UNIVERSITY OF EDUCATION, WINNEBA

THE NATURE AND CAUSES OF MATHEMATICAL ANXIETY AMONG SENIOR HIGH SCHOOL STUDENTS

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DECLARATION

STUDENTS' DECLARATION

I, JACKSON JESSEL ABOAGYE-AGBI, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ……

DATE: ……..…..…….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: MR. MICHAEL AMPPIAH

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DATE: ……

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DEDICATION

This thesis is dedicated to my dear mother, Madam Theresa Akosua Oteng, my sister Yvonne Ama Yamble and her children, Gladys Bunku and my late father Samuel Kwaku Aboagye-Agbi.

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ABBREVIATION

CoMAS	Causes of Mathematical Anxiety Scale
IBM	International Business Machine
JHS	Junior High School
MARS	Mathematics Anxiety Rating Scale
Mod-MARS	Modified Mathematical Anxiety Rating Scale
SHS	Senior High School
SPSS	Statistical Package for Social Sciences
STEM	Science, Technology, Engineering and Mathematics

ABSTRACT

The study investigated the nature and causes of mathematical anxiety among Senior High School (SHS) students and the extent to which age and anxiety level can predict their mathematics performance. Cross-Sectional survey design with a mixed-method approach was adopted to collect both qualitative and quantitative data. Purposive and simple random sampling techniques were used to sample of 270 final year students from non-science departments of four (4) public Senior High Schools in the Agona West municipality at the Central region of Ghana for the study. Questionnaire and semi-structured interview protocol were used to collect both quantitative and qualitative data, and later, secondary data was also collected on students' mathematics examination scores. Frequency count, percentage, Pearson's product-moment correlation coefficient, and regression analysis were the statistical tests used in analysing the quantitative data collected for the study while the qualitative data was presented in descriptive words. The result showed that 64% of the respondents have high mathematical anxiety, while only 2% have low mathematical anxiety. However, 34% of the participants have moderate mathematical anxiety. Besides, it was discovered that students' mathematical anxiety stemmed from assessment practices such as poor test-taking, poor test preparation, examination conditions, the structure and content of assessment items, etc. as a prevalent cause. Pearson's correlation coefficient revealed a strong and significant negative relationship between students' mathematical anxiety and their performance in mathematics, while a regression analysis unearthed that mathematical anxiety score can be considered as a significant variable in predicting students' mathematics performance at the Senior High School level of education. Finally, the researcher concluded based on the findings that Ghanaian SHS students have a high level of mathematical anxiety which is strongly connected to assessment practices as the cause and has a converse relationship with their academic performance in mathematics. Also, students' mathematical anxiety scores can predict their performance in mathematics.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter discusses the background of the study, the statement of the problem, the purpose of the study, the objectives of the study, the research questions, the limitations and delimitations, and the organization of the study.

1.1 Background of the Study

Numeracy skills are one of the basic skills emphasized right from early childhood education. This shows that mathematics forms the foundation of any further education (Adetunde, 2009). Mathematics has been described by Boinde (2009) as the mother of all subjects since it is a course that the learner takes from pre-school to university. The understanding of mathematical concepts has become more challenging for many high school and college students compared to any other subject (Achieve, 2011; ACT, 2010c). The ability of a nation to contest effectively in the worldwide market today to a larger scope depends on the mathematical literacy of its citizens (Sofowora, 2014). According to Anamuah-Mensah (2007), the utilisation of science, mathematics, and technology has been interlinked with the improvement in productivity and wealth creation of a nation. This explains the need to have skilled human resources in science, mathematics, and technology as a nation.

Knowledge in mathematics is universally applied in almost every school subject. It is therefore significant that a lot of emphases should be laid on the teaching and learning of mathematics from the basic level and through the high school level. Mathematics enjoys a lot of recognition and respect from policymakers, educational institutions, and

the world of work. The study of mathematics is important because it is associated with more academic and career opportunities, and at the same time acts as one of the critical requirements for entry into higher education programmes and even in the world of work (Anamuah-Mensah, 2007). Thus, without sufficient knowledge in mathematics, one may not climb the academic ladder effectively.

Also, people who resort to learning a trade such as tailoring, hairdressing, carpentry, building and construction, fitting and welding, plumbing, and driving probably because of their inability to make the required grade for further studies end up using mathematics as an important tool for performing their duties in their workplaces (Wedelin, & Adawi, 2014). This indicates the importance of mathematics in all spheres of human activity (Ministry of Education, Science and Sports [MOESS], 2007) and justify that the key to the economic development of Ghana strongly depends on the development of strong science, mathematics, and technology base. Despite the importance of mathematics in human development, many studies have shown that students in Senior High Schools in Ghana are not performing much better in mathematics than expected (Abotowuro, 2015; Asante, 2012; Awanta, 2004; Eshun, 2000).

There is a common perception that mathematics is a very difficult subject. Umay (1996) was of the view that mathematics is perceived as a difficult subject due to its nature and also individuals' preconceived notions about mathematics, and the anxiety individuals have for the subject. Progress in mathematics has been a challenge to many students as compared to all other subjects studied in the Senior High School curriculum and with effect to that records the lowest results in the performance of most students in final examinations (Adetunde, 2009). Mathematics is one of the greatest cultural and intellectual achievements of humankind, and citizens should develop an appreciation

and understanding of that achievement (NCTM, 2000), but most students tend to avoid taking mathematics courses in higher education due to the impressions created by the individuals about mathematics as a complex subject (Adetunde, 2009). Avoiding mathematics courses severely restricts the fields a student can study and the jobs one can find. Nowadays, however, many have realized the importance of Mathematics, not only for getting an academic qualification at school or college, but also a subject that prepares one for the future as well, irrespective of which walk of life one chooses to be a part of (Shamim, 2013).

Mathematics is critical for people living in the 21st Century for the successful growth of a country's economy and for them to be effective (Neunzert, 2000 cited in Hamamunda, 2016). However, mathematics continues to be a stumbling block to the majority of people since they fail to attain their aspirations in life because of low achievement in the subject (Paul & Hlanganipai, 2014). People have attributed students' poor performance in mathematics to a variety of reasons sometimes blaming one another without making a deep investigation of the real causes of students' low performance in mathematics. However, research has shown that a serious and common obstacle for many children's poor performance and difficulty in learning mathematics across all grade levels is mathematical anxiety (Ashcraft & Moore, 2009; Christie, 2011; Paul & Hlanganipai, 2014).

It has been observed by McLeod (1994) that over 100 articles dealing with affective issues have been published in the Journal of Research in Mathematics Education since 1970s and one touching factor that received greater attention was mathematical anxiety. Abotowuro (2015) found out that the average pass rate in elective mathematics at West African Senior School Certificate Examination (WASSCE) of Ghanaian candidates from 2007 to 2014 was 45.5% which indicated that 54.5% of candidates who sat for

WASSCE from 2007 to 2014 failed every year. This reveals the fact that most Senior High School students in Ghana are not succeeding in mathematics.

Mathematics self-efficacy and mathematics anxiety are strongly related (Bandura, 1997; Hannula, 2006; Pape & Smith, 2002). This strong relationship between mathematics self-efficacy and mathematics anxiety could have implications for how researchers understand and measure these constructs and how teachers attempt to improve students' attitudes toward mathematics. For example, when teachers are reflecting on students' mathematical anxiety towards taking mathematics examinations, the students often associated their mathematical anxiety with their lack of confidence in taking examinations (May, 2009).

Hannula (2006), and Pape and Smith (2002) believe that students' mathematics self-efficacy plays an important role in the development of students' mathematics literacy to receive increasing attention. They define mathematics self-efficacy as individuals' beliefs or perceptions regarding their abilities in mathematics. Bandura (1997) affirmed that students with higher levels of self-efficacy tend to be more motivated to learn and more likely to persist when presented with challenging tasks. He argued that poor mathematics self-efficacy in college students often decreases their motivation to learn and eventually can lead to low mathematics achievement. A student that feels very positive about mathematics is more likely to perform better than the one with negative feelings (Reyes, 1984). Forgas (2001) found that effect and cognition are integrally linked within an associative network of mental representations and affect plays an important role in learning.

According to Battista (1999), the mathematical ignorance of people seriously hinders the nation's state at a competitive and increasingly technological global marketplace.

Sofowora (2014) observed that students who enrolled in non-science related degree programmes were Senior High Schools leavers whose mathematics scores were low and insignificant due to the mathematical anxiety they had. The mathematics teacher at any level faces serious obstacles to teaching students the mathematics they need. One of the biggest obstacles for the teacher is trying to teach students who experience mathematical anxiety. Many students never really develop a solid foundation in basic mathematics. Because mathematics is an accumulative discipline, that is, complex concepts are built cumulatively on more simple concepts, a student who has not developed a solid mathematics foundation faces greater challenges when learning higher-order mathematics.

Sahin (2008) in his survey found that mathematical anxiety exists among students of 4th and 5th grade in the elementary schools. He argued that mathematical anxiety in basic school students indicates that its onset coincides with early years of schooling which could be due to social learning from parents and teachers with mathematical anxiety or negative perceptions of mathematics. Mathematical anxiety is the outcome of low self-esteem and the fear of failure. It causes problems for processing the incoming information as well as the previously learned information for problem-solving. Mathematical anxiety has been defined by Richardson and Suinn (1972) as "feeling of tension, apprehension or fear that interferes with the manipulation of numbers and the solving of ordinary life and academic situations" (p. 551).

Tobias and Weissbrod (1980) also defined mathematical anxiety as the panic, helplessness, paralysis, and mental disorganization that arise among some people when they are required to solve a mathematical problem. Pradeep (2006) as cited in Udil, Kusmayadi, and Riyadi (2017) was of the view that mathematical anxiety is a state of a sinking feeling, uncertainty and dejection at doing and understanding mathematics.

These negative feelings toward mathematics greatly affect the student's ability to perform well, and their even desire to continue learning mathematics. This as a result makes the mathematics teacher's job of teaching students to succeed in and appreciate mathematics extremely difficult, if not impossible. Knowing some of the causes, effects, and preventative measures of mathematical anxiety would be of great importance and use to the Senior High School mathematics teacher.

Mathematical anxiety was found to had an adverse effect on confidence, motivation and achievement. According to Rossnan (2006), mathematical anxiety could develop as a result of the learner's prior negative experiences of learning mathematics in the classroom or at home. Mathematical anxiety may not necessarily be experienced by only learners enrolled since everyone at least uses mathematical knowledge in life, but rather it could stir from the angle of non-utility of mathematics in actual life (Hlalele, 2012). The non-utility could be connected to instances where concepts are not delivered using practical teaching approaches and these leads to the separation of mathematics learnt in the classroom from the real-life application.

