematics achievement in East Shoa senior secondary schools of grade nine students. Hence, this study was designed to address the following objectives:

1. To assess students level of mathematics anxiety in the selected zone.
2. To investigate the relationship between mathematics anxiety and mathematics achievement.
3. To investigate the relationship between gender difference and mathematics achievement.
4. To investigate the relationship between mathematics anxiety and gender difference.
5. To investigate the direct and indirect effect of each predictor variable on the criterion variable

1.4. Research Question

Based on the objectives stated above, the following research questions were addressed.

1. What is the mathematics anxiety level of grade nine students of the study area?
2. Does there exist a statistically significant relationship between mathematics anxiety and mathematics achievement?

3. Does there exist a statistically significant relationship between the subscales of math anxiety rating scale and math achievement?
4. Is there a significant difference between male and female students in mathematics anxiety?
5. Does there exist a significant difference between male and female students in mathematics achievement?
6. What is the direct and indirect effect of each predictor variable on the criterion variable?

1.5. Significance of the Study

Findings in investigating the mathematics anxiety level of students might help to take appropriate action to moderate (reduce) the anxiety level. Moderating mathematics anxiety might in turn improve mathematics performance and achievement as the scholars agree with it. For instance, the studies conducted by Hembree (1990, cited in Sarah Boutwell Johnson, 2003), David Sheffield & Thomas Hunt (2006), Tahira Khatoon (2010), Xinbing Luo, et al. (2009) shows that math anxiety may directly influence math performance. And hence reducing math anxiety is essential in preparing the future workforce of our country, who has high literacy and competency in mathematics.

The finding might also help to initiate counseling intervention to reduce students' level of math anxiety. That is by better understanding the math anxiety of students; counselors might better assist frustrated students. It also helps educators, policy makers, curriculum designers to focus not only on the cognitive effects but also on non-cognitive factors such as self-efficacy, anxiety, value perception etc. in the teaching and learning process.

According to (Smart, 2000, cited in Eugene Geist, 2009), math anxiety does not come from the mathematics itself, but rather from the way math is presented in school. Thus, the study schools can use the findings of this study to gain an understanding of the level of math anxiety of their students, and hence apply math anxiety coping strategies with

their students. Students might also make more informed decisions about the math anxiety they experience. And hence, the findings may encourage students to learn mathematics more freely and confidently. The finding might also help future researchers to understand students' level of mathematics anxiety and its relationship to mathematics achievement as well as gender difference.

1.6. Scope of the Study

The study was limited to only one zone of Oromia region. i.e. The respondents of this study were grade nine (9) students of East Shoa zone only. Among students of grade nine (9), in the selected schools, appropriate sample were chosen.

This study was limited only on identifying the anxiety level of students and its relationship to mathematics achievement and gender difference. However, treating all the possible variables that influence gender difference, the causes of math anxiety and ways to reduce math anxiety are beyond the scope of this study.

1.7. Limitations of the study

This study is not without some limitations. One potential limitation is that the study is based on self-reported data. It is hard to determine whether the students have answered the questions seriously according to their own feeling. Because, due to social desirability students may respond not on the basis of what they really feel, but on the basis of what they think are socially acceptable. Therefore, the result obtained from the questionnaire may not reflect their actual level of mathematics anxiety clearly and significantly.

The generalization of this study results is limited. Because, the sample contains only ninth grade students, so the result of this study may be representative of grade nine students only rather than other segments of high school students. Moreover, this study was restricted only to students of East Shoa zone. Therefore, the extent to which the findings apply to other schools of Oromia region as well as in Ethiopian schools remains to be seen.

1.8. Operational Definition

Mathematics: is the study of the measurement, relationships and properties of quantities and sets, using numbers and symbols. Arithmetic, algebra, geometry, and calculus are branches of mathematics. Devlin (2000, cited in M.Marie, 2009) defines mathematics as a science of patterns and the relationships between patterns.

Avoidance of mathematics: it is the tendency for anxiety to cause individuals to seek escape from dealing with mathematical situations. This included not taking math classes, evading calculation and numbers.

Mathematics Anxiety: Mathematics anxiety is a feeling of tension and anxiety that interfere with the “manipulation of mathematical problems” in varied situations in ordinary as well as academic life (Richardson & Suinn, 1972). In this study mathematics anxiety is taken to be the score on the math anxiety rating scale that shows high anxiety.

Mathematics achievement: it is the level of attainment in any or all mathematics skills, usually estimated by performance on a test. In this study it is taken to be the score of students in the math achievement test developed by the researcher.

Gender difference: refers to the difference between boys and girls in their mathematics achievement and math anxiety scores.

Prior math achievement: refers to students’ previous level of attainment of mathematical skills. In this study it is taken to be the average scores of students on three different measurements, namely: the first semester mid exam, the first semester final exam and students’ score of mathematics in their ministry examination.

Chapter 2

Review of Related Literature

2.1. Introduction

The purpose of this survey study was to identify the extent of mathematics anxiety and its relationship to mathematics achievement in East Shoa senior secondary schools of grade nine (9) students. In this section a great deal has been made to assess the work of different scholars on mathematics anxiety and its relationship to achievement and gender.

The term math anxiety itself emerged in the early 1970's. The origin of the term is unknown, but one of the first researchers to investigate this dynamic was Shelia Tobias. The story that sparked Tobias' attention, a researcher/activist, was an informal survey conducted by Lucy Sells at the University of California at Berkeley in 1972. Sells, a sociologist, surveyed incoming freshman concerning their mathematics backgrounds. She found that 57 percent of incoming males had completed four years of math before enrolling in college; however, only 8 percent of the females had the same experience. Tobias concluded: Without four years of high school math, students at Berkeley were ineligible for the calculus sequence, unlikely to attempt chemistry or physics, and inadequately prepared for intermediate statistics and economics. (Sarah Boutwell Johnson, 2003).

This informal study became the impetus for researchers to begin looking at the cultural and social implications of math achievement in society (Sarah Boutwell Johnson, 2003). The word anxiety comes from the Latin word *anxius*, meaning a condition of worry and distress (Catherine Erin Johnson, 2006).

Generally, the review of literature attempts to focus on the following things:

- The meaning of anxiety,
- The meaning of mathematics anxiety,
- Factors that contribute to math anxiety

- Measure of mathematics anxiety,
- The relationship between mathematics anxiety and gender,
- The relationship between mathematics anxiety and mathematics achievement,
- Math anxiety and working memory,
- Mathematics Anxiety and Attitude,
- Math anxiety and teaching.

2.2. Anxiety

The dictionary definition of anxiety is that, it is the quantity of state of being anxious, uneasiness, and concern. It is a condition of distress accompanied by discomfort. It is a worried desire for a thing to do something. When we say anxious we mean trouble in mind about some uncertain events; concerned, being in disturbing suspense, distressing, worrying, fraught, with trouble.

Anxiety in general is used in response to a perceived threat to an individual. The threat may be real or imagined and for those who are unable to avoid the threat, feelings of distress, confusion and fear are experienced (Barnes 1984, cited in Lynette Joan Thijsse, 2002).

Anxiety can be described as a combination of factors such as physical, cognitive and psycho-behavioral components. Physical aspects of anxiety are biological, consisting of hormonal, chemical and muscular changes in the body which results in a disability to think. Anxiety is something that is experienced by everyone at some stage and is a normal experience. The level and reasoning for it to be prevalent determines whether or not it is a normal or abnormal reaction. Anxiety is considered to be a normal reaction to stress. It may help a person to deal with a difficult situation by prompting one to cope with it. When anxiety becomes excessive, it may fall under the classification of anxiety disorder. Anxiety is a generalized mood condition that can often occur without identifiable triggering stimuli (Mitchell 1987, cited in Lynette Joan Thijsse, 2002).

Anxiety and fear are different mechanisms. One solution suggests that the difference between fear and anxiety is that fear is a reaction to a specific danger while anxiety is unspecific, “vague,” “objectless” (May, 1977, cited in M.Marie, 2009). Thus anxiety is the basic, underlying reaction-the generic term; and fear is the expression of the same capacity in its specific, objective form. The underlying assumption is that anxiety is most commonly used in an empirical sense to describe a complex reaction or response (Spielberger, 1966, cited in M.Marie, 2009). Additionally, fear is related to the specific behaviors of escape and avoidance, whereas anxiety is related to situations perceived as uncontrollable or unavoidable (M.Marie, 2009). For example, Eysenck (1992) as cited in M.Marie (2009) defines anxiety as an unpleasant emotion and aversive state and the primary function of anxiety is to facilitate and detect threats in our environments.

According to Yerkes-Dodson law, an optimal level of arousal is necessary to best complete a task such as an exam, performance, or competitive event. However, when the anxiety or level of arousal exceeds that optimum, the result is a decline in performance. Thus in this study we mean anxiety that exceeds optimum condition that leads to a decline in performance. The **Yerkes–Dodson law** is an empirical relationship between arousals and performance (see sec 2.9). The law dictates that performance increases with physiological or mental arousal, but only up to some point. When levels of arousal become too high, performance decreases. Generally, anxiety can be a general feeling of worry, a sudden attack of panicky feelings, or a fear of a certain situation or object.

2.3. Mathematics Anxiety

Mathematics anxiety is a cognitively passive mood produced by mathematics. To be specific, mathematics anxiety refers to such unhealthy mood responses which occur when students come upon mathematics problems and manifest themselves as being panicky and losing one’s head, depressed and helpless, nervous, fearful and so on. Learners who are anxious when confronting mathematics problems are known to experience rapid pulse,

nervous stomach, heart palpitations, tension headaches, upset feelings, and sweaty palms (Adams, 2001; Cemen, 1987, cited in Quan Wei, 2010)

Students may be afraid of mathematics because of all the formulas they need to remember, because most problems are different, or because they have not developed the necessary critical thinking and analytical skills necessary for success. Eventually, students may begin to experience great fear regarding mathematics. This situation is commonly referred to as mathematics anxiety (Jehlen, 2001, cited in Armando Isaac Perez, 2005).

Cemen (1987, cited in Leung Wai Ping, 2005) defined mathematics anxiety as a state of discomfort which occurred in response to situations involving mathematical tasks which were perceived as threatening to self-esteem. Students experience a feeling of self-threat in mathematics learning, resulting in the loss of interest in mathematics and the loss of confidence in mathematics learning. In line to this Wigfield & Meece (1988) defined six possible dimensions of anxious or negative reactions to mathematics for their assessment of math anxiety: dislike, lack of confidence, discomfort, worry, fear, dread and confusion/frustration. Arem (1992, cited in Leung Wai Ping, 2005) believed that it was not only emotion but also physical reaction that became negative to mathematical thought processes and problem solving. However, Kitchens (1995, cited in Leung Wai Ping, 2005) had simply used the word “uneasy” to describe the feeling that “accompanied thoughts or fears” which keep people from doing their best in working with mathematics.

Math anxiety is a phenomenon that is often considered when examining students' problems in mathematics. Research confirms that pressure of timed tests and risk of public embarrassment has long been recognized as sources of unproductive tension among many students. Ashcraft (2002) suggests that highly anxious math students will avoid situations in which they have to perform mathematical equations. Unfortunately, math avoidance results in less competency, exposure and math practice, leaving students more anxious and mathematically unprepared to achieve.

Some scholars argue that anxiety is a learned behavior and therefore can be unlearned. For instance, Dorette Long & Sylvia Thomas (2002) suggested that if you wish to stop feeling anxious, the choice is up to you, you can choose to learn behaviors that are more useful to achieve success in math. To achieve success, there are two distinct areas in which you will begin your work. **First**, you must study math by using procedures that have been proven to be effective in learning mathematics and taking tests. **Second**, you must learn to physically and mentally relax, to manage your anxious feelings so that you can think rationally and positively. The special characteristics of math anxiety can be described as ‘the feelings of uncertainty and helplessness in the face of threat (May 1977, cited in Lynette Joan Thijsse, 2002). The following are factors contributing to math anxiety by (Steve Chinn, 2004, p.99) and (Dossel 1993, cited in Lynette Joan Thijsse, 2002, p. 20):

- o A poor understanding of math.
- o The abstract nature of math.
- o Inappropriate instruction (instruction that does not differentiate for the range of learners in a group).
- o Badly designed work tasks, for example, content beyond the learner’s capabilities or messy, overcrowded worksheets.
- o A curriculum that does not take account of the range of learners at whom it is targeted.
- o Personality factors (the belief that success cannot be attributed to effort)
- o Pressure of perceived authority figures (parents, teachers).
- o Time pressure (to answer quickly and verbally).
- o Effect of public failure (asking to perform in front of a class).
- o Right – wrong dichotomy (the teacher’s attention should be directed towards effort rather than achievement).

Another source of mathematics anxiety that has been identified is word problems. Word problems are at the heart of math anxiety. Learners need higher levels of reasoning and if not taught strategies to solve these problems, learners may grow up avoiding math and science (Tobias 1978, cited in Lynette Joan Thijsse, 2002).

Generally, some students seem to have a love for mathematics, whereas other students may not even know how mathematics can play a role in their lives. Mathematics anxiety can be described as more a dislike towards the subject than a lack of mathematical ability (Vinson, Haynes, & Gresham, 1997, cited in Armando Isaac Perez, 2005).

2.4. Factors that Contribute to Math Anxiety

According to Trujillo and Hadfield (1999, cited in Laura Hillerbrand Iossi, 2009), factors that contribute to math anxiety were categorized into three areas: **environmental**, **intellectual**, and **personality** factors. They defined these factors as follows. The environmental factor included experiences in the classroom and at home; the intellectual factor included student self-efficacy, attitude, and learning styles in which the students' styles did not match the teachers' styles; and the personality factor included such traits as introversion and conscientiousness. The following paragraphs summarize the work of different scholars regarding causes of math anxiety.

Environmental factors: To learn more about the factors that contribute to math anxiety, Harper and Daane (1998, cited in Laura Hillerbrand Iossi, 2009) studied the math anxiety of 53 education major students' before and after they completed an undergraduate elementary mathematics methods course. They found a reduction in the level of math anxiety scores at the end of the methods course. Five factors contributed to the onset of math anxiety: (a) an emphasis on "right" methods and answers, (b) word problems, (c) fear of making mistakes, (d) timed tests, and (e) confidence levels. For 75% of the elementary majors in the study, word problems were reported as the factor that contributed to the onset of math anxiety. They concluded that math anxiety often began in elementary school, possibly created by classroom teachers who exhibited math anxiety

themselves and who developed rigid and structured classroom instructional practices which in turn caused anxiety in the students.

Intellectual factors: Bursal and Paznokas (2006, cited in Laura Hillerbrand Iossi, 2009) utilized a math anxiety rating scale, in this case the Revised Mathematics Anxiety Survey, to classify 65 pre service elementary education students into low, moderate, and high math anxiety groups in order to compare the students' scores on a teaching efficacy belief instrument. Accordingly, they found that those in the low math anxiety group were more confident about teaching mathematics than those with higher levels of math anxiety; a negative correlation ($r = -0.638$) was found between preservice teachers' math anxiety and their math teaching efficacy scores with only 48% of the highly math anxious group responding that they could teach math effectively.

Personality factors: In his study, Bessant (1995, cited in Laura Hillerbrand Iossi, 2009) examined into the interrelatedness of math anxiety with attitudes toward mathematics, learning preferences, study motives, and strategies. Factor analysis of MARS confirmed six factors of math anxiety: (a) general evaluation anxiety, (b) everyday numerical anxiety, (c) passive observation anxiety, (d) performance anxiety, (e) mathematics test anxiety, and (f) problem solving anxiety. The factor analysis of the attitudinal scale revealed five attitudinal factors and five factors related to learning and instructional preference. He described how the six dimensions of the MARS correlated with the 10 attitudinal and learning preference factors while controlling for level of math anxiety by grouping participants into low, medium, and high math anxiety groups based on MARS scores. Accordingly, he found that there was a negative linear relationship between mathematics enjoyment and general evaluation anxiety. For all Bessant concluded, inquiries into learning orientations could form an important theoretical line between cognitive and affective explanation of mathematics anxiety.

Overall, studies indicates a plethora of factors that contributed to math anxiety including an emphasis on being correct (i.e., right/wrong method/answers, fear of making

mistakes), math topics (i.e., word problems, specific math content), mathematics classroom and instruction (i.e., specific episodes in math classes, instructor pedagogy and attitude, communication and language barriers (i.e., not understanding the instructor), insensitive and uncaring attitudes of instructors, quality of instruction, evaluation of instruction, instructor dislike for level of class, gender bias, age discrimination, teachers interfering with the learning process, timed tests) and aspects not directly related to the math classroom (i.e., confidence levels, family influences). Several negative experiences in the mathematics classroom and minimal positive support at home along with severe mathematics test anxiety also were reported to influence math anxiety. The students attributed negative affective factors such as anxiety, fear, and panic to their poor performance in math classes, Laura Hillerbrand Iossi (2009).

2.5. Measure of Mathematics Anxiety

According to William J. Truttschel (2002, p.2), math anxiety is measured in two ways. The **first** is by a self-examination and evaluation of anxiety when presented with various types of mathematical situations, possibly with the help of a pre-fabricated anxiety scale. A degree of anxiety is determined and usually falls under categories such as “very anxious”, “moderately anxious”, and so on. The **second** method of measuring anxiety is by a second party, who is usually someone who is trained to see physiological signs of anxiety and the actions associated with them. Psychiatrists and psychologists are an ideal outside opinion to diagnose such a problem.

Although Tobias (1980, cited in Leung wai ping, 2005, p.12) claimed that “anxiety is never easy to measure”, several scales and instruments have been constructed to measure mathematics anxiety. (Dreger and Aiken 1957, cited in Leung wai ping, 2005) provided an early instrument called Numerical Anxiety Scale that consisted of three items only. However, little or no research reported the validity or reliability of it. Later on, some other instruments measuring mathematics anxiety had been issued. After a meta-analysis of studies about the relationship between anxiety towards mathematics and achievement

in mathematics was conducted in 1999, Ma had concluded that the Mathematics Anxiety Rating Scale (MARS), designed by Suinn (1972, cited in Leung wai ping, 2005), appeared to be the most popular one among the others. The MARS is a 98-item, 5-point Likert-format questionnaire for assessing mathematics anxiety in a wide variety of specific and ordinary life situations.

The framework of the instrument is to measure students' anxious reactions when they do mathematics in ordinary life and in academic situations. It was constructed to provide a unidimensional measure of anxiety associated with the manipulation of numbers and the use of mathematical concepts. Thus, the 98 items of the questionnaire consist of descriptions of real-world and academic situations that may arouse mathematics anxiety. Participants may choose from 1 (none at all) to 5 (very much) to indicate the level of anxiety of each item. The greater number represents the higher level of anxiety and the average scores of all the items indicate the mathematics anxiety level. Moreover, it is developed for the measuring use of college students' anxiety level. More over several studies have provided evidences in supporting its validity and reliability, for instance (Dew et al., 1983; Richardson & Suinn, 1972; Richardson & Woolfolk, 1980, as cited in Leung wai ping, 2005). However, in this present study a 25- item, 5-point likert scale which is adapted from (Eshetie, 2001 & Leung wai ping, 2005) was used to assess students' level of math anxiety.

2.6. Mathematics Anxiety and Attitude

Mathematics anxiety is generally felt to be distinct from attitude towards mathematics, for instance, Jon Warwick (2008) argues that attitude seems to be inadequate in describing the variety and intensity of feelings that students are reported to experience in the classroom while Anxiety is an emotional state of individuals in which people feel uneasy, apprehensive, or fearful.

Math anxiety is a feeling of intense frustration or helplessness about one's ability to do mathematics. Math anxiety has been defined as feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations (Richardson & Suinn, 1972).

Math anxiety can cause one to forget and lose one's self-confidence. Students experience extreme discomfort and feelings of anxiety when thinking or doing mathematics and the term commonly used to describe this condition is mathematics anxiety. It can occur in all levels of education from primary school to higher education and, once established, can persist for life, interfering with everyday activities involving numeric and further learning of mathematics. Math anxiety usually comes from negative experiences in working with teachers, tutors, classmates, parents. Other times the anxiety comes from stress or a personal problem that was going on at the same time s/he was learning a particular concept. In this case, s/he associates math with whatever was going on at that time (Tobias 1993, cited in Leung Wai Ping, 2005).

Mathematical anxiety is developed as a result of a student's prior negative experience when learning math in the classroom or at home (Rossnan 2006, cited in Jon Warwick.J, 2008). More generally, it has been suggested that any negative life experience that involves some contact with numbers can be a source of future anxiety (Curtain-Phillips, 2004, cited in Jon Warwick.J., 2008).

K. Yenilmez, et al. (2007) suggests that math anxiety is a common problem; many students learn math anxiety even at home, before starting school. In line to this, (Shields, 2006; Alc, 2001; He, 2007, cited in Erden & Akgul, 2008) argues that although math anxiety is not hereditary, the confidence of parents on their own mathematical skills and their attitudes affects the feelings of children towards math. In addition to this view, views of the teachers and peers are also influential in the increase or decrease of students' confidence in their mathematical skills.

2.7. Mathematics Anxiety and Working Memory

Working memory is the part of the brain where we hold information to work upon, organize and shape it before storing in long-term memory for further use (Johnstone, 1991, cited in Seyed Hasan Alamolhoda, 2005) and it has a limited capacity and argues that individuals differ in their working memory space. In line to this, (Cowan, 2005, cited in Seyed Hasan Alamolhoda, 2005) suggests that any overload on working memory leaves students with no space forethought and conceptual organization and so faulty learning takes place.

Studies have shown that there is a relationship between math anxiety and working memory. Math anxiety exerts this effect by making it difficult to hold new information in mind while simultaneously manipulating it. Psychologists regard this capacity, known as working memory, as crucial for dealing with numbers (Bower, 2001, cited in Sarah Boutwell Johnson, 2003, p.20).

Applied to mathematics anxiety, working memory is critical for both the retrieval of facts from long-term memory and the execution of mathematical procedures such as counting and carrying. Consequently, a major factor underlying performance deficits may be decreased working memory capacity. Higher levels of math anxiety are associated with lower working memory spans (Ashcraft and Kirk, 2000, cited in Derek Richard Hopko, 2000).

The first study to address math anxiety and the underlying cognitive processes involved in doing math was conducted by Ashcraft and Kirk and published in 2001 (Sarah Boutwell Johnson, 2003). Bower (2001) cited in Sarah Boutwell Johnson's study suggests that, "the first solid evidence that math-anxious people have is working-memory problems" (p.20). According to Ashcraft & Kirk, the theory predicted "that performance deficit due to generalized anxiety will be prominent in exactly those tasks that tap the limited capacity of working memory" (cited in Sarah Boutwell Johnson, 2003, p.20).

According to this theory, anxiety and worry interfere with the thinking process and compete for the fixed resources (capacity) of working memory. This interference of efficient thinking might result in decreased performance related to speed as well as accuracy. In short there exists an extreme confusion. For instance (Ashcraft & Kirk, 2001) argues that intrusive thoughts and worries about completing math problems may interfere with working memory, and demonstrated that high mathematics anxiety is associated with smaller working memory capacity, and consequently poor performance in mathematics.

In complex problems, working memory may be important for storing information and keeping track of the calculation (Hitch, 1978, cited in Ashcraft & Kirk, 2001). Thus, the worries and thoughts about completing a math problem may decrease the chances of completing the calculation correctly. In fact, the most important finding of Ashcraft & Kirk's study was, "working memory is negatively correlated with math anxiety" (Ashcraft & Kirk, 2001, cited in Sarah Boutwell Johnson, 2003, p.21). Accordingly, as anxiety increases, working memory decreases. And hence, this leads students with bad experiences of math and test scores.

2.8. Gender Difference in Mathematics Anxiety and Mathematics Achievement

Throughout history, mathematics has usually been thought of as a male dominated and male oriented subject (Kogelman & Warren, 1978, cited in Armando Isaac Perez, 2005). However, this view may negatively affect females and their possible mathematical success. This perception continues today and could be used to explain why females usually report a higher level of mathematics anxiety than males (Betz, 1978; Buxton, 1981; Hembree, 1990; Llabre & Suarez, 1985; Ruben, 1998, cited in Armando Isaac Perez, 2005). However, some researchers have found that, there is no significant difference between male and female students math anxiety level. For instance, the studies conducted by Resnick, Viehe & Segal 1982 and Richardson & Suinn 1972, cited in

Leung Wai Ping (2005), as well as the study conducted by Leung Wai Ping (2005) indicates insignificant difference between male and female students math anxiety level.

Although there have been a significant increase in the enrollment of women in law, medicine and business schools, women's are still underrepresented in physical science and engineering programs and in all male dominated vocational educational program (Eccles,1987, cited in Eshetie, 2001).

Gender has been a topic of discussion and research related to math anxiety for many years. A number of studies have found gender to be both a significant and insignificant variable to consider. The most generally accepted belief is that gender is a predictor of math anxiety (Reily, 1992, cited in Sarah Boutwell Johnson, 2003).

Some researchers believe that the differences in levels of math anxiety between genders may actually be due to cultural expectations rather than any real differences in ability. For instance, (Fennema and Sherman1977, cited in Sarah Boutwell Johnson, 2003) stated that, "Many females have as much mathematical potential as do many males. The generalized belief that females cannot do well mathematics is not supported" (p.23).

Gender dynamics are prevalent at different intensities in the maturation process. "Similar to Tocci and Engelhard's (1990) results Hyde et al. (1990) revealed that males stereotyped math as masculine more than females did and that the peak in this gender difference occurred in high school years" (Abramovich, 1997, cited in Sarah Boutwell Johnson, 2003, p.23).