Mathematical anxiety affects all aspects of teaching and learning (Mohamed & Tarmizi, 2010). Learners need to view mathematics as a human endeavour so that they learn to value and realise the application for learning mathematics both in the classroom and outside the classroom. Research suggests that if mathematical anxiety levels are decreased, there will be improvements in the individuals' cognitive, behavioural and attitudinal aspects of mathematics learning (Cavanach & Sparrow, 2011; Perry, 2004). Mathematical anxiety affects student achievement and attitude towards mathematics (Hembree, 1990). It may lead to poor performance and avoidance of mathematics or seeing mathematics as a punishment or something that induces stress (Zaslavsky, 1999).

There are many causes postulated for mathematical anxiety. Arem (2010) equated a great amount of mathematical anxiety with test anxiety and said it is in three-folds: poor test-taking strategies, poor test preparation, and psychological pressures. According to Dodd (1999), as cited in Paul and Hlanganipai (2014), the lack of confidence is probably the mathematics anxious learner's greatest obstacle. Zopp (1999) found that unrelated life events, trigger events in education, and a lack of support contributed to mathematical anxiety. Also, a parent with mathematical anxiety passes it along to their children, while teachers with mathematical anxiety pass it along to their students (Fiore, 1999). Preis and Biggs (2001) discovered that male students had high mathematical anxiety than females. Vann (1993) observed that mathematical anxiety in mothers predicts mathematical anxiety in children. This was asserted by Gectan (1995) that children of parents with excessive expectations whose love and acceptance is conditional to how well children live up to these expectations had a high degree of anxiety. Low self-esteem, confidence, and efficacy are closely related to mathematical anxiety (Uusimaki & Nason, 2004; Woodard, 2004). Ferrell in her study observed that one of the main causes of mathematical anxiety is the gap in a student's prior mathematics education that holds them back from learning more complicated concepts. She continued and said this gap emerged from most students not mastering every mathematical lesson in high school. With regards to that students falls behind since they are often afraid to ask questions about concepts they feel they should know already (Farrell, 2006). A meta-analysis study on mathematical anxiety conducted by Hembree (1990) indicated that there was a negative relationship between mathematical anxiety and mathematics performance. Thus, mathematical anxiety has been studied to help students learn mathematics more successfully and build positive attitudes towards mathematics in the long-term (Reyes, 1984).

Among Senior High School students in Ghana, the fear of not succeeding in mathematics is high, and the negative perception of mathematics is a contributing factor to the failure of these students in mathematics. Some Senior High School mathematics students are faced with the task of completing several remedial mathematics courses before beginning tertiary mathematics courses. Therefore, the anxiety to succeed appears over the heads of these students. Research has also found that mathematical anxiety, coupled with poor mathematics skills, is interlinked as a possible causal relationship (Bai, Wang, Pan, & Frey, 2009).

According to Perry (2004), a mathematics student can seriously hamper his or her performance by being nervous and insecure toward mathematics. Most mathematics teachers would agree that mathematical anxiety stems primarily from students' fears of failure and feeling of inadequacy. In most cases, mathematical anxiety is not extreme or overwhelming, yet it continues to haunt most students throughout their encounter with mathematics. Fears and anxiety about mathematics may have more widespread consequences. If teachers/tutors who are uneasy about mathematics are charged with teaching students mathematics, their anxieties could have consequences for their students' mathematics achievement.

According to literature, many of the students with mathematical anxiety have revealed an over-reliance on mathematical procedures as opposed to understanding the mathematics concept (Wang, et al., 2015). When students resort to memorizing procedures, rules, and routines without much understanding, the concept is forgotten and panic sets in. Researchers argued that "mathematical anxiety" can bring about rife, intergenerational discomfort with the subject, which brings effects ranging from fewer students pursuing mathematics and science careers to less public interest in the subject (Paul & Hlanganipai, 2014). Although factors which make learners feel nervous when

they confront mathematics have not been categorically confirmed, learners with high mathematical anxiety show a strong propensity to avoiding learning mathematics, hold negative attitudes towards mathematics, have weak self-confidence in doing mathematics, and receive lower grades in mathematics-related courses in general (Ashcraft, 2002; Hembree, 1990; Ma & Xu, 2004).

Mathematical anxiety is prevalent among Senior High School students and pre-service teachers in Ghana and the world as a whole (Asante, 2012; Awanta, 2004; Bruce, 2016; Hembree, 1990; Tapia & Marsh, 2004) and therefore the need arise to investigate its' nature and causes among Ghanaian Senior High School students. There are many signs of mathematical anxiety including an unwillingness to attempt mathematics work, classwork and being unusually nervous when in mathematics class. Mathematical anxiety hinders students' working memory (Perina, 2002).

Some researchers argued that the root cause of this varying amount of mathematical anxiety was poor instructional methods, such as assigning the same work for everyone, working through the textbook problem by problem, insisting on only one correct way to solve a problem, using the lecturing method often, concentrating on basic skills rather than concepts, and devoting more time to seat work and whole-class instruction (Furner & Berman, 2005). These "traditional" ways of teaching can lead to mathematical anxiety (Boaler, 2002; Chinn, 2009; Whyte, & Anthony, 2012) and students failing mathematics, which invariably develops negative attitude in students and ultimately a lack of interest in the subject.

The performance in mathematics of Ghanaian schools is among the worst in the world (TIMSS, 2011 cited in Mullis, Martin, Foy, & Arora, 2012). Some teachers have a bad attitude towards mathematics and their lack of confidence in their practices triggers

anxiety in their students (Sofowora, 2014). Teachers need to take steps to reduce mathematical anxiety by reviewing basic mathematics skills, making sure students understand the mathematical language, and providing a support system for their students (Abotowora, 2015). Several solutions have been suggested to help reduce mathematical anxiety, such as the provision of corrective feedback and experience of success, the use of systematic desensitization, relaxation training, counselling support group, instructional games, computer-assisted instruction, and many more (Aksu & Saygi, 1988; Davidson & Levitov, 1993; Hannula, 2002; Hembree, 1990; Hendel & Davis, 1978; Williams, 1988). In traditional classroom settings, teachers may attempt to reduce mathematical anxiety of students by teaching them effective problem-solving strategies, providing corrective feedback, and encouraging students to sustain mathematics (Aksu & Saygi, 1988; Berman, 2003; Davidson & Levitov, 1993). Also, clinical psychologists suggested that helping students to be aware of the nature of their mathematical anxiety and how they should positively cope with their fear of doing mathematics (Hackworth, 1992; Williams, 1988) could help reduce their mathematical anxiety. With the rapid development of technology, an inquiry is being held into how to simulate those suggested strategies to reduce mathematical anxiety in computer-based learning environments. The capability of affective interaction could be applied to simulate some of the anxiety treatment strategies that teachers and clinical psychologists used and thereby contribute to reducing learners' mathematical anxiety. The more a teacher understands mathematical anxiety the more he/she will be able to prevent or reduce it and also help students overcome it.

1.2 Statement of the Problem

Mathematical anxiety is a common psychological factor among Senior High School students in Ghana (Asante, 2012; Awanta, 2004; Bruce, 2016). Many researchers conducted several studies to determine the influence of mathematical anxiety on students (Asante, 2012; Awanta, 2004; Bruce, 2016; Bull, 2009; Chinn, 2009; Prevatt, Wells, & Li, 2010). Some of these studies showed that the level of a student's mathematical discomfort and anxiety directly affects their achievement and progress in mathematics (Bull, 2009). That is, as mathematical anxiety increases the student's success and understanding of mathematics concepts decreases (Prevatt, Wells, & Li, 2010). Much of this mathematical anxiety was experienced in and outside the classrooms due to many reasons. Some related factors identified as the common causes of mathematical anxiety among Senior High School students include lack of teacher's consideration of different teaching and learning style among students, society's perception on the nature of mathematics, demographic variables (i.e. gender, age and home language) and others. However, findings from various researches had not made known to the public the nature and causes of mathematical anxiety among SHS students in Ghana and worldwide.

Besides, literature justified that mathematical anxiety exists among Ghanaian SHS students (Akakpo, Nyarko, Boateng, Adjekum, & Kwarteng, 2013; Asante, 2012; Awanta, 2004; Bruce, 2016), and it has a considerable correlation with student success in mathematics (Hembree, 1990) but its nature was not identified. Hence, the researcher decided to survey and identify the nature and causes of mathematical anxiety among Senior High School students and the influence it has on their academic achievement in mathematics.

1.3 Purpose of the Study

The purpose of this study is to investigate the nature and causes of mathematical anxiety among Senior High School students, its relationship with their success in mathematics, and the extent to which age and mathematical anxiety score of students' can predict their performance in mathematics.

1.4 Objective of the Study

The objectives of this study include:

- To find out the level of mathematical anxiety among Senior High School students in the Agona West Municipality.
- To determine the prevalent causes of mathematical anxiety among Senior High School students in the Agona West Municipality.
- To find out if there is a significant relationship between students' mathematical anxiety level and their performance in school mathematics in the Agona West Municipality.
- To find out the extent to which student's age and mathematical anxiety predict his/her achievement in mathematics in the Agona West Municipality.

1.5 Research Questions

The following research questions guided this study:

1. What is the level of mathematical anxiety among Senior High School students' in Agona West Municipality of Ghana?
2. What are the prevalent causes of mathematical anxiety among Senior High School students in Agona West Municipality of Ghana?

3. Does a significant correlation exist between students' mathematical anxiety and mathematics achievement?

4. Do students' age and their mathematical anxiety predict their mathematics achievement?

1.6 Research Hypotheses

The following null hypotheses were postulated which guided the study, and were tested at 0.05 level of significance:

1) Hypothesis 1

H_0: There is no significant relationship between students' mathematical anxiety and mathematics achievement.

2) Hypothesis 2

H_0: There is no significant relationship between students' mathematical anxiety, age, and mathematics achievement.

1.7 Significance of the Study

Mathematical anxiety is a learned emotional response to listening to a mathematics lesson, participating in a mathematics class activity, working through mathematics-related problems, discussing mathematics tasks etc (Stoehr, 2017). Due to its nature, it posses negative feeling on to the learner resulting in students' poor achievement in mathematics. Stakeholders expressed an increased need for investigating the nature, causes, and remedy of mathematical anxiety (Olatunde, 2009).

The outcome of the study would make mathematics educators and various stakeholders of education aware of:

a) the mathematical anxiety level of Senior High School students in the Agona West Municipality,
b) the prevalent causes of mathematical anxiety among Senior High School in the Agona West Municipality,
c) the relationship that exists between students' mathematical anxiety and their mathematics achievement.
d) the extent to which age and mathematical anxiety predict students' performance in mathematics.

1.8 Delimitation of the Study

The researcher would have wished to do the study in all the Senior High School in Ghana but due to limited time frame and financial constraints, the study engaged only some randomly selected students in Senior High Schools at Agona West Municipality of Ghana.

Due to a large number of potential participants in the study, the researcher targeted only SHS final year students in the Municipality's Senior High Schools. The researcher was so curious about the core mathematics results because the researcher noticed a sharp decline in performance and wanted to explore the nature and causes of the psychological factor associated with this challenge in performance.

The researcher just focused on the scope of the study and not measures that could be taken to reduce it. Thus it was clear that the research instrument does not in any way reduced participants mathematical anxiety but was rather used to identify the anxiety level, prevalent causes, its relationship with participants' mathematics achievement and the predicting power of mathematics achievement based on mathematical anxiety and age. Also, the research does not attempt to explain whether the nature and causes of

mathematical anxiety can be differentiated by other factors like age, ethic, place of origin and other demographic variables.

1.9 Limitations of the Study

This study was limited to the size of the population in the various institutions used for the research. Attitude and bad experience on the day of the survey could skew the respondents to the survey. Moreover, the study was only carried out in some part of Ghana. Although the focus of the study was on students randomly sampled, it will limit the ability of the researcher in generalizing the findings to a large population to some extent. More also, the researcher did not use any strategy to decline mathematical anxiety during the study.

1.10 Definition of Terms

The following terms are defined for clarification as used in this study:

Senior High School students. Senior High School students refer to all students who are under preparation to acquire a certificate for admission into a tertiary institution.

Mathematical anxiety. Mathematical anxiety includes "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, p. 551)

Mathematics Anxiety Rating Scale (MARS). The MARS is a 98-item, Likert-style assessment that was "constructed to provide a measure of anxiety associated with the single area of the manipulation of numbers and the use of mathematical concepts" (Richardson & Suinn, 1972, p. 551).

High Mathematical anxiety. High mathematical anxiety is an illogical feeling of panic, any discomfort, embarrassment, avoidance, failing and fear, which are physically visible, and which prevent solution, learning and success about mathematics (Cemen, 1987)

Mathematics avoidance. Mathematics avoidance is the empathy for mathematics anxiety to cause students to seek escape from dealing with mathematical situations or doing mathematics at higher levels.

High Mathematics achievement. High mathematics achievement refers to competency, reduced errors when performing mathematical tasks, completion rate and high academic performance in mathematics as measured by the assessment.

1.11 Organization of the Study

The introductory chapter of this study includes the background of the study, the statement of the problem, the purpose and significance of the study. More importantly, the research questions that are the primary focus of this study were identified under this chapter. The limitation and delimitation of the study are outlined. The last part of this chapter comprises the organisation of the study.

A review of related literature is presented in chapter two and addresses the research on the topics of definition and understanding of mathematics anxiety, symptoms of mathematics anxiety, causes of mathematics anxiety, effects of mathematics, and interventions for mathematic anxiety reduction. This chapter also described the theoretical model employed in the study.

The methodology used in this study is described in detail in chapter three and also includes the research design, population, sample and sampling methods, data collection

process, data analyses procedure and contribution to existing knowledge. The analysis and interpretation of data are provided in chapter four, in which the research questions and hypotheses are addressed. Chapter five includes a summary of the study, a report of the findings and the researcher's conclusions concerning possible implications for practice and recommendations for further research.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter discusses the review of related literature relevant to the study. Thematic areas covered include:

- Theoretical framework
- Definition and understanding of mathematical anxiety
- Causes (origins) of mathematical anxiety
- Symptoms of mathematical anxiety
- Mathematics teaching anxiety
- Mathematical academic achievement
- Effects of mathematical anxiety
- Interventions for mathematical anxiety reduction
- Summary of the review

2.1 Theoretical Framework

Preis and Biggs (2001) cycle of mathematics avoidance was adopted as a model to explain why students experience mathematical anxiety (see Figure 1). The model comprised of four phases. In the first phase, the learner experiences negative reactions to mathematics situations. These reactions may derive from their past negative experiences with mathematics, and lead to the second phase in which the person avoids mathematics situations. This avoidance leads to phase three, poor mathematics preparation, which brings them to phase four, poor mathematics performance. This generates more negative experiences with mathematics and brings the student back to

the first phase. This cycle can repeat so often that the mathematics anxious person becomes influenced that they cannot do mathematics and the cycle is not often broken.

In essence, students go through this cycle over and over and rarely rebound and are consequently convinced that they cannot do mathematics. Biological studies carried out on mathematical anxiety found that mathematics-anxious individuals had a deficient inhibition mechanism whereby working memory resources are consumed by task-irrelevant distracters (Hopko, Ashcraft, Gute, Ruggerio, & Lewis, 1999). According to Jones (2006), as cited in Paul and Hlanganipai (2014), students who performed poorly in tests and examinations claim that they become confused, are unable to focus on the task at hand or keep thinking about how poor they are at mathematics. Mathematical anxiety disrupts the on-going, task-relevant activities of working memory, slowing down performance and degrading its accuracy. The diagram of the adopted Preis and Briggs (2001) model is shown in Figure 1.

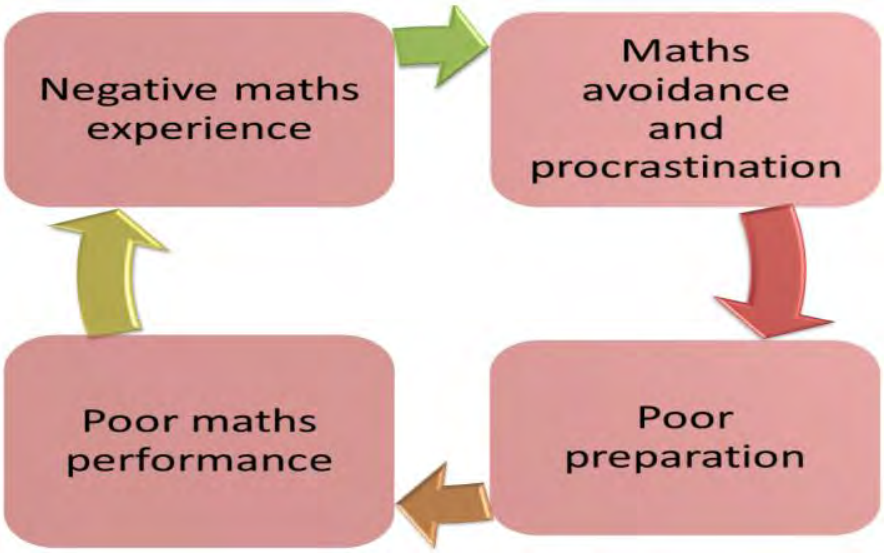

Figure 1: Cycle of Mathematics Avoidance Model

2.2 Definition and Understanding of Mathematics Anxiety

There is a common myth that mathematics is difficult as a subject of study (Zakaria, Chin, & Daud, 2010). This perception drives the feeling and passion of much students away from studying mathematics and has greatly affected students' performance in the subject at schools as well as job places (Recber, Isiksal, & Koç, 2018; Soni, 2016). Research has shown that a serious and common psychological factor that that is highly connected to children's poor performance in mathematics across all grade levels is mathematical anxiety (Christie, 2011; Hembree, 1990; Paul & Hlanganipai, 2014).

Peters (2008) described anxiety as a mind-body reaction that occurs instantaneously, and its effects are felt physiologically, behaviourally, and psychologically all at the same time. He argued strongly that in these circumstances the individual feels tense and worried, and under pressure but is able to cope with this without improving any further in performance. Once anxiety levels increase outside this point, performance disintegrates quickly leading to the deterioration of concentration, loss of the ability to perform coordinated physical and mental activities, and ceases a person from having control over the task in hand. Peters again defined anxiety as a state of intense agitation, tension, or dread occurring from a perceived threat of danger. The American Psychological Association (2014) also defined anxiety as an emotion characterized by feelings of tension, worried, thoughts and physical changes like increased blood pressure. Further to this, Tyrer (1999) explained that anxiety covered a range of experience, which is normally experienced by all at the same time in their lives, and some of which is pleasurable. At the other hand, anxiety can become unpleasant and stressful. Anxiety can cause stress, an emotional experience that takes over our mind and body.

According to Ertekin, Dilmac, and Yazici (2009), anxiety is a state of arousal that surfaced through bodily, emotional, and mental changes an individual experiences when faced a stimulus. These feelings of anxiety can lead to fear, distress, shame, inability to cope, sweaty palms, nervous stomach, difficulty in breathing, and loss of ability to concentrate (Hembree, 1990; Malinsky, Ross, Pannells, & McJunkin, 2006). Other symptoms of anxiety include tension, nervousness, worrying, edginess, impatience, confusion, fear, and developing a mental block (Pérez-Tyteca, et al., 2009). Therefore, the fear of learning or doing mathematics, also referred to as mathematical anxiety, reflects an internal aversion to any form of mathematical data or fear of working with numbers or equations that interfere with the performance of an individual and inhibit subsequent learning (Hembree, 1990; Kelly & Tomhave, 1985).

Mathematical anxiety was defined in different ways by most researchers. Christie (2011) defined mathematical anxiety as negative emotions that interfered with the solving of mathematical problems. Students' negative reaction experience to mathematics situations may result from past negative experiences with mathematics and lead to avoiding mathematics situations in general. Mathematical anxiety can influence students' mathematical performance by affecting memory and creating nervousness and an inability to concentrate (Elizabeth, 2008). This happens when the avoidance of mathematics situation leads to poor mathematics preparation. Mathematical anxiety exists in some adults (Perry, 2004), including teachers (Haylock, 2003) and it is influenced by people's beliefs. It is both an emotional and cognitive dismay of mathematics (Tobias, 1993). Richardson and Suinn (1972) also defined mathematical anxiety as "feeling of tension, apprehension or fear that interfered with the manipulation of numbers and the solving of ordinary life and academic situations" (p. 551).

Tobias and Weissbrod (1980) asserted that mathematical anxiety is a serious and pervasive problem. Like other forms of anxiety, students may feel depressed and not be capable of completing mathematical tasks or may avoid attempting mathematics courses. Students may experience mathematical anxiety in many forms and degrees, from mathematics examination to avoiding anything that has to do with numbers. Moreover, mathematical anxiety is "an emotion that blocks a person's reasoning ability when confronted with a mathematical situation" (Spicer, 2004, p. 1). Also, mathematical anxiety is panic, helplessness, paralysis, and mental disorganisation that arises among some people when they are required to solve a mathematical problem (Tobias & Weissbrod, 1980).