The Study of Mathematically Precocious Youth identified students at age thirteen that were distinguished in their mathematical abilities. The data on 40,000 students confirmed the hypothesis that gender was a significant variable related to mathematical reasoning and ability (Benbow, et al., 2000, cited in Sarah Boutwell Johnson, 2003). In line with this (Heyneman1980, cited in Eshetie, 2001) believes that an individual's sex is one of

the major factor associated with academic performance and a powerful predictor of achievement differences. Studies of mathematics ability and achievement (e.g. Carr & Jessup, 1997; Leder, 1986; Morkos & Koff, 1978; Silkon, 1985, cited in Eshetie, 2001) have consistently found that sex difference favoring male.

Claudia Zaslavsky (1994) contested that the belief that females have an inborn, unalterable inferiority when it comes to doing math is among the myths that induce them to avoid mathematics. According to Claudia Zaslavsky, the following are beliefs that still pervade the society (p.59):

- Math is for boys.
- Males have more spatial ability than females, and that makes them superior in mathematics.
- Asians are superior to all other groups in their aptitude for mathematics.
- Whites are superior to blacks in intelligence.

Many researchers show that boys tend to be more confident than girls in academic areas related to mathematics, science and technology (Hackett and Betz, 1989, Pajaras & Miller, 1994; Yalaw, 1997, cited in Mustofa abdela, 2008). In line to this, studies shows that, women's continued under representation in the relatively higher paying, higher status, scientific and technical fields has been partially explained by their lack of preparation relative to men in mathematics (Goldman & Hewit, 1976, Hackett & Betz, 1989, cited in Mustofa Abdela, 2008).

Low mathematical self-efficacy and inadequate high school math preparation present more often in females than in male. Many researchers found that "the field of mathematics, science and technology are typically viewed by students as being with in a male domain" (Fenna & Sherman, 1978; Asefa & Carkiyogy, 2002, cited in Mustofa Abdela 2008, p.15). In further support of gender difference in mathematics , Lamba (1997, ,cited in Eshetie, 2001) suggests that gender difference in many areas of

participation in school are diminishing, but the gap favoring males in mathematics study in senior secondary school persists.

Researchers also revealed that female students take significantly fewer mathematics related courses than male students do in collage and fewer women than men elect to major in mathematics related courses (Tamir, 1988, Asefa & Carkiyogy, 2002, cite in Mustofa Abdela, 2008).

In Ethiopian context, a study conducted by Eshetie (2001) in Bale zone high school students shows that female students experience more math anxiety than do male students. And also he found that male students were superior in mathematics achievement as well. In line to this a longitudinal study (grade 8 through 11) conducted by Seleshi (1995, cited in Eshetie, 2001) has found a significant gender difference in mathematics achievement in favor of boys in all grade levels.

2.9. Mathematics Anxiety and Achievement

Several studies have been undertaken to examine the relationship between math anxiety and performance or achievement. In the following paragraphs reference will be made to some of these findings.

Though, Brian F. Sherman and David P. Wither (2003) have raised a question mark over the assumption that mathematics anxiety is a cause of poor achievement in mathematics after conducting a longitudinal study over five years of the relationship between mathematics anxiety and mathematics achievement, most studies have concluded that there is a significant relationship between math anxiety and performance. However, the results are not fully consistent. For instance, Hembree (1990, cited in Sarah Boutwell Johnson, 2003) investigated the relationship between math anxiety and achievement scores. This study determines that math anxiety is related to poor math performance on math achievement tests and that math anxiety is related to negative attitudes concerning math, i.e. Positive attitudes toward mathematics is related to lower mathematics anxiety.

However, a study conducted by Leung Wai Ping (2005) shows that mathematics anxiety is not significantly related to mathematics performance in his study. And his conclusion is consistent with (Lupkowski & Schumacker 1991 and Resnick, Viehe & Segal 1982, cited in Leung Wai Ping, 2005, p. 44).

Individuals may affect performance on math problems in at least two ways. **First**, math anxious may avoid math courses or subjects including math. This may mean that math anxious individuals do not gain competence or mastery of math operations (David Sheffield and Thomas Hunt, 2006). **Second**, math anxiety may directly influence math performance (Hembree, 1990, cited in David Sheffield & Thomas Hunt, 2006 and Sarah Boutwell Johnson, 2003). In line to this the more recent investigation by Tahira Khatoon (2010) shows that there is a significant negative correlation (-0.48) between math anxiety and math achievement. On the other hand, while there is no absolute evidence for proving that poor performance causes mathematics anxiety, (Hembree 1990 & Lazarus 1974, cited in Leung Wai Ping, 2005) concluded that anxiety seriously constrains performance in mathematics. In line to this (Quilter & Harper 1988, as cited in Lynette Joan Thijsse, 2002) and Venkatesh Kumar, G., & Karimi, A, 2010) also argues that a high level of anxiety is associated with a lower level of achievement. Thus, after having that math anxiety is negatively correlated with mathematics performance, Xinbing Luo, et al. (2009) concluded that mathematics anxiety usually happens among low performing students.

As it is indicated above, anxiety is not always a bad thing; it has a positive relationship with performance but the performance decline when anxiety level **exceeds the optimum** level. Sarah Boutwell Johnson (2003) described the performance curve as a concept in psychology that illustrates the relationship between arousal (anxiety) and performance. According to Sarah Boutwell Johnson, this relationship was first observed in 1908 by Robert M. Yerkes and John D. Dodson (p.37).

The basic notion of the relationship between anxiety and performance is that performance increased as anxiety increased to a certain point. This manageable level of anxiety or arousal served as a motivator for performance. The important thing the Yerkes-Dodson law illustrated was when people's arousal or anxiety increased beyond a manageable level, their performance began to decline. Therefore, it is critical for optimum level performance for people to be able to manage their anxieties or arousal levels (Guy K. Hutt, 2007) (see figure 1).

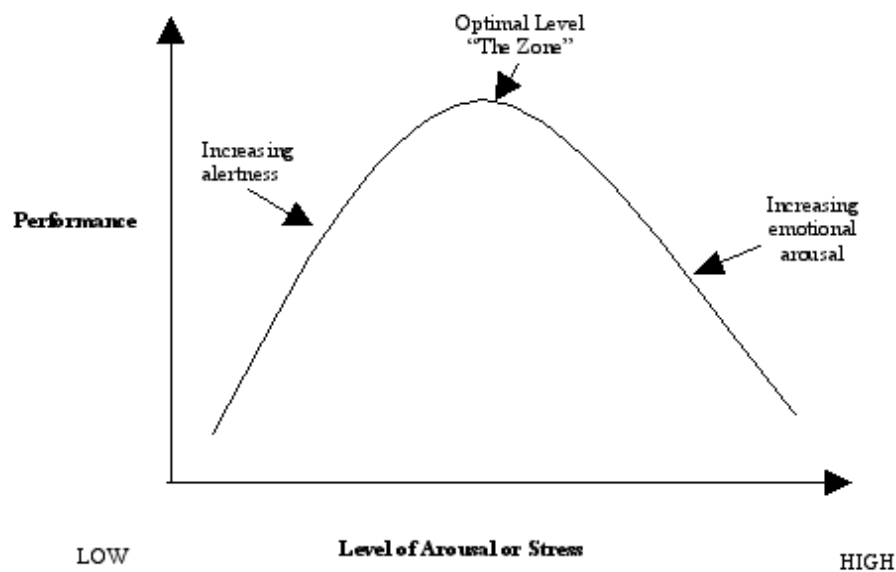


Figure 1: Yerkes-Dodson Law of Arousal (adopted from Guy K. Hutt 2007, p.48).

In the Ethiopian context, Eshetie Abate (2001) have found that those students who had high mathematics anxiety score performed poorly in mathematics achievement test than those who had less math anxiety. Generally, math anxiety appears to account for variation in mathematics achievement.

2.10. Mathematics Anxiety and Teaching

Research indicates that teachers have a significant impact on students' learning. Many issues in the classroom surrounding teaching can affect students' learning. The teacher's style is important for the classroom environment to be conducive to learning. For

instance, Dossel (1993, cited in Lynette Joan Thijsse, 2002) has suggested that the atmosphere in the classroom, including perceived warmth, may lower anxiety and improve math performance. Stuart (2000, cited in Lynette Joan Thijsse, 2002) stated that students like to do what they are good at, and to feel good about math, teachers need to build up the self-confidence and refine the skills required to be successful at math.

In many cases positive feedback is important for human beings. However, some research finding shows that this phenomenon varies with sex. For instance, (Ward & Jungbluth, 1980, cited in Sarah Boutwell Johnson, 2003) discovered in their research that girls are more responsive to positive feedback than boys.

Armando Isaac Perez (2005) argues that some students see mathematics as a complicated subject that serves no purpose in the “real world.” They just do not seem to understand the subject. This may be because some previous teachers “turned them off” or because mathematics may appear to them as just a series of numbers. According to (Barnes, 1984, cited in Lynette Joan Thijsse, 2002) Math anxiety has been related to teachers and the classroom setting. Math anxious children often show signs of nervousness when the teacher comes near, freezing and stopping work or covering it up to hide it.

The teaching style in a mathematics classroom is one of the causes of mathematics anxiety (Greenwood 1984, Buxton 1991, Greenwood & Anderson 1983, Hilton 1980, Kitchens 1995 & Tobias 1978, cited in Leung Wai Ping, 2005) listed a set of situations related to the teaching methodologies which might induce mathematics anxiety. Such as poor explanations, improper rate of presenting ideas, speed needed in finding answers, the emphasis on memorizing formulae, excessive drilling and practicing the emphasis on procedures for producing answer instead of the development of logical thought processes and offering little opportunity for debate or discussions are regarded as harmful ways of teaching.

National Association for Developmental Education (NDE, 2007, p.55) suggests that students often learn more from teachers' attitudes than from their ability in the classroom. If math instruction is to be effective, it must start with teachers portraying a positive, confident attitude about the subject. Teachers need to change students' mindsets that are often negatively conditioned for years. These students learn to manage in their math classes, but do not have confidence in their ability. They must be taught to take control of their learning and take necessary steps to alleviate math anxiety so that they do not pass it on to future generations.

Research has shown that a teacher's own mathematics anxiety could be a cause of anxiety for learners. For instance, (Martinez, 1987, cited in Lynette Joan Thijsse, 2002) states that a teacher's own math anxiety is likely to be transmitted to their students. In a study to determine the underlying anxieties of teacher trainees it was found that many had gaps in their math knowledge or an awareness of imperfectly learned concepts which in turn, can be transmitted to the learners they teach (Martinez, 1987, cited in Lynette Joan Thijsse, 2002).

Martinez (1987, cited in Lynette Joan Thijsse 2002, p.24) provides the following guidelines to teachers for creating an anxiety free math class:

- o Match instruction to cognitive levels – by teaching at the learners' level of cognitive development, frustration and anxiety can be prevented.
- o Make numbers real by exploring and using examples from everyday living.
- o Mastery learning – by reducing the risks and consequences of failing. By competing only with themselves, working at the individuals own pace.
- o Teaching through play. Math games and puzzles motivate learning.
- o Early learning experiences that are creative and unpressured reduce early anxiety

Similarly, (Cruikshank and Sheffield, 1992, cited in Sarah Rossnan, 2006, p.2) argued that if teachers fail to implement seven important measures, then they cause their students to learn math anxious behaviors. These measures include teachers who:

- Show that they like mathematics
- Make mathematics enjoyable and provide successful activities
- Show the use of mathematics in careers and everyday life
- Adapt instruction to students' interests
- Establish short-term and attainable goals

Chapter 3

Methodology

The purpose of this study was to identify the extent of mathematics anxiety and its relationship to mathematics achievement in East Shoa senior secondary schools of grade nine (9) students. The study area has been selected because; the researcher knows the culture of the society. Many students hate mathematics, and they even join the social science stream in grade eleven (11) not to take more mathematics classes in their future academic life.

The intent of this section is to identify the research design and to discuss design of the study, the population, sampling procedure, the variables under the study, the data collection instruments and the data collection procedure.

3.1. Design of the Study

This study is a quantitative study which is a survey study, because it is a useful methodology for the study of attitudes and other psychological constructs such as behaviors and beliefs (Schumacher & McMillan, 1993; Thorndike, Cunningham, Thorndike & Hagen, 1991, as cited in Rahmah B. Murshidi, 2005). A path analysis model was used to investigate the relationship among prior math achievement, gender, math anxiety, cognitive subscale, affective subscale, avoidance subscale and math achievement. According to Schumacker and Lomax (2004, cited in Benjamin R. Tickle, 2008), a path analysis model is the logical extension of a multiple regression model where any number of independent and dependent variables are used to establish any number of equations.