Latterell (2005) defined mathematical anxiety as a penetrating fear of mathematics that prevents a person from being able to do mathematics, while Lou, Wang, & Lou, (2009) and Sparks (2011) described mathematical anxiety as a kind of disease or a negative emotional stage created when engaging in activities requiring mathematical computation. They continued to explain that mathematical anxiety created discomfort in mathematics and could lead to fewer students pursuing mathematics and science-related careers. Ma (1999) referred to mathematical anxiety as disturbance of the recall of prior mathematics knowledge and experience as Legg and Locker (2009) defined mathematical anxiety as "a general fear or tension associated with anxiety-provoking situations that involve interaction with mathematics" (p. 471).

Bessant (1995) also described mathematical anxiety as a multidimensional concept having both cognitive and affective roots. Bessant further clarified that the cognitive domain contributed to the learning approaches structure for exploring the students' difficulties in learning mathematics and for linking mathematical anxiety with an evaluation of mathematical skills while the affective domain contributed to the

framework for examining mathematics affects, attitudes and the larger unclear concept of anxiety. According to Cemen (1987), and Trujillo and Hadfield (1999), mathematical anxiety is a state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to self-esteem, whiles Mathison (1977) referred to mathematical anxiety as an irrational fear of mathematics that ranged from a simple discomfort associated with numerical operations to total avoidance of mathematics classes.

These various definitions offered on mathematical anxiety reveal that it is an intense emotional feeling, a state of discomfort or fear that people have about their ability to understand and do mathematics. Emotional and mental distress occurs in some students in their effort to understand or work with mathematics situations. Though the concept of mathematical anxiety is unclear within mathematics education, it is evident that the concept being observed has a considerable correlation with students' success in mathematics. Helping to determine the nature and common causes of mathematical anxiety and how it relates to performance in mathematics would contribute significantly to future students' mathematics knowledge acquisition and application.

2.3 Causes (origins) of Mathematical Anxiety

There have been multiplicities of speculated reasons for how and why students develop anxiety in mathematics. Tobias (1993) was of the view that gender plays a large role in mathematical anxiety. Although Hembree (1990) supported Tobias' belief that girls exhibit more mathematical anxiety, he withdrew but still recognises obstacles that women can face. Some school of thoughts debated that mathematical anxiety develops because of a student's prior negative experience when learning mathematics in the classroom or at home. Research findings also disclosed that teachers and parents often

intensify a child's level of anxiety by imposing their personal views about mathematics (Rossnan, 2006).

According to Hadfield and McNeil (1994), as cited in Trujillo and Hadfield (1999), mathematical anxiety originated from three areas: environmental, intellectual, and personality factors. They explained that environmental factors included negative experiences in the classroom, parental pressure, insensitive teachers, presenting mathematics as a rigid set of rules, and non-participatory classrooms (Dossel, 1993; Tobias, 1993). Further to that, intellectual factors included being taught with uneven learning styles, student attitude and lack of persistence, self-doubt, lack of confidence in mathematical ability, and lack of perceived usefulness of mathematics (Cemen, 1987; Miller & Mitchell, 1994). Personality factors included reluctance to ask questions due to shyness, low self-esteem, and viewing mathematics as a male domain (Cemen, 1987; Gutbezahl, 1995; Levine, 1995; Miller & Mitchell, 1994). Other research also shows that unsuitable curricular and the culture of doing mathematics quickly can lead students towards a negative attribution style and ultimately learned helplessness (Arem, 2010; Chinn, 2009; Hembree, 1990).

Arem (2010) identified some initial factors that cause mathematical anxiety among students which are discussed as follows:

2.3.1 Embarrassments

Teachers, society and peer embarrassment and humiliation became the conditioning experience that caused some students' mathematical anxiety. Many students fear to work mathematics problems on the board when asked by a teacher because explaining that knowledge to peers is difficult even if they knew how to solve the problem. Being embarrassed by family members can also cause mathematical anxiety. Some parents

who tried to help their children in mathematics sometimes leads to serious upset. Some of these tutoring results in scolding when their children are not able to complete mathematics problems. Peers also tease one another about not being doing well in mathematics. This is particularly true of boys telling girls that they cannot do mathematics. When students hear these statements frequently, they start to believe them and associate some bad feelings with mathematics. So, hearing the word 'mathematics' triggers in the student response of anxiety, consciously or unconsciously recalling the bad feelings and becoming uneasy (Nolting, 2002).

2.3.2 Poor curriculum

The introduction of new mathematics concept to some students creates a major obstacle to their progress (East, 2008). Other curriculum choices that have also adversely affected students include continuous changes in the school curriculum on mathematics topics for different grades, unsatisfactory textbook selections which are not explicit enough for self-study, inadequate pre-algebra preparatory courses, gaps in course sequencing and modules moving at too fast a pace (Shields, 2006).

According to Newstead (1998), between the ages of 9 and 11, attitudes and emotions towards mathematics learning begin to develop. This corresponds with findings that mathematical anxiety began around the 4th class and peaks somewhere in higher school around form one (Blazer, 2011). The reason why mathematical anxiety and mathematics avoidance began to increase after the fourth grade and the positive attitudes that children previously had concerning mathematics began to decline is that mathematics concepts changed from the world of the concrete (shapes and block) to the world of the abstract (variables, numbers, and operations) (Martinez & Martinez, 2003; White, 1997).

Studies showed that Algebra involves many abstract concepts and the increase in these abstract concepts create anxiety in some students (Hembree, 1990). According to Ferguson (1986), abstraction anxiety is an important factor in mathematical anxiety. This was consistent with Hembree (1990) when he mentioned in his study that abstraction anxiety was anxiety associated with specific mathematics topics and was related to mathematical anxiety. The abstract nature of mathematics makes mathematical comprehension difficult for many students (Bush, 1991) hence, there is a greater potential for mathematical anxiety if the topics have a high level of abstraction.

Bessant (1995), studied psychology and sociology students at the university level and referred to deep learning and surface learning as being a factor in the development of mathematical anxiety. He further explained that deep learning is associated with more interest in the subject which activates intrinsic motivating factors and lesser anxiety among students while surface learning tends to focus on fixed strategies and reproducing facts, generating greater external pressures, and leading to high levels of anxiety. Warburton (2003) stated that environments that encouraged freedom of learning and devoid of external pressures tended to encourage deep learning. Conversely, insensitive teaching and over-demanding syllabi are associated with a surface learning approach and, connecting to high levels of mathematical anxiety.

2.3.3 Parental and societal pressures and expectations

Many parents or guardians have often discouraged their children by being overly demanding or obsessional, very inconsiderate as to their choice of words used on their children, comparing them with other peers around them. Some parents have also put pressure on their children by tutoring them with mathematics for them to pick the same career path as them or they feel they should be doing. This general perceptions of mathematics are among the most common social factors that cause mathematical

anxiety. Students can experience mathematical anxiety in an informal setting, that is, outside a mathematics classroom situation, for instance when solving problems in their everyday lives which involve the manipulation of mathematical ideas or when discussing issues to do with mathematics.

Research has shown that students' parents play an essential role in mathematics achievement as they try to provide material resources and support for their children in a variety of ways (Tobias, 1993). Fraser and Honeyford (2000) noted that parents who gave mathematics low status or applying too much pressure to children may also contribute to the development of mathematical anxiety, while Dossel (1993) believed that parental disappointment and despair were especially demoralising due to the value placed on the high positive esteem of parents by children.

Thomas and Furner (1997) noted that parents might emphasise how difficult mathematics was and, at the same time, tell their children how mathematics skills were essential for learners' future achievements. Further, parents who were overly concerned about results can cause anxiety in their children. Geçtan (1995) said that children of parents with excessive expectations whose love and acceptance was conditional to how well children live up to those expectations had a high degree of mathematical anxiety. Such parents who were so much concerned about results in mathematics could be common nowadays especially in Ghana and in most African countries where success is defined by one's level of education especially in STEM-related and core subjects (Foley, et al., 2017). The researcher believes these parents end up putting more unnecessary pressure on the children leading to low achievement in mathematics.

If parents performed poorly in mathematics or had a negative attitude toward mathematics, they have had their own negative experience (Lazarus, 1974). Research

has shown that parents with such attitudes can pass their mathematical anxiety to their children and often reinforce their children's mathematical anxiety (Lazarus, 1974). Kurtner (1992) suggested that a parent can transfer feelings of mathematical anxiety unintentionally by simply demonstrating their discomfort with mathematics. It is very difficult for students to like the subject when their parents did not do well in mathematics themselves, and thus do not understand it or do not think it was important.

Stolpa, (2005) said that response from parents, such as 'do not worry, I've never understood most concepts in mathematics when I was a student' or 'never mind, mathematics was always tricky for me at school too', played a significant role in developing views and attitudes toward mathematics in terms of having favourable or unfavourable opinions. The researcher believed such negative predispositions of parents had detrimental effects on the performance of their children. Students might see their parents as having a good job and doing very well in life without any appreciation of mathematics and think that they will be successful without an appreciation of mathematics as well.

Furthermore, Kurtner (1992) pronounced that parents can promote the myth that a person has a mathematical mind or he does not have a mathematical mind. Tobias (1993) questioned whether one must have a mathematics mind for mathematics achievement. Eccles (1994) strengthened this argument by maintaining that parents who have traditional opinions about the abilities of their children may provide unnecessary anxieties in their sons and daughters. Moreover, parents who tend to avoid mathematics can also contribute to their children's anxiety in mathematics and research has shown this to have harmful effects on students (Zaslavsky, 1999).

Geist (2010) suggested that children from families of a low socio-economic background are also at a disadvantage in mathematics since they are not normally provided with the extra support at home or in the community to succeed. Tocci and Engelhard (1994) looked at the influence of parental support on mathematical anxiety and found that parental support had a significant effect on all attitudes measured. To further examine these reactions, Mahigir, Venkatesh and Karemi (2012) asserted that parents' educational level, income, age, and their school type are good predators of mathematical anxiety. They also found out that Tocci and Engelhard's study found out that the higher the parental support, the higher the scores constituted attitudes toward mathematics.

Chinn (2009) said that what one hears and sees with regards to mathematics ultimately sets up future experiences in the subject. He further said if one is constantly faced with a statement like 'mathematics is not important in the world', such a statement might eventually turn into one's beliefs about their competency in mathematics. If society views a lack of mathematics skills as adequate or just enough to get by, one might not found the reason for doing so well in the subject. Not only of what one hears about mathematics' important but the seemingly social acceptance of having less than great abilities in mathematics also plays a vital part (Chinn, 2009).

Vann (1993) testified that mathematical anxiety in mothers was significantly predictive of mathematical anxiety in children. This was consistent with other research findings such as Sterenberg (2008) when he said that many parents tell stories of their childhood when they were frustrated in a mathematics class and or scared of problem-solving in mathematics. The long thread of their struggle in learning mathematics in schools may create different images of mathematics; many of them, unfortunately, negative.