3.2. Population of the Study

The population of this study was both male and female regular students who were attending grade nine (9) in East Shoa zone senior secondary schools. In this zone, there are a total of 20,812 students. Where, 11,189 are male and 9,623 are female students (the

zonal education bureau, personal communication, March 9, 2011). Among those students, a sample was taken to represent the whole population. Moreover, In East Shoa zone there are 13 weredas and 17 public senior secondary schools (the zonal education bureau, personal communication, February 11, 2011). Hence the sample was taken from 17 public senior secondary schools.

3.3. Participants of the study

For the first time questionnaire was distributed to 418 (205 male and 213 female) students, however, 47 (21 male and 26 female) students were rejected from the study because of not taking the achievement test. Due to her arrival from another zone, one female student was rejected from the study because of unavailability of her ministry examination in East Shoa zone. Thus a total of 48 students were rejected and 370 students were involved in the study. In the sample, the number of female students was greater than that of male, this is because, in two of the sample schools the number of female students was greater than that of male students. And more male students were absent during data collection period. For instance in Modjo senior secondary and preparatory school there are 743 female and 705 male students. Demographic information of the participants of the study is given in table 1 below:

Table.1. Demographic information of participants of the study

Gender	N	Total
Male	184	370
Female	186	

3.4. Sampling Procedure

The sampling method used for this study was multi-stage sampling. First of all, all the 13 weredas in the zone were listed and arranged in an alphabetical order (see appendix B). Then a random number of 1-13 was given for each woreda. Next 5 weredas were selected using random number generator in Microsoft Excel. Namely: Adama, Dugda, Bora, Modjo city and Adea wereda. Then after, in these weredas, all public secondary schools were listed and one representative school was selected randomly. In this case only two

weredas namely Adama and dugda weredas have more than one high school (see appendix D & E). The other weredas namely: Adea, Bora and Modjo city have only one public high school, thus these schools were taken purposely.

Hence, the actual study was conducted in five (5) public secondary schools, namely: Hawas malkasa senior secondary school, Ude senior secondary school, Bora senior secondary school, Oda bokota senior secondary and preparatory school and Modjo senior secondary and preparatory school. Again in the selected schools, sections were selected randomly. From Oda bokota senior secondary and preparatory school, section A and F were selected. From Ude senior secondary school, section C and D were selected. From Bora senior secondary school, section E and F were selected. From Modjo senior secondary and preparatory school, section E and F were selected. From Hawas malkasa senior secondary school, section B and D were selected. All students in the section were not included in the study; some of them are rejected from the sample randomly, because they were out of the sample size. The sample size were determined by using table in Louis Cohen, Lawrence Manion & Keith Morrison (2007, p.104) by 95% confidence level. Accordingly, the sample size for this study was 418 students. The following table shows the number of participants of the study from each school, according to Louis Cohen et al. (2007):

Table.2. the number of participants from each school

Schools	N	n	rejected
Hawas melkasa senior secondary school	449	82	10
Modjo senior secondary and preparatory school	1448	102	15
Oda bokota senior secondary and preparatory school	725	88	9
Bora senior secondary school	354	74	12
Ude senior secondary school	275	72	2
Total	3251	418	48

In this study, students are expected to complete both the MARS and MAT correctly. A student who misses one of the instruments was rejected from the study. Since MAT was administered one day after MARS have been administered, 48 students were absent and hence are rejected from the study.

3.5. The Pilot Study

The objective of pilot study was to assess and improve the contents of the instrument and it was conducted first before the main study. On the basis of the pilot data the MARS as well as the MAT was improved. Hassein Arsham (2003) suggests that a pilot sample must be drawn from the population. And hence for this study, the pilot study was conducted in a randomly selected public senior secondary school of the study area. Note that the pilot school was not included in the actual study. The selection of this pilot school was done after the actual study schools have been identified. The remaining 8 weredas were listed in an alphabetical order and a random number 1-8 was given for each woreda (appendix C). Then one woreda was selected randomly namely Boset woreda. Since there is only one high school in this woreda, namely Boset senior secondary and preparatory school, this school was selected purposely. In this school there are a total of 1004 (533 male and 471 female) grade nine students and distributed in 14 sections. One section was randomly selected for pilot study.

3.6. Data collection instruments

Two main instruments were used for data collection. These were: the Mathematic Achievement Test (MAT) and Mathematics Anxiety Rating Scale (MARS) (see appendix F). However, to measure students' prior math achievement, their average scores on three different measurements were taken; namely the first semester final & mid exam and mathematics scores on grade 8 ministry examination.

The standard of MOE for students of secondary school of Ethiopia was, excellent: 90-100, very good: 80-89, satisfactory: 60-79, fair: 50-59 and poor: < 50. For the purpose of

this study, some rearrangement was made because, students' mathematics score on ministry examination was considered and the research wants to categorize students' achievement into three categories namely: high achiever, medium achiever and low achiever. When using standard distribution of students score on ministry examination, lower achievers fall below 39. Accordingly, excellent, very good and satisfactory were merged and serves as a high achiever (60-100). On the other hand, medium achiever was taken as 40-59 while low achiever was taken as a score (< 39).

3.6.1. The Mathematic Achievement Test (MAT)

In this study, students' scores on Mathematics Achievement Test were served as the basis for judging students' math achievement. This test was developed by the researcher in order to assess the level of acquisition of mathematical concepts of the students. It covers the main topics of mathematics taught in the first semester, i.e it is from chapter 1 to chapter 3. It consists of 30 multiple choice questions with 4 options A-D and it was based on three cognitive levels that is knowledge, understanding and application. To identify the achievement domains being measured and to ensure that a fair and representative question will appear on the test, the researcher developed a table of specification. The table of specification is developed based on the idea of test preparation by Norman E. Gronlund (1977). He suggested that before preparing the test, one have to prepare a table of specification based on the learning outcome and topics in accordance with their relative importance. Accordingly, the table of specification for MAT is given in (appendix A).

The test was scored manually by the researcher. Each correct answer holds one mark while a wrong answer was scored zero. The level of achievement of a student was taken as students total test score. To insure content validity, the test was checked by advisors as well as mathematics teachers of the study area. Moreover, the table of specification also insures content validity. MAT was piloted on 49 students first before it was applied to the main study. Using Kuder- Richardson formula KR- 21 the internal consistency reliability

of the test was found to be 0.57. The average difficulty index obtained was 0.41, which shows the instrument was neither too difficult nor too simple. Moreover, items with difficulty index of less than 0.4 and items with discrimination index of less than 0.2 were revised and modified for the actual study, while items with negative discrimination index were rejected and another questions were developed and it was checked by mathematics teachers there in the study area. Distractors that are not plausible were also changed. But items with difficulty index of greater than 0.4 and with discrimination index greater than 0.2 were retained for the actual study.

3.6.2. The Mathematics Anxiety Rating Scale (MARS)

As mentioned in the previous chapter, a 25- item, 5-point likert scale was used to assess students' level of math anxiety. The main criterion for selecting this scale was that the statements fit the levels of the participants under the study and are unambiguous as well as understandable for students. The scale was adopted from (Eshetie, 2001 and Leung wai ping, 2005) where Eshetie selected most of the items from plake & payker (1982) Wigfield & Meece (1988) & Taylor(1997) and some of the items were developed by himself. The wording of the adopted item was changed to fit issues of this study and some of the items were changed and developed by the researcher to fit the requirement of this study.

Though MARS was adapted from Eshetie (2001) and Leung wai ping (2005), most of the selected items were used in many other studies such as Sarah Boutwell Johnson (2003), Tahira Khatoon (2010), Armando Isaac perez (2005), Brian F. Sherman & David P. Wither (2003) and others. Initially, anxiety scale was developed by Richardson, F.C, & Suinn, R.M. (1972) for college students and many researchers use by modifying the items as per their study (see sec 2.5). The number of items varies from study to study. Thus, the MARS used in this study consistently measure the same thing as other studies. So the scale was standardized. This provides construct validity evidence for the 25-item MARS used in this study.

Moreover, to reduce obtaining wrong data due to language confusion, the researcher have changed the English version of the MARS to Oromic version of the MARS. However, since there exists students who do not understand Afan Oromo clearly, the English version was held in reserve. There were 90 (25 male and 65 female) participants who declared that they don't understand the Afan Oromo and hence the English version of MARS was provided to them. The translation of language was made by language translators (specialists) while its consistency was checked by language teachers.

The participants' rate from five possible alternatives: strongly agree, agree, neutral, disagree and strongly disagree. The following numeric values were assigned to the **positively** phrased questions: Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2 and Strongly Disagree = 1. And the following numeric values were assigned to **negatively** phrased questions: Strongly Agree = 1, Agree = 2, Neutral = 3, Disagree = 4 and Strongly Disagree = 5. Scores range from 25 to 125 and the sum total of all items was used to determine whether or not the students have math anxiety. The level of math anxiety was interpreted as of the following categories: high anxiety, moderate anxiety and low anxiety.

Before its use to the actual study the MARS was piloted on 49 students. Since they left many questions blank 4 students were rejected from the pilot analysis. To ensure the reliability of this scale, the split-half technique and the Cronbach alpha coefficient was used. Both calculate a coefficient of reliability that can lie between 0 and 1.

Using Cronbach's alpha, the degree of internal consistency of MARS for this study, was estimated to be 0.76, while using the split half technique its reliability was found to be 0.78. However, 3 items that does not correlate very well with the overall scale are rejected from the actual study and hence for the actual study 22 items were used, which is in agreement with Nachmias (1987,cited in Eshetie, 2001), he suggested that the investigator can select 20 to 25 items with the largest inter item correlation. Based on the

idea of Tahira Khatoon (2010), the anxiety levels of students are taken between the following ranges: low level of mathematics anxiety 22-55, moderate level 56-77 and high level of mathematics anxiety 78-110.

3.7. Data Collection Procedure

The data collection for this study comprises of two phases: phase one was administering the MARS while phase two was administering MAT.

3.7.1. Phase one: Administering the Mathematics Anxiety Rating Scale (MARS)

During both a pilot study and the actual data collection, before working on the scale students were informed about the purpose of the study and their role as a participant. A brief explanation was provided, participation is voluntary and they were also informed of their anonymity, since their name is coded, no one can know their responses. Student identification number is used to insure that the same students have participated in phase one and two. And hence all information was kept confidential. Voluntary participation in this sense means that, whether or not students participate in the study, it has no impact on their academic life in their school and everybody have the right to withdraw from the study at any time he/she wants to do so by any reason. Students were also oriented of how to fill the scale and illustrations were provided to them. Furthermore, they were instructed to read instructions carefully to answer all questions and give their authentic response and to work on all items independently. The MARS was administered at the end of mathematics class.

3.7.2. Phase two: Administering the Mathematics Achievement Test (MAT)

During the phase one session, students were informed that there will be an examination the next day. This is because to reduce absence of students during phase two session. By coordinating with the school director, some teachers of the school and with students, the MAT was administered in the opposite shift. During the test, students were sat in such a way that it is manageable to control any cheating. However, in some schools due to

shortage of classes in the school, the researcher was forced to administer the MAT for large amount of students in a class. To overcome this problem, more assistant teachers were selected for testing. And the researcher coordinates the situation in such a way that students fill all required information such as the research identification number and their grade 8 schools. Research identification number was used to maintain participants' confidentiality, because it masks their identity

3.8. Variables under the Study

The items in the MARS were categorized into three domains. Namely: cognitive subscales, affective subscales and avoidance subscales. Sex and prior math achievement were taken to be as exogenous variables while cognitive subscale, affective subscale, avoidance subscale, math anxiety and math achievement were taken to be as endogenous variables. Exogenous variables in a path model (see fig 4) are those with no explicit causes (no arrows going to them). Endogenous variables in turn are those which do have incoming arrows. Endogenous variables include intervening causal variables and dependents; in this case math anxiety, cognitive subscales, affective subscales and avoidance subscales were taken as intervening endogenous variables while math achievement was taken as a dependent variable. Intervening endogenous variables have both incoming and outgoing causal arrows in the path diagram. The dependent variable (math achievement) have only incoming arrows.

3.9. Method of data analysis

Two main software programs were used to analyze the data, fathom and SPSS version 19. Firstly, to determine the level of math anxiety of students, descriptive statistics were computed followed by correlation analysis, t- test and regression analysis. Finally, the path analysis was conducted to investigate the direct and indirect effect of each predictor variable on the criterion variable.

3.10. Data Compilation and Coding

All data related to this study were collected and compiled using a computer spreadsheet program. Subjects were assigned a code at the beginning of the study which protected their privacy. In addition to recording each student's score on the MARS, the final score obtained in mathematics on the last three measurements namely, the first semester mid & final exam which is changed to 100% and math score on ministry examination were compiled. Students' average score on these different measurements were taken to be prior math achievement and all these computations are made using the spread sheet.

In order to complete the data analysis, the data were coded within SPSS. Gender was coded as 0 or 1 (0 = female, 1 = male). Prior math achievement were coded as 0,1or 2 (0 = low achiever : < 39, 1= medium achiever: 40-59, 2 = high achiever: 60-100). This categorization was adapted from the standard of MOE (see sec 3.6).

Chapter 4

Data Analysis and Interpretation

The goals of this study were: (1) to assess students' level of mathematics anxiety in the selected zone, (2) to investigate the relationship between mathematics anxiety and mathematics achievement, (3) to investigate the relationship between gender difference and mathematics achievement (4) to investigate the relationship between mathematics anxiety and gender difference, (5) to investigate the direct and indirect effect of each predictor variable on the criterion variable. The total participants of the study were $N = 370$, taken from five different high schools of East Shoa zone. Based on participants' responses on the MARS and the MAT as well as students prior math achievement obtained from secondary sources, this chapter presents the results of statistical analysis carried out to answer the basic questions raised in the study.

For the first research question, descriptive statistics of math anxiety score i.e. mean of the score was used. For the second and third research question, Correlation analysis was used. For the fourth and fifth research question i.e. to examine gender difference, independent sample t- test was employed. Additionally, to predict the dependent variables on the basis of the independent variables, regression analysis was conducted. While for the sixth research question, the path analysis was conducted to investigate the direct and indirect effect of each predictor variable on the criterion variable.

4.1. Mathematics Anxiety Level of Grade Nine Students

Table.3. Descriptive statistics of math anxiety score

Variable	N	Min	Max	Mean	Std. Deviation
Math anxiety	370	26	88	57.33	11.063

The first objective seeks to study the mathematics anxiety level of grade nine students'. To assess this question, the mathematics anxiety mean scores of ninth grade students

were used. As reported in table 3 above, grade nine students' mean scores on the mathematics anxiety rating scale was 57.33 and standard deviation of the scores was 11.063. This shows that grade nine students' mathematics anxiety is at a moderate level. The distribution of the score is shown in figure 2 below:

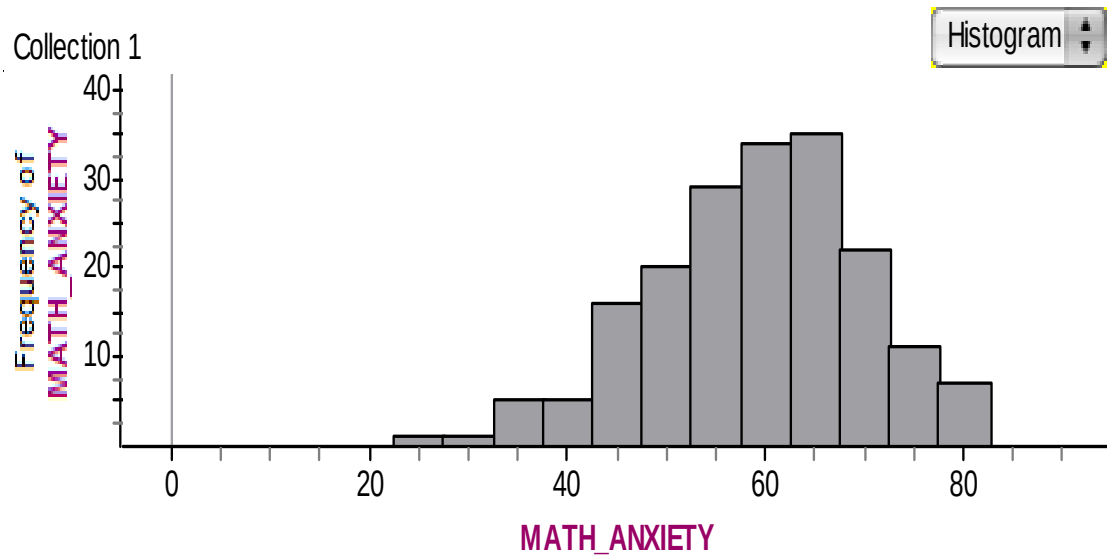


Fig.2. Histogram of math anxiety scores for 370 grade nine students

4.2. Gender Difference in Mathematics Anxiety and Achievement

Mathematics anxiety mean scores of ninth grade students as well as all the variables treated in the study and the results of t-test were carried out to determine the differences according to gender:

Table.4. Comparison of male and female students on the variables treated in the study.

Variables	Male(n=184)		Female(n= 186)		t	df	p
	M	SD	M	SD			
Math anxiety	55.47	11.141	59.17	10.70	-3.258	368	.001
Math achievement	50.97	14.956	42.87	15.277	5.151	368	.000
Prior math achievement	45.78	10.287	42.17	8.147	3.745	368	.000
Affective subscale	28.86	6.924	31.19	6.616	-3.316	368	.001
Cognitive subscale	22.26	4.811	23.31	4.706	-2.124	368	.034
Avoidance subscale	4.35	2.460	4.66	2.341	-1.256	368	.210

The result of independent t-test indicated in table 4 above, shows that female students scored a higher mean mathematics anxiety than male students ($df = 368$, $t = -3.258$, $p < .01$). Showing that, female students' are more anxious about mathematics than male. Moreover, male students are also superior in mathematics achievement in a statistically significant extent ($df = 368$, $t = 5.151$, $p < .01$). Male students are also superior in prior math achievement ($df = 368$, $t = 3.745$, $p < .01$). When we see the subscales that we are going to use during path analysis, male students are superior on affective and cognitive subscales but the result of the study shows no gender difference on avoidance subscale. Generally, as shown in table 4, the result of the study shows that male students are superior in all variables treated in the study in a statistically significant extent except for avoidance subscale ($df=368$, $t = -1.256$, $p > .05$).

4.3. Correlation Analysis of the Variables in the Study

The correlations given in table 5 below are calculated using the statistical package SPSS, which usually provide exact probability values associated with each significance test. In this study, the p values reported by SPSS were used to make decisions about the significance of correlations. If the p value is larger than .05, then the correlation is not

significant, whereas if the p value is smaller than .05, then the correlation is significant. Therefore, if someone uses statistical software such as SPSS for correlational analysis, then he will not need to refer to a table of t values for significance test, because the result obtained for significance will be the same.

Table.5. Zero order correlation coefficient of the variables treated in the study.

variables	1	2	3	4	5	6	7
1. Sex	--						
2. PMA	.192**	--					
3. MAch	.259**	.418**	--				
4. MAnx	-.167**	-.324**	-.250**	--			
5. AFS	-.170**	-.295**	-.231**	.885**	--		
6. CGS	-.110*	-.231**	-.146**	.746**	.407**	--	
7. AVS	-.065	-.190**	-.198**	.592**	.407**	.284**	--

PMA: prior math achievement

MAch: math achievement

MAnx: math anxiety

** P < 0.01

*p < 0.05

AFS: affective subscale

CGS: Cognitive subscale

AVS: Avoidance subscale

The correlation described in table 5 above contains a dichotomous variable (sex) and the others are continuous variables, thus the interpretations of correlation of other variables with sex were made based on the idea of DeCoster, J. (2004). He suggested that, if the analyst codes the dichotomous variable with values of 0 and 1, and then computes a standard Pearson correlation using this variable; it is mathematically equivalent to the point-biserial correlation. The interpretation of this variable is similar to the interpretation of the Pearson correlation. A positive correlation indicates that group associated with the value of 1 has larger values than the group associated with the value of 0. A negative correlation indicates that group associated with the value of 1 has smaller values than the group associated with the value of 0. In this study, sex codes were 1 for male and 0 for female

Table 5 Portrayed that sex (the dichotomous variable) was negatively and significantly correlated with math anxiety ($r = -0.167$, $p < 0.01$) which shows female students score larger in math anxiety than male students, revealing that female students are more

anxious. Sex was positively and significantly correlated with math achievement ($r = 0.259$, $p < 0.01$) which shows that male students have scored larger values in mathematics achievement than female. Thus, sex of students had adverse relationship with math anxiety as well as with math achievement.

Math achievement was positively and significantly correlated with prior math achievement ($r = 0.418$, $p < 0.01$) which shows students who have a good prior math achievement scored better on math achievement test. Prior math achievement in turn was negatively and significantly correlated with math anxiety ($r = -0.324$, $p < 0.01$). This shows that math anxiety manifests among students with poor prior math achievement. Generally, the result of the study shows that all variables in the study correlate with each other in a statistically significant extent except for the correlation of avoidance subscale with sex ($r = -0.065$, $p > 0.05$), revealing that sex of students have no relationship with avoidance subscale.

4.4. Mathematics Achievement and Mathematics Anxiety

In order to determine if there are any relationships between the anxiety levels of students and their achievement scores, Pearson Product Moment Correlation is applied (see table 5). The results of the study have revealed that there is a significant negative relationship between mathematics anxiety and mathematics achievement ($r = -0.250$, $p < 0.01$). This shows that students who have high mathematics anxiety tended to perform fewer score in mathematics achievement. However, those who have low mathematics anxiety tended to perform high score in mathematics achievement.

This finding was not surprising because many researchers have found similar result. For instance, The finding confirms with the pervious findings such as Hembree (1990, cited in Sarah Boutwell Johnson, 2003), Tahira Khatoon (2010), Ayatollah Karimi and S. Venkatesan (2009), Ashcraft, M. H., & Kirk, E. P. (2001), Xinbing Luo, et.al (2009), which reports a significant negative relationship between mathematics anxiety and

mathematics achievement. However, it is against with the finding of (Lupkowski & Schumacker 1991; Resnick, Viehe, & Segal, 1982, cited in Leung Wai Ping, 2005) and Leung Wai Ping (2005).

4.4.1. Mathematics Achievement and Subscales of Mathematics Anxiety Rating Scale

In order to determine if there are any relationships between mathematics achievement and students affective experience, cognitive experience and avoidance experience, Pearson Product Moment Correlation is applied (see table 5). The results of the study have revealed that there is a significant negative relationship between students affective experience and mathematics achievement ($r = - 0.231, p < 0.01$). This shows that students who have poor affective reaction towards mathematics tended to perform fewer score in mathematics achievement. However, those who have good affective reaction towards mathematics tended to perform high score in mathematics achievement. There is also a significant negative correlation between students cognitive reaction towards mathematics and mathematics achievement ($r = - 0.146, p < 0.01$). Showing that, achievement increases as students' cognitive reaction towards mathematics increases. Since high score in the subscales represents poor reaction towards mathematics, don't confuse with negative correlation. Students avoidance reaction towards mathematics is also correlated negatively with math achievement ($r = - 0.198, p < 0.01$). Therefore, students' affective reaction, cognitive reaction and avoidance reaction towards mathematics have adverse relationship with mathematics achievement.

4.5. Multiple Regressions

To determine the impact or contribution of each independent variable on the dependent variable, multiple regression analysis was used. Accordingly, a significant model emerged ($F_{(3,366)} = 8.920, P < 0.01$). The following table shows summary of results from regression analysis.

Table.6. Regression analysis for mathematics achievement and components of variables

Multiple R = .261						
Adjusted R ² =.060				R ² = .068		
ANOVA table						
	Sum of squares		df	Mean square	F	Sig.
Regression	6144.033		3	2048.013	8.920	.000
Residual	84032.059		366	229.596		
Total	90176.097		369			
Variables in the Equation						
variables	r	B	Std. Error	Beta	t	Sig.
Affective Subscale	-.231	-.375	.133	-.165	-2.813	.005
Cognitive Subscale	-.146	.150	.182	-.046	.822	.412
Avoidance Subscale	-.198	-.766	.363	-.118	-2.109	.036

In the regression table above, since $R^2 = 0.068$, then the combined effect of affective subscale, cognitive subscale and avoidance subscale was 6.8% of the total variability on mathematics achievement. The percent of effect of each component affective subscale, cognitive subscale and avoidance subscale on mathematics achievement can be found by:

$$(R^2 = r_{Af} \beta_{Af} + r_{Co} \beta_{Co} + r_{Av} \beta_{Av}) \times 100\%$$

$$[R^2 = (-0.231) \times (-0.165) + (-0.146) \times (-0.046) + (-0.198) \times (-0.118)] \times 100\%$$

$$6.8\% \approx 3.81\% + 0.67\% + 2.33\%.$$

Thus the contribution of students affective reaction towards mathematics enhanced achievement of mathematics by 3.81%, the contribution of students cognitive reaction towards mathematics enhanced achievement of mathematics by 0.67% while the

contribution of students avoidance reaction towards mathematics enhanced achievement of mathematics by 2.33%. The contribution of cognitive reaction towards mathematics (cognitive subscale) is negligible and so it is insignificant ($\beta = -0.046$, $t = 0.822$, $p > 0.05$). But, all subscales collectively affect mathematics achievement in a significant extent ($F = 8.920$, $p < 0.01$). From this, one can assume that since the combined effect of affective subscale, cognitive subscale and avoidance subscale gives math anxiety, then math anxiety enhanced the achievement of mathematics by 6.8%.