Bulmahn and Young (2000) conducted a study on the underlying cause of mathematical anxiety in pre-service teachers and their results suggested that the pre-service teachers' negative experiences as a student, developed from lack of support from their families and effect of their previous mathematics classes were the root causes of mathematical anxiety among them. However, Puteh (2002) noted that some students believed that mathematics is a measure of their intelligence and are embarrassed by their inadequate performance. It means that if this issue of mathematical anxiety is not dealt with properly it may continue to have negative effects in our educational system. If such students who believe that mathematics is a measure of their intelligence performed poorly too often, it is likely to lead to loss of self-confidence and tension in the subject.

Sam (1999) reported that there were beliefs which seem to be more like misconceptions developed in societies about mathematics. Kogelman and Warren (1978) also noted with great concern that there were some commonly held beliefs about mathematics that were associated with mathematical anxiety. These beliefs include inherited mathematics ability, that some people have a mathematics mind and some do not (Sterenberg, 2008), one must always know how he or she got the answer, mathematics is a very difficult subject, mathematics requires a good memory, men are better at mathematics than women, and mathematicians solve problems quickly in their heads. Such beliefs also planted seeds in the children's mind as they always have justification for their low achievement in mathematics.

The society also viewed mathematics as a subject which was too formal or was just required for calculations. This negative repute held by society makes the subject appear too dry for the students. Also, social interactions in the society which tend to prepare children to hate mathematics includes assigning time, and again a variety of negative adjectives like boring, dry, hard, dull, to describe mathematics in general (Stolpa,

2005). Such beliefs were hindering factors for people's interest to studying Mathematics.

Foong conducted a study in 1987 with secondary mathematics students from a single school in Singapore. She reported that mathematics is viewed by society as an inherently difficult subject and this is worsened by the fact that most students are not able to see its practicality in real-life situations. Shields (2006) stated that society plays a large role in the development of mathematical anxiety. For some reason, mathematics seems to be the only subject which people can express their lack of knowledge and hate for, and still be considered socially acceptable normal contributors to society. Miller and Mitchell (1994) also suggest that if parents are too harsh in punishment for bad grades received in mathematics, stress, anxiety and avoidance of the subject may increase. This could be so for exceeding expectations as well.

Tocci and Engelhard (1994) were of the view that achievement in mathematics represents direct experiences with the attitude object, providing students with information that might affect their belief systems, feelings, and intended behaviours while Ho, et al. (2000) noted that this family and societal stress placed on students may produce a big number of students who are extremely apprehensive about mathematics.

2.3.4 Competency levels

Classes may contain students with varying degrees of competency in mathematics. The desire of a student is to be the first in obtaining the right answer to a mathematics problem and that there should always be a right and a wrong answer. If however, they get the answer wrong, they feel it is a poor reflection on them and their academic abilities. They tend to feel discouraged in themselves, and this negative self-image develops within them, making them avoid situations that will highlight their

weaknesses, as with mathematics. Each time they are called upon and they give a wrong answer, they feel less worthy, dumb or unintelligent. Students who are weak or experience mathematical anxiety may hesitant to participate or ask questions because they fear that their input may be perceived as insignificant or trivial (Steele, 1998). The perception that some students are more competent also causes the mathematics anxious students to further withdraw.

2.3.5 Poor teaching methods and classroom factors

Oxford and Vordick (2006) as cited in Hamamunda, (2016) suggested that many causes of mathematical anxiety appear to stem from teachers' methods of teaching. This was consistent with the finding of Fiore (1999) when he established that mathematical anxiety begins to take form with the methods teachers use to instruct mathematics. Preparation and thought must be taken into account when planning how lessons are delivered and how students will feel during each lesson. When planning, teachers must be able to take into consideration what questions students have, the struggles students will encounter, and how students' will react when they do not understand (Fiore, 1999).

Regardless of the class level of students, the way the instructor teaches mathematics has a great impact on the level of mathematical anxiety in students (Alexander, 2010). Martinez and Martinez (2003) listed several teacher-initiated instructional strategies that help in the reduction of mathematical anxiety. One important aspect, they stated, was teaching students to keep fighting instead of taking the flight response to difficult mathematics problem-solving. The second most important strategy listed was taking learning out of the mathematics textbooks and putting it back into the context of real-world applications so that students could grasp the practicality of learning the material. Some teachers have ridiculed their students by shouting at them, telling them they

would not be able to learn mathematics, due to the students' inability to comprehend what teachers teach them or through students' poor performances in tests or classwork. Others have no alternative teaching methods to help their students learn mathematics properly.

Research highlights the teacher's contribution to student's fears of mathematics. For example, Shields (2006) noted that mathematical anxiety can be perpetuated in the classroom; Traxler (2013) as cited in Paul and Hlanganipai (2014) believes the primary cause of mathematical anxiety is the learning environment; Jackson and Leffingwell (1999) say that one cause of mathematical anxiety is the teacher himself or herself and Greenwood (1984) considered one of the causes of mathematical anxiety as teaching methods that do not support creative thinking and deep understanding. Fiore (1999, p.403) stated that "teachers and the teaching of mathematics are known to be the root cause of mathematical anxiety." Other researchers strongly believe that mathematical anxiety can originate from teaching methods, attitude and behaviour of teachers (Haralson, 2001; Norwood, 1994).

Silva and Roddick (2001) found that most students indicated the powerful role of the teacher in the development of mathematical anxiety. Plaisance (2007) noted that the main cause of mathematical anxiety emanates from teacher-related behaviours such as intimidating comments, inability to explain concepts fully, lack of enthusiasm for the subject matter, failure to consider students feelings and lack of patience with students. Martinez (1987) also singled out teachers' shaming behaviour such as sending a student to work a question on the chalkboard that they were not sure of as another possible cause of mathematical anxiety. Tobias (1987) simply put it as bad experiences with the mathematics teacher can result in mathematical anxiety.

Jackson and Leffingwell (1999) investigated students in a senior-level mathematics course of the types of teacher behaviour that causes mathematical anxiety. Students reported the mathematics teacher's explicit and concealed behaviours that connected to their mathematical anxiety. The findings of the study showed that explicit behaviours responsible for producing mathematical anxiety in students include telling students that they already know a concept and or telling them that they do not perform well as others. On the other hand, concealed behaviours likely to cause mathematical anxiety included ignoring students and or avoiding eye conduct with the students. The study also revealed that students experienced mathematical anxiety as a result of the difficulty of the subject matter, competition with peers, teacher gender bias and hostility towards students, teachers' anger and lack of remediation.

Oxford and Vordick (2006) noted other factors assumed as causes of mathematical anxiety. The major findings of their research underlined the teacher's attitude as the major factor which causes mathematical anxiety since students do not want to do a subject that the teacher seems uninterested in or uncomfortable with. This was consistent with other pieces of literature which reported that students tend to internalize their instructor's interest in and enthusiasm for teaching mathematics (Jackson & Leffingwell, 1999). Meaning if the teacher has a negative attitude about mathematics it is likely to be passed on to his students as well.

Skemp (1986) suggested that exposure to some teaching and learning methods that rely heavily on behaviourist models leads to surface understanding or no understanding. When students learn through drill and practice as opposed to conceptual learning practices, the concepts are easily forgotten and the learner begins to panic and that forms the genesis of mathematical anxiety. Greenwood (1984) and Skemp (1986) reinforced this point and said most mathematical anxiety has its roots

in the teachers and their teaching approaches that involved rote learning with an emphasis on explain-practice-memorize teaching model. These results are consistent with the research findings of Shields (2006) when she noted that the genesis of mathematical anxiety lies in the teachers' teaching strategy in which the concept was explained and how the students practised the procedure. Meaning, the emphasis is on instrumental understanding and not conceptual understanding or both.

Research has also shown that mathematics anxious teachers can transfer their fear to the students. For example, Bush (1989) conducted a study purposely to determine if a statistically significant relationship existed between mathematical anxiety and classroom practice. The result revealed a statistically significant relationship between mathematically anxious teachers and their classroom practices. He concluded that mathematically anxious teachers tend to use more traditional teaching methods than non-traditional methods. These traditional methods of teaching led to instrumental understanding where the teacher emphasised rules without reasons and there was dependence on an algorithm. Teachers here were simply worried about the mechanics of getting correct answers hence learners are not guided to justify their answers. This means that students would not be able to form networks, and such methods of teaching do not promote enduring learning, and thus concepts are easily forgotten. Williams (1988) paraphrased the Chinese proverb which discourages teachers from using the traditional methods as:

> Tell me Mathematics, and I will forget;
> Show me Mathematics and I may remember;
> Involve me and I will understand Mathematics;
> If you involve, I will not panic and will approach Mathematics with confidence.

Further, studies had also found that some classroom activities initiated by the teacher which led to instrumental or surface understanding include experiences of learning in structured, rigid classrooms with little or no opportunity for discussion, speed in getting the answer, rote-memorizing rules, manipulation of symbols with little or no meaning attached, less time to reflect on thinking, focus on correct answers only with no room for justification and competition among students (Greenwood, 1984; Oberlin, 1982; Shields, 2006). Tobias (1987) believed that while correct answers are important in mathematics, the method of finding those correct answers was equally important and should not be ignored. She further stated that students of mathematics should understand that the power of mathematics lies not only in the exactness of the solutions but in the processing of information. This entailed that teachers should allow their students to justify their answers even on questions they had wrong.

It was noted that some of the research findings are just beliefs about the teaching and learning of mathematics that are well established that the researcher would like to investigate whether they are still a cause of concern. Cornell (1999) believed that most of the negative beliefs held by teachers stemmed from the frustration and failure in learning mathematics caused by unsympathetic teachers' who incorrectly assumed that computational processes were simple and self-explanatory. One such belief was that 'mathematics problems have only one correct answer' (Mtetwa & Garofalo, 1989). This belief according to Mtetwa and Garofalo (1989) led children to think that mathematics is highly judgmental and that answers were either right or wrong. Teachers also contribute to mathematical anxiety by giving the impression that mathematics ability is inborn, rather than a skill that can be developed in students (Tobias, 1993; Godbey, 1997). The other belief discussed by Mtetwa and Garofila (1989) was that computation problems must be solved by using a step by step

algorithm. This belief led students and their teachers to believed that mathematics is a series of procedures (formulas') which had to be learnt by rote or heart and not necessarily understood, and this according to research could be the root cause of mathematical anxiety. It can be said that these beliefs have been, and still are, influential in the way people perceived mathematics, the way mathematics is being taught in the schools, and the way mathematics' curricula were designed. Other beliefs leading to mathematical anxiety include 'a mathematical mind' is needed (Furner & Duffy, 2002) and that to be good at the arts means one cannot be good at mathematics (Tobias, 1993).