Table.7. Regression analysis for mathematics anxiety and components of variables

Multiple R = 1.00						
Adjusted R ² =1.00				R ² =1 .00		
ANOVA Table						
	Sum of squares	df	Mean score	F	Sig	
Regression	45161.430	3	15053.810	1.12*10 ³²	.000	
Residual	.000	366	.000			
Total	45161.430	369				
Variables in the Equation						
Variable	r	B	Std. Error	Beta	t	Sig.
Affective subscale	.885	1	.000	.620	1.096*10 ⁹	.000
Cognitive subscale	.746	1	.000	.432	8.021*10 ⁸	.000
Avoidance subscale	.592	1	.000	.217	4.031*10 ⁸	.000

Table 7 shows that, the combined effect of affective subscale, cognitive subscale and avoidance subscale accounts 100% of the variability in math anxiety. This is because these variables are subscales and their sum gives math anxiety. The percent of effect of

each component affective subscale, cognitive subscale and avoidance subscale on mathematics anxiety can be found by:

$$(R^2 = r_{Af} \beta_{Af} + r_{Co} \beta_{Co} + r_{Av} \beta_{Av}) \times 100\%$$

$$[R^2 = (0.885) \times (0.620) + (0.746) \times (0.432) + (0.592) \times (0.217)] \times 100\%$$

$$100\% \approx 54.87\% + 32.22\% + 12.84\%.$$

Therefore, the contribution of students' affective reaction enhanced math anxiety by 54.87%, the contribution of students' cognitive reaction enhanced math anxiety by 32.22%, while students' avoidance reaction enhanced math anxiety by 12.84%.

4.6. Causal relationship of the variables treated in the study

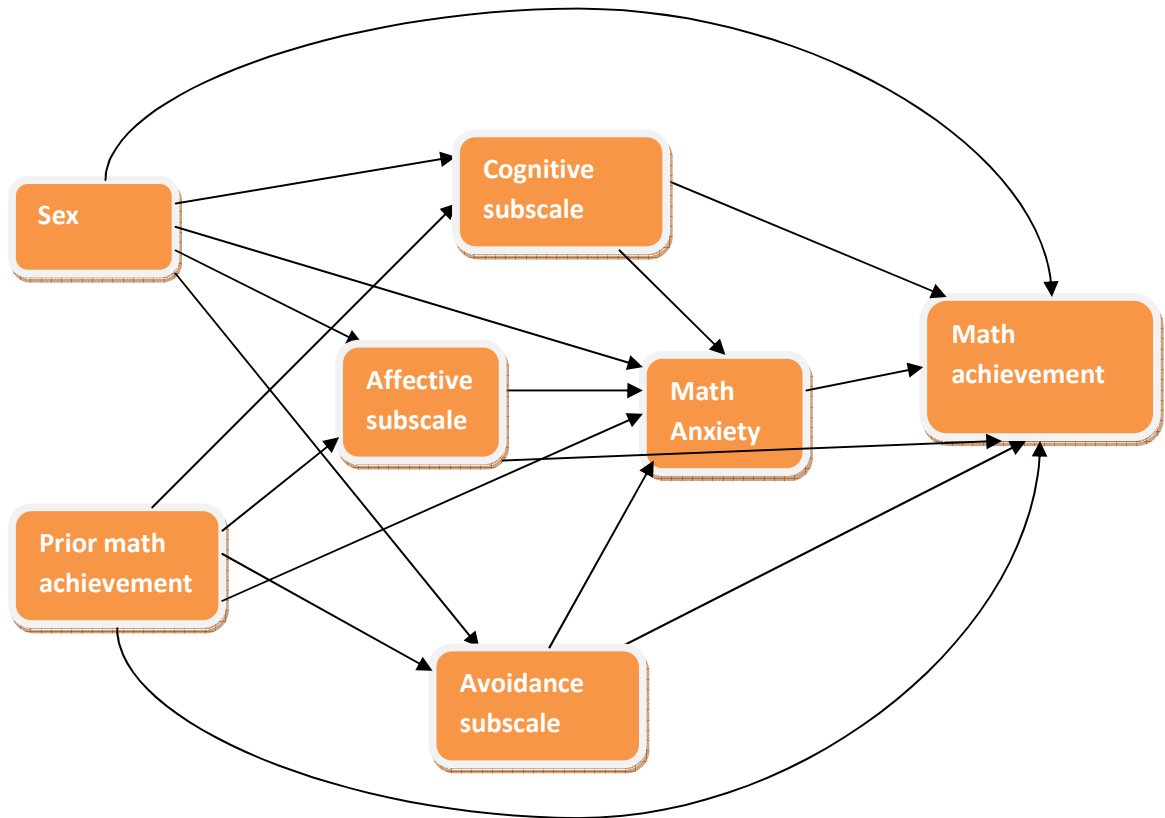


Fig.3. The initial path model for mathematics achievement

Figure 3, shows the initially hypothesized path analysis model, which was developed by the researcher prior to the beginning of the study. The expected relationship between variables was both direct and indirect. For instance, there is both direct and indirect path from sex to math achievement and so which path is the strongest path? will be answered later on.

Table.8. Decomposition effect from the path analysis

Effect	Intercept (parameter estimate)(B)	Standardized coefficient (beta)	t	p	R ²
On mathematics achievement					.169
Of sex	6.366	.204	4.181*	.000	
Of prior math achievement	6.509	.238	4.737*	.000	
Of math anxiety	-.231	-.001	-.010	.958	
Of affective subscale	-.194	-.085	-1.503	.134	
Of cognitive subscale	-.018	-.005	-.103	.918	
Of avoidance subscale	-.712	-.110	-2.070*	.039	
On cognitive subscale					.055
Of sex	-.773	-.081	-1.579	.115	
Of prior math achievement	-1.751	-.210	-4.091*	.000	
On affective subscale					.091
Of sex	-1.855	-.135	-2.694*	.007	
Of prior math achievement	-3.020	-.252	-5.013*	.000	
On avoidance subscale					.028
Of sex	-.209	-.044	-.839	.402	
Of prior math achievement	-.656	-.156	-3.008*	.003	
On math anxiety					1.000
Of sex	-7.322×10^{-17}	.000	.000	1.000	
Of prior math achievement	7.910×10^{-15}	.000	.000	1.000	
Of affective subscale	1.000	.620	1.441×10^9 *	.000	
Of cognitive subscale	1.000	.432	1.070×10^9 *	.000	
Of avoidance subscale	1.000	.217	5.41×10^8 *	.000	

Math anxiety was excluded from the model of math achievement because it did not significantly strengthen the model. Its impact can be seen through the three subscales. Thus, we have no direct path from math anxiety to math achievement. As could be seen in table 8, the effect of sex on math achievement ($\beta = 0.204$, $t = 4.181$, $p < 0.01$) was statistically positive and significant. The effect of prior math achievement on math

achievement ($\beta = 0.238$, $t = 4.737$, $p < 0.01$) was also positive and significant. The effect of sex on avoidance subscale ($\beta = -0.044$, $t = -0.839$, $p > 0.05$) and the effect of cognitive subscale on math achievement ($\beta = -0.005$, $t = -0.103$, $p > 0.05$) were not statistically significant. Revealing that sex of students has no direct effect on avoidance subscale and cognitive subscale has no direct effect on students' mathematics achievement respectively.

The combined effect of gender, prior math achievement, affective subscale, cognitive subscale, and avoidance subscale accounts 16.9% of the variability in mathematics achievement ($F_{(5,364)} = 14.769$, $p < 0.01$). Of this gender contributes 5.28%, prior math achievement contributes 7.35%, affective subscale contributes 1.96%, cognitive subscale contributes 0.07% while avoidance subscale contributes 2.18%. Thus the variables other than those studied in this study accounted for 83.1% of the variability in students' achievement. The following figure shows the final path model for mathematics achievement:

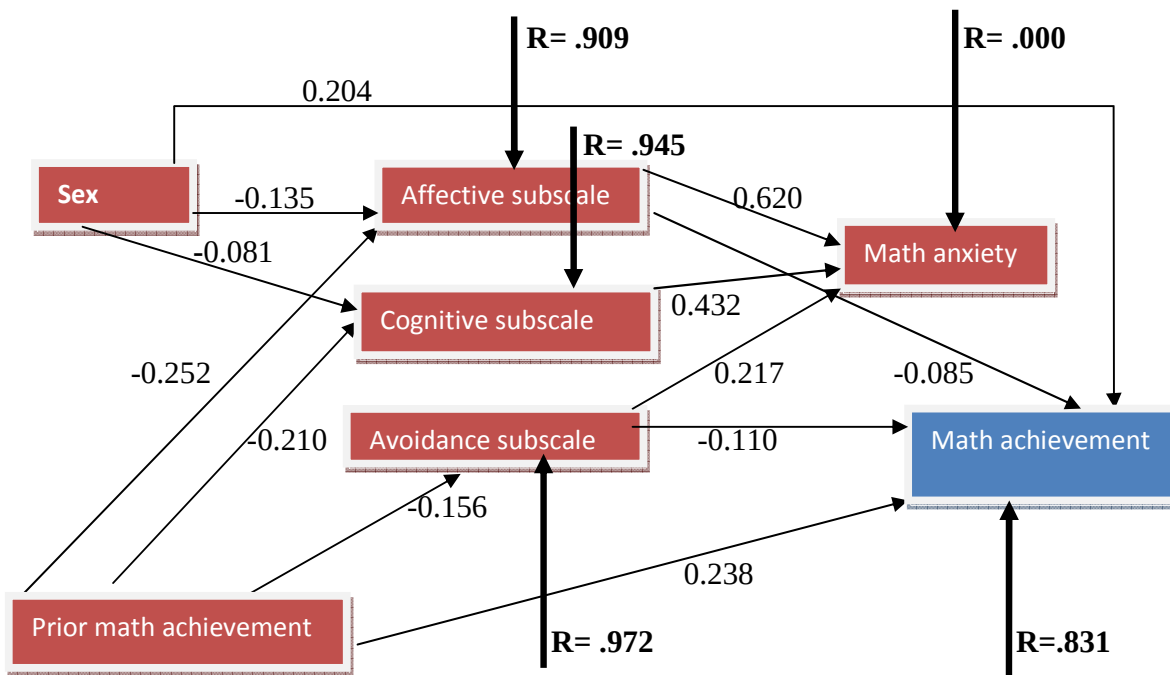


Fig.4. The final path model for mathematics achievement

The residual path coefficient(R) in the model represents factors that affect the endogenous variable that were not accounted in the model. Mathematics achievement of grade nine students was considered to be a function of sex, prior mathematics achievement, affective subscale, cognitive subscale, avoidance subscale and mathematics anxiety. Of all path coefficients from the independent variables to mathematics achievement, only cognitive subscale was insignificant ($\beta = -0.005$, $t = -0.103$, $p > 0.05$). The impact of mathematics anxiety was seen through the subscales and hence is significant. The direct effect of sex on affective and avoidance subscale was negative and significant. Thus, the negative effect of sex to the dependent variable in the model indicates a greater average value on the dependent variable for females.

The path further revealed that prior math achievement was the strongest predictor of math achievement. While affective subscale was the strongest predictor of math anxiety. Generally, the path revealed that sex, affective subscale, avoidance subscale and prior math achievement were reliable predictors of math achievement. On the other hand affective subscale, cognitive subscale and avoidance subscale was a reliable predictor of math anxiety.

The structural parameter estimates shown in figure 4 indicates prior math achievement, sex, affective subscale and avoidance subscale were the most influential causes for mathematics achievement. Similarly, affective subscale, cognitive subscale and avoidance subscale were the causes of mathematics anxiety. The following table shows direct, indirect and total effect of each predictor variable on the criterion variable:

Table.9. Direct, indirect and total effect of each predictor variable on the criterion variable

Effect	r	Direct effect	Indirect effect	Total effect
On mathematics achievement				
Of sex	.259	.204*	.0114	.215
Of prior math achievement	.309	.238*	.0385	.276
Of math anxiety	-.250	-.001	-	-.001
Of affective subscale	-.231	-.085	-	-.085
Of cognitive subscale	-.146	-.005	-	-.005
Of avoidance subscale	-.198	-.110*	-	-.110
On cognitive subscale				
Of sex	-.110	-.081	-	-.081
Of prior math achievement	-.221	-.210*	-	-.221
On affective subscale				
Of sex	-.170	-.135*	-	-.135
Of prior math achievement	-.271	-.235*	-	-.235
On avoidance subscale				
Of sex	-.065	-.044	-	-.044
Of prior math achievement	-.162	-.156*	-	-.156
On math anxiety				
Of sex	-.167	.000	-.049	-.049
Of prior math achievement	-.299	.000	-.280	.280
Of affective subscale	.885	.620*	-	.620
Of cognitive subscale	.746	.432*	-	.432
Of avoidance subscale	.592	.217*	-	.217

The result of table 9 depicts that prior math achievement had a stronger direct effect on mathematics achievement than did any of the variables in the study. Affective subscale had a stronger direct effect on mathematics anxiety than did any of the other two variables. The effects of prior math achievement and gender on mathematics achievement were more direct than indirect. While the effects of sex and prior math achievement on

math anxiety were more indirect than direct. Affective subscale and avoidance subscale had a statistically significant direct effect on each of the variables assumed. The effect of sex had mediated the negative direct effect on affective subscale and on cognitive subscale, while prior math achievement mediated the negative indirect effect on math anxiety as well as the negative direct effect on avoidance subscale, affective subscale and on cognitive subscale.