Shields (2006) established seven teaching strategies that contributed to the causes of mathematical anxiety. All of them were significantly related to mathematical anxiety. The strategies were individual competitive mathematics activities, independent mathematics work, being taught in large and small groups, working with a partner in mathematics activities, social interactions which include teacher-student discussion in mathematics class, being a member of a team in competitive mathematics activities and a teacher's inclination to emphasize only one method of solving a mathematics problem. Also, some teachers had even discouraged their students in doing mathematics, as they never really liked mathematics, but are just victims of circumstance. The study of Greenwood (1984), in Arithmetic, concurred with the research findings by Vinson (2001) since the results of his study shows that the primary origin of mathematical anxiety is the teaching methods used in the teaching of basic mathematics concepts. He suggested that pedagogical approaches likely to cause mathematical anxiety include assigning the same homework problems for all students, following the textbook exactly problem by problem, allowing only one method for solving a problem, assigning mathematics as punishment for misbehaving

in a mathematics class, and giving written work every day. Other issues suggested causing Mathematical anxiety include impractical applications of mathematics, high volumes of assigned work, and short time spans given to complete an assignment (McNaught, 2007).

Furner and Duffy (2002) believed that following the textbook problem by problem can turn off the learners from learning mathematics since no one enjoys this. Also, assigning mathematics work as punishment for misbehaving in a mathematics class can cause students to hate or dislike the subject. Arem (1993) found one high school mathematics teacher who openly told his class that if they were good the whole day, then they would not have any mathematics work to do that day.

Further studies by Kesici and Ahmet (2009) on foreign mathematics teachers showed that mathematics educators can cause mathematical anxiety by treating students unfairly because of gender or race, by embarrassing students in front of classmates, by lacking the necessary communication needed for mathematics, holding unrealistic expectations, or demonstrating anger or uncaring attitudes. Other issues raised included teachers who teach too fast, explaining poorly and scolding students for doing questions wrongly. Though in this case, the school does not have any foreign teachers, the researcher would like to survey whether the causes of mathematical anxiety in his study are similar to that in Ghana or whether there are any similarities between the foreign teachers in his setting of the studies and the mathematics teachers we have in this our Senior High School institutions.

Chaves and Widner conducted a study in 1982 among elementary school mathematics teachers through interviews and questionnaires. More than half of the participants testified that they had negative experiences at primary and secondary school. The

experiences included impatient, inadequate or sarcastic teachers, parents who were impatient with lack of success in mathematics and low grades. Turner, et al. (2002) noted that the patterns of student avoidance resulted from teachers who conveyed a high demand for correctness but provided little cognitive or motivational support during lessons. Such patterns included students not being involved in classroom activities like group work or seeking help. They also noted that the teacher typically did not respond to mistakes and misunderstandings with explanations but rather often showed annoyance when students gave wrong answers.

Also, Jackson and Leffingwell (1999) noted that there were many specific ways that teachers can intensify their students' mathematical anxiety which include forcing students to write answers on the board, responding negatively to questions, demonstrating an insensitive and uncaring attitude towards students, and relying heavily on hand-outs to teach the content. Such insensitive teachers plant a seed that may grow into a strong belief for children that they are incapable of learning mathematics. Student cohesiveness within a class was found to had a significant positive correlation with mathematical anxiety. (Taylor, 2004). An investigation by Ashcraft (2002) showed that teachers who complained of insufficient teaching time end up resorting to preparing their students for assessment (examinations) rather than for understanding. The researcher believed it could be a common practice in Ghana since our curricula were content-based as opposed to competency or skills-based curriculum, so the teachers might end up just preparing students for examinations with little or no understanding of the concepts involved. Ashcraft (2002) further explained that this habit of just preparing students for examinations without understanding creates tension when students encounter unconventional problems or problems that required application.

Though evidence suggested that mathematical anxiety results from the way the subject is presented than from the subject itself (Greenwood, 1984), the researcher has got mixed feelings over the relevance of these research findings, since the mathematics teachers in Senior High Schools had been attending workshops on best practices in the teaching and learning of mathematics and emphasis had always been on methods of teaching that enables deep understanding as opposed to surface understanding. The researcher would like to believe that this lack of empathy and enthusiasm in the subject and some personality traits of teachers suggested above could be common these days since most educators are now worried about the issue of remuneration in the public service at the expense of offering quality education to the learners, Thus teachers could be losing patience because of low morale. The researcher then intended to carry out comprehensive research to find out whether the issues arising from the literature were substantiated in current practice.

Furthermore, the researcher also believed that some of the ideas raised could not be applicable in this situation, for example, the idea of teachers failing to explain concepts. This was because almost all the mathematics teachers in the mathematics department at the Senior High School schools were professional teachers, well experienced and had the necessary qualifications to teach mathematics. Also, the quality control measures at the school were high. The researcher also noted with great concern the idea of teachers who held unrealistic expectations on their students thereby heaping a lot of pressure on them. Such mathematics teacher who viewed mathematics as one of those unpleasant facts of life constantly influences the students not to like mathematics but just to do it. In this case, the teacher does not value mathematics, and surely one would expect the students to do the same. Such teachers send the wrong message to the students as students are likely to develop a negative attitude about

mathematics learning and certainly cannot be expected to perform well in the subject. Students do not want to do a subject that the teacher seems uninterested or uncomfortable with.

2.3.6 Negative mathematics games people play

The most negative words we say in our minds are mind games, which have gone a long way in projecting our fear and hatred for mathematics. These talks are harmful to our thinking and can easily lead to loss of self-confidence in mathematics, which is one of the most important aspects of achieving success in mathematics. Statements such as, "I was never good in mathematics, so I can't be good now." "Why do I need mathematics anyway?" or "Everyone knows how to do it except me" etc. are very common among students (Oluwaseun, 2014).

2.3.7 Cultural myths and stereotypes

In our society today, the community holds certain false beliefs regarding mathematics. When students read or listen to such fallacies, which had no basis in reality, it obviously affects or even stops them from progressing in mathematics. Some of such statement includes, "Do you believe that you must have a 'mathematics mind' or be a mental giant to succeed in mathematics?" or "Do you believe that only men are good in mathematics?" or "That careers requiring mathematics are mainly for men." Most parents also discouraged their children about mathematics by telling them they were never good at mathematics when in school but are successful in life (Oluwaseun, 2014).

There was a relationship between mathematical anxiety and performance in mathematics. However, Hembree (1990) suggested that there is little evidence that poor performance causes mathematical anxiety or even that Intelligence Quotient (IQ) was a determining factor. In support of this idea, Jansen, et al. (2013) implemented a

program that adapted to the student. The program gave some students problems that they would answer with high accuracy, and others with much lower accuracy. There was no significant difference in the groups' anxiety levels at the end of the study. The aversion and anxious thought patterns might have been built up over time. However, it does not appear that high levels of success have a significant effect on anxiety according to Jensen's et al. study.

Hembre (1990) again found evidence that mathematical anxiety relates to general anxiety. This implies that rather than attempting to get rid of mathematics phobias, it may be more fruitful to use generalized anxiety approaches with students. If this is the case, techniques such as cognitive therapy could become primary in treating a student with mathematical anxiety. Hembre's study further indicated that reducing mathematical anxiety also improves mathematics performance, implying a causal relationship.

Hamamunda (2016) in his studies identified four factors as common causes of mathematical anxiety among learners and these are classroom practices and activities, societal influences, assessment practices, and personal factors. However, he believed that there was no single cause of mathematical anxiety but a variety of causes.

2.3.8 Teacher ability and confidence

The teacher may also be considered the primary source of mathematical anxiety. The teacher was responsible for introducing the student to new mathematical material and evaluating the student's mastery and understanding of the material. The teacher's attitude and approach were crucial in developing the student's interest or dislike for mathematics.

Schwartz (2000) suggested methods to address mathematical anxiety in the classroom. He proposes that preventing and overcoming mathematical anxiety begins with teachers and teaching strategies that developed positive and realistic self-concepts. When teaching mathematics, the teacher needs to put himself/herself in the students' place to remember how intimidated some of these students might feel about learning mathematics. This according to Schwartz (2000), may help reduce the development of mathematical anxiety caused by the teacher.

The mathematics teacher can have a great influence on a student's mathematical anxiety. Lazarus (1974) cited in Bush (1991) stated that mathematical anxiety resulted from poor instruction and poorly designed mathematics curricula. Besides, enthusiasm toward a subject had a greater impact on student attitudes than instructional variables. Teachers with mathematical anxiety transferred their anxiety to the students (Bush, 1991). By altering the approach to the subject matter, the attitude towards the student, the atmosphere in class, and the attitude towards the course, a teacher may be able to reduce the mathematical anxiety in the student.

When teachers cannot explain a mathematics concept in-depth, lacks the patience necessary to teach a student with varying degrees of performance levels, have little to no joy for teaching the subject, and frighten their students into submission behaviourally, they are often responsible for creating students with the highest degrees of mathematical anxiety (Blazer, 2011). Teachers need to feel confident in their abilities to plan, teach, and answer questions about various mathematics lessons. Fiore (1999) was of the view that mathematically confident teachers showed compassion for their students, cared whether or not learning was taking place, and motivated students to work harder to learn. The power that teachers posed over student successes and failures was also responsible for affecting self-esteem.

Chapline and Newman (1984) suggested that teachers need to be responsible by increasing their mathematics content knowledge, developing their confidence in teaching mathematics, and finding ways to show how mathematics can be useful by providing appropriate tools for students to use in the real world. Additionally, increased reliance on state testing has been responsible for the high negative emotions that students and teachers had towards mathematics, thus increasing the prevalence of students with mathematical anxiety (Blazer, 2011).

According to Beilock and Willingham (2014), targeting pre-service teachers with specific training on mathematics concepts and how to address them will help reduce mathematical anxieties in these instructors. Furthermore, Blazer (2011) suggested that teacher training should be focused on shaping positive teacher attitudes towards mathematical concepts and skills. This could be accomplished through the teaching of teacher best practices and workshops centred on informing teachers about how mathematical anxiety can affect achievement. If mathematics instructors had mathematical anxiety, the consequences could be disastrous for students and their mathematics achievement.

College students in teacher preparation programs typically had few mathematics requirements, which would assume that more mathematics training was necessary for educators to reduce their anxieties (Beilock, Gunderson, Ramirez, Levine, & Smith, 2010). Training needs to take place because once mathematical anxiety has taken root within a person, those negative attitudes become difficult to change, allowing that negativity to continue into adulthood (Newstead, 1998).

2.3.9 Individual confidence

Stuart (2000) compared the learning of mathematics to playing a sport and released that Mathematics is 90% mental, or how the student perceives their confidence, and only 10% physical, which is how the student perceives their competency level while performing mathematics. Teachers need to find methods of increasing students' confidence to ensure they can experience success. When a person has low or no self-confidence in their own beliefs, an obstacle to learning takes place due to the idea that beliefs govern action (Dodd, 1992). Fincham, Hokoda, and Sanders (1989) defined learned helplessness as the ability to not place the blame of failures on the amount of effort that students put into their work, but rather place blame on the teachers, parents, lack of time, extracurricular activities, and other factors that begin to develop around the middle school years when students become better conversant with who they are.

When students have strong, positive motives to achieve, situations will be approached with a better attitude and by more creative means; however, when students carry negative feelings into the mathematics classroom, situations will be approached with thoughts of failure or humiliation (Green, 1990). High levels of mathematical anxiety negatively impact the part of the brain responsible for reasoning and emotional regulation causing it to slow down and ultimately hinder student success (Young, 2013).

Students' beliefs and attitudes towards mathematics can be shaped by the beliefs held by their teachers. Interactions between students and teachers greatly influence a student's abilities, weaknesses, strengths, and mathematical journey (Forgasz, 1995). When educators can change mathematical anxiety into mathematical confidence, students receive not only an emotional boost to their self-esteem, but teachers can make major professional gains by finding a way to bridge the gap between academic

achievement and mathematical anxiety (Ma, 1999). Mathematics self-efficacy, as described by May (2009), is a student's feelings about how well they do in mathematics. Further, their self-efficacy is closely tied to motivation, previous successes or failures in mathematics, and the type of mathematics problems they are confronted with. Consequently, students consistently estimate their abilities inaccurately. While some overestimation in abilities is needed to keep students persevering in mathematics, these overestimations, or even underestimations, can be detrimental to achievement. In a study conducted by May (2009), 57% of students were found not to have overestimated what they were able to do mathematically and 20% underestimated just how much mathematics content they could master.

There are many factors which contribute to mathematical anxiety, which have led researchers to develop several different tests designed to measure the level of mathematical anxieties in students and adults. Over the past sixty years, these tests have been adapted for different audiences to look for gender, socioeconomic status, and academic variables to predict which students at-risk for developing mathematical anxiety; however, the overall goal of these measures was to look at how mathematical anxiety affects mathematical achievement (Wu, Barth, Amin, Malcarne, & Menon, 2012). The following section will outline these different tests and describe the intended audience.

Literature identified personal factors such as reluctance to ask questions due to shyness, self-doubt, student's attitude, lack of persistence, low esteem and lack of confidence (low self-efficacy) in mathematics ability, lack of perceived usefulness of mathematics, viewing mathematics as a male domain and the dropped stitch- concept are likely to cause mathematics anxiety (Cemen, 1987; Gutbezahl, 1995; Levine, 1995; Tobias, 1993).

Mathematical anxiety is also believed to stem from the student's inability to solve problems. Tobias (1987) stated that some believe that people experience mathematical anxiety because of inadequate preparation and as such these students do not study regularly and hence can easily panic when given a mathematical situation. The fact that some students believe that mathematics is a very abstract subject adds to this cycle. Puteh, (2002) noted that there are students who believe that mathematics is a measure of their intelligence and are embarrassed by their inadequate performance. Thus students could be concerned that their academic outcomes will impede their future.

Research has also unearthed students who are troubled by abstraction anxiety which stems from more abstract topics taught in the middle classes (Ferguson, 1986). Research has also found that mathematics anxiety can be related to poor self-concept caused by previous results of failure, previous experiences in a student's mathematics history which was embarrassing. However, Hembree (1990) suggests there is little evidence that poor performance in mathematics causes mathematical anxiety or even that IQ is a determining factor. Russell (2008) failure experiences in mathematics and fear of future failures as the major contributing factor to mathematical anxiety and fear for mathematics. This could explain the reason why some people have a poor self-concept and people end up believing that no matter how much effort they make they will not be able to do it in mathematics hence pupils end up avoiding mathematics or not studying regularly. In short, research results on gender and mathematical anxiety have not been consistent since they often report mixed results. Researchers have found that there is a significant relationship between mathematical anxiety and gender since the girl's experience of mathematical anxiety is higher than that of boys (Sahin, 2008; Woodard, 2004). However, this finding contradicts the research findings that

concluded that there is no relationship between mathematical anxiety and gender (Marsh, 2004). Also, studies by Rexses (1995) did not detect any significant gender differences in mathematical anxiety among elementary school students.

Confidence in mathematics, can either make or break a grade (Mackenzie, 2002). Further, she pronounced that confidence levels are low in mental calculations, fractions, and geometry. Casey, Nuttall, and Pezaris (1997) also stated that self-confidence in mathematics can be attributed to lower achievement among gender and other factors. Furthermore, some students have repeatedly performed poorly, leading to a loss of self-confidence and increased tension. Clute (1984) says that the amount of confidence required on the student's part to learn the mathematics concepts was partially determined by the instructional method and he concluded that there was an interaction between mathematical anxiety and confidence. On the other hand, Ashcraft and Kirk (2001) believe that intrusive thoughts and worries about completing mathematics problems may interfere with working memory and so they cannot excel or perform well.

According to Tobias (1993), situations such as a student being absent from school for an extended period and missing the initial discussion of a key mathematics concept or a teacher being absent for an extended period could create stitches in learning. Farrell (2006), described this stitches as a gap in a student's prior mathematics learning that prevents more advanced concept learning and can arise when students miss learning access to particular concepts due to different reasons such as shifting schools, illness, or other related reasons. Foong (1987) concurs and reinforced this point by stating that due to the subject being cumulative and sequential when students missed out something along the way, it is likely that they may never fully comprehend it. Such situations might explain the reason for low achievement in mathematics and ultimately

the beginning of mathematical anxiety. However, the researcher feels that further studies are necessary to re-confirm this claim and thus the need for this research study.

2.3.10 Assessment practise

According to Shields (2006), poor test scores and too much emphasis on timed tests propagates mathematical anxiety. Thus poor performance in mathematics has been linked to an increase in mathematical anxiety (Furnner & Duffy, 2002). Students may experience mathematical anxiety because they have never experienced success in their mathematics classes. Research shows that this can be as a result of poor instruction or very difficult tests set by the teacher. Research findings from the Mathematics Anxiety Rating Scale Abbreviated (MARS-A) by Johnson (2006) to investigate the prevalence of mathematical anxiety among Algebra 1 students in an urban, Midwestern high school showed that more than half of the students experienced mathematical anxiety, which is mostly associated with writing a test.

Moreover, Beilock (2008) discussed how timed assessment tasks, which are a very common part of mathematics courses, can lead to higher levels of anxiety in students. Since the research was done in an urban setup, the setting of the research study is almost similar. And the researcher would want to investigate whether the causes of anxiety in Algebra 1 are similar to the causes of mathematical anxiety since Algebra is an integral component of mathematics. In New Zealand, mathematics educators are encouraged to incorporate a wide range of assessment practices that support students' learning. However, research has shown that implementing effective assessment for learning practices is challenging. Written tests, in particular, are often the primary source for students' anxiety (Shields, 2006). Other types of assessment that might also contribute to mathematical anxiety are timed assessments or activities within competitive environments. Since this research was done in New Zealand the

researcher would like to investigate whether timed tests and examinations could be a source of mathematical anxiety among our students in Ghana.

In a study by Chinn in 2009, taking the end of term examination was ranked the highest in anxiety-provoking among those interviewed followed by waiting for scores on an examination and taking a written mathematics test. As soon as a mathematics examination is mentioned, students begin to panic. The student combines the fear of not succeeding on the test, the uncertainty of being able to do the problems, and the urgency to get it done in time and this is likely to cause mathematical anxiety. Time is the other factor which was raised by most students to cause mathematical anxiety. Time affects students when they know that they will be having a test shortly. This delay in time causes fear to set in. There is a gradual approach of an undesirable event which one knows he/she cannot avoid, so one begins to panic. In a study conducted by Tsui and Mazzocco (2007), it was found that students with a higher level of mathematical anxiety performed better on an administered untimed test than when administered with a timed test. Thus the researcher would like to know if there are any similarities with the Ghanaian Senior High School students since timed tests and examinations are common features in our examination system.

The National Council for Teachers of Mathematics (1989) encouraged the use of assessment strategies that seek evidence supporting the students' ability to express mathematical ideas by speaking, writing, and visual depiction. More recent publications suggest that because mathematics is often stated in symbolic terms, the use of oral and written communication about mathematical ideas is not recognized as an important component of mathematics education (NCTM, 2000). Mathematics has long been viewed as strictly a quantitative subject. Research findings confirmed that the pressure of timed tests and risk of public embarrassment had long been recognized

as sources of unproductive tension among many students. Three practices that are a regular part of the traditional mathematics classroom and cause great anxiety in many students are imposed authority, public exposure and time deadlines.

2.4 Symptoms of Mathematical Anxiety

Mathematical anxiety can be demonstrated in many dissimilar ways. One way could be the inability on the part of the student to solve mathematical problems. A student may exhibit bad attitude about mathematics by being jumpy and unable to sit well or focus in mathematics class. Most students with mathematical anxiety fear taking more advanced mathematics classes (Hsiu-Zu, 2000). Students with mathematical anxiety may also feel embarrassed, irritated, frustrated and fearful (Buxton, 1981). Students who experience mathematical anxiety are more likely to delay completion or not do tasks assigned to them at all. As an irritative fear towards mathematics studies, mathematical anxiety hinders learners' positive thinking about mathematics learning. This fear causes low self-esteem, disappointment and academic failure of students in mathematics (Paul & Hlanganipai, 2014).

Marshall, Mann, and Dan (2006) identified and describe five signs and symptoms of mathematical anxiety namely:

- Anxiety: Appearing generally anxious especially when having something to do with mathematics examination.
- Panic: Feeling of helplessness that will not go away.
- Paranoia: Believing that they are the only person not capable of doing mathematics.
- Passive behaviour: Feeling there is no point in trying or wanting to quit and go home.

- Lack of confidence: Do not know where to start or expect never to know the answer to questions.

These signs led to some taught that occurs in the brain when someone experienced mathematical anxiety. Some of these mathematics phobias taught are:

- " I just can't think about mathematics" (Young, Wu, & Meno, 2012). According to Young et al. (2012), mathematical anxiety eats away ones working memory because the brain is too busy worrying about mathematics rather than doing mathematics which makes mathematics seem harder than it is.
- "I can't get started or I just can't switch onto mathematics" (Pletzer, Kronbichler, Nuerk, & Kerschbaum, 2015) Mathematical anxiety prevents the brain from switching off, making it hard to focus on mathematics. In this situation, one does not know where to start solving a mathematics problem from (Pletzer, et al., 2015).
- "Mathematics hurts my brain" (Lyons & Beilock, 2012). Lyons and Beilock (2012), in their study, found out that thinking about mathematics activates the regions of the brain associated with pain whereas doing mathematics does not activate these pain regions.