Chapter 5

Summary, Conclusion and Recommendation

This chapter includes a discussion of the findings of the study. The chapter begins with a summary and overview of the significant findings followed by conclusion. Finally, recommendations for practice and further research were given.

5.1. Summary of the Study and Overview of Significant Findings

This study was concerned with identifying levels of mathematics anxiety and its impact to mathematics achievement on grade nine students in East Shoa zone. The participants were taken from five randomly selected high schools in the zone. The objectives of the study were: (1) To assess students level of mathematics anxiety in the selected zone. (2) To investigate the relationship between mathematics anxiety and mathematics achievement. (3) To investigate the relationship between gender difference and mathematics achievement. (4) To investigate the relationship between mathematics anxiety and gender difference. (5) To investigate the direct and indirect effect of each predictor variable on the criterion variable.

To accomplish the goal, a quantitative study which is a survey study was used and a path analysis model was used to investigate the relationship among prior math achievement, gender, math anxiety, cognitive subscale, affective subscale, avoidance subscale and math achievement. There were four sources of data for this study. The Mathematics Anxiety Rating Scale (MARS), Mathematics Achievement Test (MAT), first semester mid and final exam, students' mathematics score on their grade 8 ministry examination. Participants (N = 370, male =184, female = 186) completed both the math anxiety rating scale (MARS) and math achievement test (MAT). Students' first semester results were taken from each study school and mathematics score on grade 8 ministry examination were obtained from East Shoa zone education bureau.

There were 90 (25 male and 65 female) participants who declared that they spoke Amharic and hence the English version of MARS was provided to them. In this study, five research questions were addressed. The research questions were addressed using descriptive statistics, correlation, independent t- tests, regression analysis and path analysis. The research questions addressed in this study were:

1. What is the mathematics anxiety level of grade nine students of the study area?
2. Does there exist a statistically significant relationship between mathematics anxiety and mathematics achievement?
3. Does there exist a statistically significant relationship between mathematics achievement and the subscales?
4. Is there a significant difference between male and female students in mathematics anxiety?
5. Does there exist a significant difference between male and female students in mathematics achievement?
6. What is the direct and indirect effect of each predictor variable on the criterion variable?

For the first research question, descriptive statistics of students score on MARS yielded that grade nine students math anxiety level is at a moderate level. Grade nine students' mean math anxiety score was 57.33 and standard deviation of the score was 11.063 which is moderate.

To address the second research question, the relationships between reported math anxiety levels and math achievement, results of (N = 370) students were analyzed. The result of the study revealed that there is a statistically significant and negative correlation between math anxiety and math achievement ($r = -0.250$, $p < 0.01$). Revealing that students who have high mathematics anxiety tended to perform low in mathematics achievement. However, those who have low mathematics anxiety tended to score high in mathematics achievement.

Although it is in contrast with some studies such as (Lupkowski & Schumacker 1991; Resnick, Viehe, & Segal, 1982, cited in Leung Wai Ping, 2005) and Leung Wai Ping (2005), it is consistent with others such as (Betz, 1978; Hendel, 1980; Richardson & Suinn, 1972, cited in Leung Wai Ping, 2005), Venkatesh Kumar, G., and Karimi, A (2010), Hembree (1990, cited in Sarah Boutwell Johnson, 2003), Tahira Khatoon (2010), Ayatollah Karimi and S. Venkatesan (2009), Ashcraft, M. H., & Kirk, E. P. (2001), Xinbing Luo, et.al (2009).

The third research question addressed the relationship between students' affective reaction, cognitive reaction, avoidance reaction and math achievement. The result of the study revealed that students affective reaction towards mathematics have the strongest correlation than the other two subscales. Generally, students' affective reaction, cognitive reaction and avoidance reaction towards mathematics have adverse relationship with mathematics achievement. but, the result of path analysis shows that the impact of cognitive subscale on mathematics achievement is insignificant.

The fourth research question addressed the relationship between reported math anxiety levels and gender difference. The result of t- test shows that there is a statistically significant difference in mathematics anxiety between male and female students ($df = 368$, $t = -3.258$, $p < 0.01$); showing that female students' are more anxious about mathematics than male. Female students mean math anxiety score ($M = 59.17$, $SD = 10.70$) was higher than that of male students ($M = 55.47$, $SD = 11.141$), which shows female students are more anxious than male. This result agrees with the finding of Eshetie (2001), (Betz, 1978; Buxton, 1981; Hembree, 1990; Llabre & Suarez, 1985; Ruben, 1998, cited in Armando Isaac Perez, 2005). They found that females report a higher level of mathematics anxiety than males. And is against with the findings of (Resnick, Viehe & Segal, 1982 and Richardson & Suinn, 1972, cited in Leung Wai Ping, 2005), as well as with the finding of Leung Wai Ping (2005) which indicates insignificant difference between male and female students math anxiety level.

The fifth research question addressed relationships between math achievement and gender difference. There was a statistically significant difference in mathematics achievement between male and female students ($df = 368$, $t = 5.151$, $p < .01$). This result is consistent with a number of studies undertaken on gender difference in academic achievement. For instance this finding is consistent with (Benbow, et al., 2000, cited in Sarah Boutwell Johnson, 2003), (Heyneman 1980, cited in Eshetie, 2001), Eshetie (2001) (Carr & Jessup, 1997; Leder, 1986; Morkos & Koff, 1978; Silkon, 1985, cited in Eshetie, 2001), (Hackett and Betz, 1989, Pajaras and Miller, 1994; Yalew, 1997, cited in Mustofa, abdela 2008), (Goldman & Hewit, 1976, Hackett & Betz, 1989, cited in Mustofa Abdela, 2008), Seleshi (1995, cited in Eshetie, 2001), Genet (1991, cited in Eshetie, 2001). Moreover, the result of the study reveal that, among the variables treated in the study, prior math achievement have the strongest correlation with math achievement ($r = 0.418$, $p < 0.01$).

The sixth research question addressed the direct and indirect effect of each predictor variable on the criterion variable. The result of path analysis indicates that prior math achievement, sex, affective subscale and avoidance subscale were the most influential causes for mathematics achievement. While affective subscales, cognitive subscales and avoidance subscales were the causes of mathematics anxiety. Moreover, prior math achievement had a stronger direct effect on mathematics achievement than did any of the variables in the study, while affective subscale had a stronger direct effect on mathematics anxiety than did any of the other two subscales.

The obtained results contradicts the findings of Pajares (1996, cited in Mas'oud Kabiri and Ali Reza Kiamanesh, 2005), Pajares & Miller (1994, cited in Mas'oud Kabiri & Ali Reza Kiamanesh, 2005), Pajares and Kranzler (1995, cited in Mas'oud Kabiri & Ali Reza Kiamanesh, 2005) since in these studies mathematics self-concept had a stronger effect on math performance than did any of the other variables including prior math achievement. However, this finding is consistent with differences among societies

proposed by Bandura (1997, cited in Mas'oud Kabiri & Ali Reza Kiamanesh, 2005), Mas'oud Kabiri & Ali Reza Kiamanesh (2005).

5.2. Conclusions

This study joins the vast expense of research on math anxiety. Our country dreams of the day when students can confidently and successfully practice mathematics. However, this dream might only be realized when the entire educational community strives to prevent, recognize, and treat math anxiety for all students; especially, attention should be given for the start of secondary education, because it is at this stage that students identify their talent and if they hate mathematics here, they will shift their inclination to other social science subjects, and hence the need of future engineers and mathematicians were affected. Based on the aforementioned discussion and the findings of the study, the following conclusions were drawn:

- Grade nine students' math anxiety level is at a moderate level.
- Individuals' affective experiences with mathematics are highly correlated with their development of math anxiety. This variable is also the most significant predictor of math anxiety.
- There is a significant negative correlation ($r = -0.250$, $p < 0.01$) between math anxiety and math achievement. Math anxiety manifests among students having poor mathematic achievement.
- There was gender disparities in all variables treated in the study. Female students' are more anxious about mathematics than male. The result of the study also shows the superiority of male students in mathematics achievement as well as all the variables treated in the study.

In addition to these, based on the results from path analysis, the following conclusions can also be drawn:

- Prior math achievement, sex, affective subscale and avoidance subscale were the most influential causes for mathematics achievement. Similarly, affective

subscales, cognitive subscales and avoidance subscales were the causes of mathematics anxiety.

- Prior math achievement had a stronger direct effect on mathematics achievement than did any of the variables in the study, while affective subscale had a stronger direct effect on mathematics anxiety than did any of the other two subscales.

In general, the result of the study shows that math anxiety occurs among students with poor performance. Thus, since math anxiety is associated with low achievement and also with a negative feeling towards mathematics, it predicts students' future employment and their success in higher education. Thus, this issue might be a major concern of our country. Therefore, the result of the study seems to have some practical implication to grade nine students in particular and all grade level in general.

5.3. Recommendations

The researcher believes that the findings of this study have the potential to add value to educators as well as those who are interested in furthering the research in more detailed way. Based on the aforementioned discussion and conclusion, the following recommendations were made:

- Educators, curriculum designers, counselors etc., might focus not only on cognitive factors but also on non-cognitive factors such as math anxiety.
- School counselors, teachers, and parents might help their students to become conscious about mathematics and guide them in correcting their misbeliefs.
- Teachers may want to implement techniques that have been found to reduce the math anxiety of students. In addition authors may want to carefully consider math anxiety as they construct mathematics text book as well as reference book, since the nature of that material may cause math anxiety.
- Students may use the findings of the study to improve understanding about their own math anxiety. They can reflect on how their own math anxiety fits in with the findings of the study and they may try to know the cause of their own math

anxiety. Students may remember their prior activities at which they were good at and might think that they could still be good at those activities, this may develop their confidence.

- The finding of this study indicate that math anxiety is associated negatively with performance; since performance of students was associated with several factors, future studies may include questioning the relationship between assessment design and math anxiety, school type and math anxiety, teacher factor and math anxiety, etc.
- In light of previous research on how math anxiety affects working memory (Ashcraft & Kirk, 2001); future studies may investigate how math anxiety affects the working memory of students. Because knowing how math anxiety affects the brain processing during math problem solving may ultimately suggest strategies for improving performance of students.
- Future researchers might examine whether math anxiety constructs on math achievement are generalizable to other segments of high school students. In addition it might be fruitful to conduct research on math anxiety with different methodology to give a richer description of students' feeling.
- The result of the study shows that math anxiety hinders students achievement in mathematics, and hence to overcome this problem, its cause might be important. To examine the root causes of math anxiety, future researchers might include a large sample including elementary, secondary, college and even university.

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Appendix A

Table of specification for Mathematics Achievement Test (MAT)

Topics	Knowledge no. of items. 33%	Understanding no. of items. 50%	Application no. of items. 17%	Total
The number system	6	6	2	14
Solution of equations	2	4	2	8
Further on sets	2	5	1	8
total	10	15	5	30

Appendix B

List of all weredas of East Shoa zone

- *1. Adama
- 2. Adami Tulu
- *3. Adea
- 4. Batu
- *5. Bora
- 6. Boset
- *7. Dugda
- 8. Fantale
- 9. Gimbichu
- 10. Liban chukala
- 11. Lume
- 12. Matahara city
- *13. Modjo city

-
- *Represents sample weredas

Appendix C

List of weredas out of the actual study

1. Adami Tulu
2. Batu
- *3. Boset
4. Fantale
5. Gimbichu
6. Liban chukala
7. Lume
8. Matahara city

-
- * represents the pilot wereda

Appendix D

List of senior secondary schools in Adama wereda

- *1. Hawas melkasa senior secondary school
- 2. Wanji gafarsa senior secondary school
- 3. Wanji shoa senior secondary school

* represents the sample school

Appendix E

List of senior secondary schools in Dugda wereda

1. Bole senior secondary school
- *2. Oda bokota senior secondary and preparatory school

* represents the sample school

Appendix F

Data collection instruments

1. The Mathematics Anxiety Rating Scale(MARS)

1.1.The English version of the MARS

Research ID. NO _____

Section_____

Age_____

Sex:

☐

Male

☐

Female

Your grade 8 School_____

General: Dear respondents, this questionnaire is prepared to collect data that will be used for writing my masters thesis as a partial fulfillment of the program of graduate studies in Addis Ababa University. The data obtained from this questionnaire is used for the purpose of this study only. All information will be kept confidential. Thus you are kindly requested to complete the questionnaire carefully and honestly. Your genuine response is the only way to reach a reliable research result. Thank you in advance for your cooperation.

Direction: Below are statements which have been designed to assess your opinion (feeling) about mathematics. Describe yourself as you generally are now, not as you wish to be in the future. Accordingly, Indicate tick (✓) mark under the five alternatives given below. The five alternatives are: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD).

NO	ITEM S	SA	A	N	D	SD
	Affective items					
*1	I fear mathematics greatly other than any subject.					
*2	My mind goes blank and unable to think clearly when doing math.					
3	I am very calm and unafraid when studying math.					
4	I do not feel scared of taking math test.					
5	Looking through the pages of math text book does not make me worry.					
*6	I feel scared when seeing activities and group works on the math text book.					
7	When I am in math class, I usually feel at ease and relaxed.					
8	I am very happy and feel comfort when my mathematics teacher works mathematical problems on the chalk board.					
*9	I fear greatly of thinking about math exam one day before the exam.					
10	When I start a new chapter in mathematics, I feel happy.					
*11	I fear math test more than any other kind of test.					
12	I don't afraid to ask a question in math class.					

	Cognitive items					
*13	I cannot predict the type of questions on math test and exam.					
14	I feel a sense of happiness when working with numbers.					
*15	Compared to other subjects, I feel worry about how well I am doing in math.					
*16	As compared to others, I am concerned that the teacher may think I am a poor student in math.					
17	I feel that I can do any math problems.					
18	I like solving square root problems.					
*19	I understand math now, but I worry that it is going to get really difficult soon.					
*20	I feel worry that other students might understand mathematical problems better than me.					
	Avoidance items					
*21	If I could, I prefer to avoid mathematics.					
*22	I don't want to think about mathematics outside the class room.					

* represents negatively worded items

1.2.The Oromic version of the MARS

Lakk. Enyummaa _____ Daree _____ Umrii _____

Saala: Dhiira Dubra

Mana barumsa kutaa 8 itti xummurte _____

Barattota, waraqaan gaafanno kun kan qophaa'e, odeeffanno adda addaa funaanufi dha. Odeeffannon kun kan barbaachiseef qo'anno fi qorannoo digrii lammaffaa kan Universiti Finfinnetti hordofaa jiruf kan oolu dha. Odeeffannon waraqaa gaafii kana irraa argamu qorannoo kana qofaaf oola. Kanaafuu qorannoo kana galmaan ga'uuf deebiin isiin kennitan baay'ee barbaachiisaa dha. Deegarsa keessaniif galatoomaa.

Qajeelfama: Himmotni armaan gadiitti qophaa'an kunnin, ilaalcha barattoonni barnoota herregaaf qaban hubachuufi. Akkataa himootni kun ilaalcha keessan ibsaniin deebii keessan filannoowwan kennaman keessaa mallattoo (✓) kaayuun filadhaa.

Lakk.	Himoota	Daran waliigala	Hamma tokko waliigala	Hin murteessine	Hamma tokko walii hin galu	Gonkumaa walii hin galu
1	Barumsi herregaa, barumsa kamiyyu caalaa na sodaachisa.					
2	Yommun herrega hojjedhu, sammun kiyya qullaa ta'a. Akkasumas sirritti naaf hin xiinxalu.					

3	Ani barumsa herregaa sodaa tokko malee tesgabbaa'een qo'adha.					
4	Ani qorumsa herragaa fudhachuun jeequumsa homaa natti hin fidu.					
5	Yommun baay'ina fuula kitaaba herregaa irra jiru ilaalu, hin jeeqamu.					
6	Kitaabni herregaa waan hojii garee fi hojii dhuunfaa baay'isuuf natti hin tolu.					
7	Yommun heerrega baradhu, hin dhiphadhu, baay'ee tokko natti tola.					
8	Yommu, barsiisaan herregaa pirobileemota adda addaa gabatee gurraacha irratti hojjetu, nan gammada; natti tolasi.					
9	Waa'ee qorumsa herregaa guyyaa tokko dura yaaduun baay'ee tokko na sodaachisa.					
10	Yommun boqonna haraa barumsa herregaa jalqabuu, gammachuu guddatu natti dhagahama.					
11	Qorumsi herregaa qorumsa kamiyyu caalaa na sodaachisa.					
12	Daree herregaatti gaafi gaafachuun na hin sodaachisu.					
13	Gaaffiwwan qurumsa herregaa irratti dhufu danda'an tilmaamu hin danda'u.					
14	Ani yommun gaafii lakkofsota qaban hojjedhu, gammachuu guddaatu natti dhagahama.					

15	Dandeetti herregaa ani qabu dandeetti barumsa birootiin yommun madaalu, jeequmsatu natti dhagahama.					
16	Barsiisaan kiyya barrattota biroo caalaa dadhabina ani barnoota herregaatiin qabu waan natti beeku natti fakkata.					
17	Gaafi herregaa kamiyyu waan hojjedhu natti fakkata.					
18	Pirobilomota skuwer ruuti hojjechu nan jaaladha.					
19	Wayita ammaa barumsi herregaa haalan naaf gala, garuu booda baay'ee waan cimaa deemu natti fakkaata.					
20	Ani yeroo maraa barattoonni biroo pirobileemota herregaa na caalaa qalbeeffatu jedheetan yaada.					
21	Osoon danda'ee, baruumsa herrega jedhamu kana nan balleessan ture.					
22	Ani dareedhaan alatti waa'ee barumsa herregaa yaadu hin fedhu.					

1.3.The Mathematics Achievement Test (MAT)

Name _____

Research ID.NO _____ Section _____ Age _____

Sex: ☐ Male ☐ Female

Your grade 8 School _____

Time allowed 1 hr.

Direction: This exam booklet contains 30 multiple-choice items. Work on all statements carefully. Each item is followed by four possible alternatives. There is only one best answer for each question. Hence choose one best answer and give your answer on the space provided.

_____ 1. 92,485 is divisible by _____.

A.9 B.5 C.10 D.6

_____ 2. Which of the following number is a composite number?

A.23 B.7 C.45 D.11

_____ 3. The fractional form of $-1.00\bar{3}$ is _____

A. $\frac{-904}{900}$ B. $\frac{-903}{990}$ C. $\frac{-1003}{900}$ D. $\frac{-903}{900}$

_____ 4. The simplified form of $(9^{\frac{1}{3}} \times 3^{\frac{1}{3}})$ is _____.

A. $3\sqrt{3}$ B. $2\sqrt{3}$ C. $\sqrt[3]{3}$ D. 3

_____ 5. Find the solution set of $5x^2 - 18x = 8$.

A. {4} B. $\{4, \frac{-5}{2}\}$ C. $\{4, \frac{-2}{5}\}$ D. $\{\frac{-2}{5}\}$

_____ 6. Find b and c respectively, given that the graph $y = x^2 + bx + c$ passes through $(-1, 2)$ and $(3, 4)$.

- A. $\frac{-3}{2}, -5$ B. $\frac{-1}{2}, \frac{-3}{2}$ C. $\frac{-3}{2}, \frac{-1}{2}$ D. $\frac{-1}{2}, -5$

_____7. Which of the following expression is equal to $(x+2) + (x-2)(2x+1)$

- A. $2x^2 - 2x$ C. $2x^2 + 2$
B. $2x^2 - 4x$ D. $4x^2 + 2x$

_____8. Simplifying $4^2 - (9)(3^{-2})$ will result in_____.

- A. 15 B. 17. C. 16. D. 97

_____9. A number to the 17th power divided by the same number to the 14th power equals 343. Then what is the number?

- A. 6 B. 5. C. 7 D. 8

_____10. If the cube root of a number is 24, then what is the number?

- A. 12,368 B. 18,324 C. 13,824 D. 13,842

_____11. When we simplify $\frac{(\sqrt{2})(\sqrt[4]{16})}{2}$, we will get _____.

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

_____12. Which of the following is an irrational number?

- A. 3.333... C. 3.131131113...
B. 3.030303... D. $3.\overline{027}$

_____13. Abera has 6 times as many coins as Rediet. If Abera has 126 coins then, how many coins does Rediet have?

- A. 20 B. 6 C. 21. D. 12

_____14. Factorizing $x^2 + 2x + 1$ will result in _____.

- A. $(x+1)(x+2)$ C. $(x+2)(x+2)$
B. $(x+1)(x+1)$ D. $(x+1)(x-1)$

_____15. Find the solution set of the equation $x^2 + 6x + 9 = 0$

- A. {3,-3} B. {-3} C. {-1,-3} D. {3}

_____16. Which of the following quadratic equation has **NO** real solution?

- A. $x^2 + 4x - 20 = 0$ C. $3x^2 + 2x - 1 = 0$

$$B. x^2 - 3x + 2 = 0$$

$$D. 2x^2 + 2x + 1 = 0$$

_____17. Let $A = \{a, b, c\}$ and $B = \{b, c, e\}$, then find $(A \setminus B) \cup (B \setminus A)$.

$$A. \{a, b\}$$

$$B. \{b, c\}$$

$$C. \{c, e\}$$

$$D. \{a, e\}$$

_____18. Suppose A and B are sets such that $A \cup B$ has 40 elements, $A \cap B$ has 8 elements and the number of elements in B is three times that of A . Then find the number of elements in A .

$$A. 36$$

$$B. 12.$$

$$C. 48$$

$$D. 32$$

_____19. Let $A = \{1\}$, $B = \{1, 4\}$ and $C = \{-1, 2\}$. Then find $(A \times B) \cup (A \times C)$.

$$A. \{(1, 1), (1, 4), (-1, 2)\}$$

$$B. \{(1, 1), (1, 4), (1, -1), (-1, 1), (2, 1)\}$$

$$C. \{(1, 1), (1, 4), (1, -1), (1, 2)\}$$

$$D. \{(1, 1), (1, 4), (1, -1), (4, 2)\}$$

_____20. What is the standard notation for 0.0524?

$$A. 5.24 \times 10^2$$

$$C. 52.4 \times 10^2$$

$$B. 5.24 \times 10^{-2}$$

$$D. 52.4 \times 10^{-2}$$

_____21. when we rationalize the denominator of $\frac{2 + \sqrt{3}}{1 - \sqrt{3}}$ we will get _____.

$$A. \frac{5 - 3\sqrt{3}}{2}$$

$$B. \frac{-5 + 3\sqrt{3}}{2}$$

$$C. \frac{5 + 2\sqrt{3}}{2}$$

$$D. \frac{-5 - 3\sqrt{3}}{2}$$

_____22. The simplified form of $\frac{15\sqrt{27}}{5\sqrt{3}}$ is _____.

$$A. 5\sqrt{3}$$

$$B. 15$$

$$C. 27.$$

$$D. 9$$

_____23. Suppose A and B be two disjoint sets. If $n(B) = 6$ and $n(A \cup B) = 14$, then

$$n(A) = \text{_____}.$$

$$A. 20$$

$$B. 8$$

$$C. 14$$

$$D. 10$$

_____24. If $(A \times B) = \{(a, b), (c, d), (e, m)\}$, then set $B = \text{_____}$

$$A. \{a, b, d, m\}$$

$$B. \{a, c, e\}$$

$$C. \{b, d, m\}$$

$$D. \{e, m\}$$

_____25. Which of the following numbers are arranged in an **ASCENDING** order?

A. 0, 1, 4, -7

C. 0, -7, 1, 4

B. 4, 1, 0, -7

D. -7, 0, 1, 4

____ 26. Let the general quadratic equation be given in the following way,

$ax^2 + bx + c = 0, a \neq 0$. Then which of the following is the quadratic formula?

A. $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

C. $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

B. $\frac{-b \pm \sqrt{b^2 + 4ac}}{2a}$

D. $\frac{b \pm \sqrt{b^2 - 4ac}}{2a}$

____ 27. Let $x = 1.6$ and $y = 0.002$. Then $x - y =$ _____.

A. 0.598

B. 1.698

C. 1.598

D. 1.602

____ 28. The number of proper subsets of the set $\{a, b, c, d\}$ is equal to _____

A. 16

B. 15

C. 17

D. 18

____ 29. How many elements does the set $A = \{\{1, 2\}, \{6, 7\}, 2\}$ have?

A. 4

B. 3

C. 5

D. 2

____ 30. Which of the following is **TRUE** about the set $B = \{a, b, c\}$?

A. $\{a\} \in B$

B. $\{b, d\} \in B$

C. $a \in B$

D. $a, b \notin B$

Declaration

I, the under signed, hereby declare that this thesis is my original work and has not been presented for a degree in any University, and that all sources of materials used for this thesis have been dully acknowledged.

Name_____

Sign_____

Submitted to Addis Ababa University

Date_____

This thesis has been submitted for examination with my approval as a university advisor.

Advisor: Name _____

Sign_____

Date _____

Co-advisor: Name _____

Sign_____

Date_____