Mathematical anxiety also has some physical, psychological, and behavioural symptoms which include: increased heart rate, clammy hands, upset stomach, lightheadedness, inability to concentrate, feelings of helplessness, worry, disgrace, avoidance of mathematics classes, putting off mathematics homework until the last minute, and not studying regularly in mathematics class (Mission College, 2009; Plaisance, 2007; Woodard, 2004 as cited in Christie, 2011). Students with mathematical anxiety are likely to experience no success in their mathematics classes. Therefore,

teachers' understanding of the magnitudes of this problem, and their ability to identify all or some of the signs and symptoms of mathematical anxiety among his or her students activate the urgency in assisting the students to overcome their mathematical anxiety.

2.5 Mathematics Teaching Anxiety

Mathematics teaching anxiety is a frequent fear of some teachers. It may reflect real or comprehended knowledge shortfalls in mathematics content as well as in mathematics teaching skills and memories of past occurrences of mathematics failure or anxiety. Mathematics teaching anxiety could be attributed to prior school experiences such as experiences as a mathematics student, the effect of prior teachers, and teacher training programs (Peker, 2009).

Peker (2009) defined mathematics teaching anxiety as a feeling of tension and anxiety teachers experience when teaching mathematical concepts, theories, formulas or problem-solving. It is a commonly experienced fear among most teachers. Mathematics teaching anxiety of a teacher relates to insufficient content knowledge and previous unpleasant mathematics learning experiences (Levin, 1996 as cited in Peker & Ertekin, 2011). Also, Levine (1996) as cited by Peker and Ertekin (2011) observed that high levels of mathematics teaching anxiety decreased when the teacher had access to concrete materials while it increases when the teacher engages in abstract discussions. He argued that teachers who suffer from mathematics teaching anxiety are lacking in learning how to teach mathematics and create mathematic learning materials as pre-service teachers. Levin further suggested based on his findings that some elements that stir mathematical anxiety might also cause mathematics teaching anxiety and that the two concepts might be linked.

Moreover, good teaching strategies, methods, and techniques subdue a strong influence on teachers' mathematics-teaching anxiety.

2.6 Mathematical Anxiety and Academic Achievement

Academic achievement in mathematics is a major concern of educational organisations across the world. In mathematics, just like other subjects, people have different learning abilities. According to Pajares and Miller (1995) and Lou, et al., (2009), learning mathematics is about a student's emotional state. They further mentioned that students who feel a high level of anxiety about mathematics will lower their success in the subject.

Defining high mathematics achievement and low mathematics achievement in our current educational setting is difficult. Grades are used as criteria to define mathematics achievement in our Ghanaian Education System. O'Conner (2009) pointed out that grades need to be consistent, accurate, meaningful, and support learning. These grades need to express information useful to all stakeholders and show evidence of achievement. For this study, the researcher defined high mathematics achievement as scores in 60% to 100% range and low mathematics achievement as scores below 60%.

Cheema and Galluzzo (2013) used a multiple regression framework to predict mathematics achievement from different variables (gender, mathematics anxiety and mathematics self-efficacy). According to their findings, when mathematics self-efficacy and mathematical anxiety are properly controlled, students tend to attain high mathematics achievement despite their gender. Research had found that mathematical anxiety associates significantly with mathematics achievement (Pajares & Miller, 1994; Remirez & Dockweiler, 1987; Wigfield & Meece, 1988). Also, other findings have shown that mathematical anxiety has a negative correlation to students' performance

on tests of mathematics achievement, grades in mathematics, plans to enrol in advanced high school mathematics courses, and selection of mathematics-related college majors programmes of study (Armstrong, 1985; Betz, 1978; Richardson & Woolfork, 1980; Sherman & Fennema, 1977; Wigfield & Meece, 1988).

Gierl and Bisanz (1995) surveyed students in grade 3 and 6 by using mathematical anxiety survey and collected the results of an achievement test in mathematics from school records. They found that correlations between mathematics achievement and mathematical anxiety were moderate and negative for students in both grades. Students' mathematical anxiety accounted for a small but significant portion of the variability in mathematics achievement in grade 3 and grade 6. Moreover, mathematics problem-solving anxiety tended to account uniquely for more variance on achievement tests than in mathematics test anxiety.

In a meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics, Ma (1999) examined 26 students on this relationship among elementary and secondary students. The correlation coefficient for the relationship is significant ($r = -.27$). A series of general linear models indicated that the relationship is consistent across gender groups, grade-level groups, ethnic groups and anxiety measuring instruments. However, the relationship differs significantly among instruments measuring achievement test since it reported a relationship of significantly with smaller magnitude than researchers using mathematics teachers' grades and researcher-made achievement tests (Ma, 1999).

Mathematical anxiety is usually associated with mathematics achievement individually but not necessarily collectively (Ma, 1999). For instance, research had indicated that the relationships between mathematical anxiety and mathematics achievement may not

be significant after controlling for previous mathematics performance (Dew, Galassi, & Galassi, 1984). Even though the direct effects of mathematical anxiety tend to be relatively small, it has been suggested that mathematical anxiety may have several important indirect effects on the individual. For example, anxious individuals may avoid mathematics classes, may be more likely to have negative attitudes about computers, and mathematics-related activities such as statistics (Adams & Holcomb, 1986; Betz, 1978; Gressard & Loyd, 1976). Engelhard (1990) examined the effects of mathematical anxiety on mathematics achievement after controlling for previous performance, mother's education and gender. His results indicated that mathematical anxiety had a significant effect on mathematics achievement after controlling for the effects of previous mathematics performance, mother's education, and gender. A significant inverse relationship between mathematical anxiety and mathematics achievement was evident. The effects on mathematics performance of gender, mother's education, and previous achievement were also statistically significant. The overall model accounted for approximately 66% of the variance in mathematics achievement.

2.7 Effects of Mathematical Anxiety

Mathematical anxiety can adversely influence students' attitudes toward learning in several ways. It can affect how students do their homework, participation in group study and the classroom. Students with higher anxiety may have difficulties starting or completing their homework and other mathematics tasks such as projects. Doing homework reminds students of their learning problem in mathematics. It also reminds them of their previous mathematics failures that cause further anxiety. This anxiety leads to the development of avoidance or procrastinating of homework behaviour. Mathematical anxiety also affects classroom participation when students are afraid to

speak out in class and ask questions. This makes learners sit in class fearful of being asked a question, looking like they understand the lesson to avoid being called by the teacher. They also take many notes even though they do not understand the lesson. Mathematical anxiety students avoid doing additional mathematics outside the classroom (Nolting, 2002).

Lyons and Beilock while anticipating the work of doing mathematics observed increased activity in parts of the brain related to intuitive threat and pain, which had a direct correlation with Short Mathematical Anxiety Rating Scale (SMARS) results. Therefore, despite no danger of significant harm from doing mathematics, some students seem mentally influenced as though they are (Lyons & Beilock, 2012). Through cue-based mechanisms, Lyons and Beilock (2012) determined that anticipation, but not the actual performance of mathematics caused these responses. This gives a neural explanation of why some students avoid mathematics subjects despite the career advantages for taking them. In addition to this intuitive consequences, Maloney (2012) pointed out that the worrying thought took up mental resources that should be directed toward mathematics. It is uncertain how connected the emotion and thoughts related to anxiety are and to what extent they appear in tandem with one another. Witt claims, "The anxious reaction causes a fall in central executive working memory functioning, something that has been shown in many studies to underpin successful mathematical processing" (Witt, 2012, p.272). However, it is commonly known that anxiety influence a student's decisions about what classes to take, often leading to avoidance of mathematics (Maloney, 2012) and this can radically alter a person's career path. As Tobias (1993) observed, when you eliminate mathematics from your curriculum, it automatically shuts you off from being successful in most university majors, significantly narrowing a student's options.

Mathematical anxiety affects students' achievement and attitude toward mathematics (Hembree, 1990). It may lead to poor performance and avoidance of mathematics. Many people think of mathematics as a punishment or something that induces stress (Zaslavsky, 1999 cited in Paul & Hlanganipai, 2014). Mathematical anxiety affects how students feel and behave. Students' severe anxiety may lead to mathematics phobia while for others it may lead to improved achievement. Mathematics avoidance results in less competency, exposure and mathematics practice, leaving students more anxious and mathematically unprepared to achieve (Ashcraft, 2002 cited in Paul & Hlanganipai, 2014). Students who have had bad experiences learning mathematics often develop this phobia and, in turn, struggle to learn various concepts because they feel they are unable to do the mathematics.

2.8 Some Interventions for Mathematical Anxiety Reduction

Preis and Biggs (2001) recommended the use of stress management techniques and positive thinking as initial steps to reduce mathematical anxiety. Also, successfully solving mathematics problems perceived as easy can break the cycle of mathematical anxiety by providing a positive experience. This approach, however, places the burden for reduction of mathematical anxiety on the student. In contrast to Briggs and Preis (2001), the majority of the literature offers suggestions for teachers to reduce mathematical anxiety.

Rossnan (2006) recommended that teachers should take proactive measures to show the usefulness of mathematics outside the classroom and to establish short-term goals that students can achieve, which breaks the cycle of poor performance and the initial stages of mathematical anxiety. The emphasis on establishing relevance and usefulness of

mathematics in students' which lives outside the classroom was also noted by Zaslavsky (1999) as an important technique for reducing mathematical anxiety.

Stolpa (2005) points out that introducing each new topic with a real-world problem, whose context brings the mathematics to the students' world, rather than dragging the student into an abstract, imaginary world of mathematics is a more valid approach since the rationale for developing the concept is built into the lesson. Imagine a mathematics classroom where the students are not wondering, "Why do we need to know this?" This natural cognitive process of developing a useful strategy for a specific case and then validating it with an appropriate generalization establishes and reinforces the mental connections which promote deeper understanding. Stolpa (2005) advocates against this instructive tradition, advising teachers to design solutions with students instead of for students, and upon arrival at the solution, taking explicit time to examine the path taken to it. This approach calls for students to individually inspect previous knowledge, construct personal and meaningful connections, and consistently evaluate and re-evaluate what has been learned. The idea is that students will be less likely to feel anxiety if they feel they are charting their course through the world of mathematics.

Godbey (1997) suggested that teachers should be aware of the level of abstraction they present in mathematics instruction based on the perceptions and cognitive developmental stages of students. Besides, teachers should attempt to communicate enthusiasm for the subject. Cavanaugh (2007) also indicated that a positive attitude of teachers towards students' difficulty with understanding mathematics concepts is a critical factor for overcoming mathematical anxiety. Scarpello (2007) also recommended that teachers should use effective instructional practices to reduce mathematical anxiety, but did not discuss specific practices that may be considered effective. One study found a significant reduction in anxiety levels of college algebra

students during testing simply by playing soft music in the background (Haynes, 2003). Rossman (2006) sums several researchers' findings and noted three areas that cause great anxiety in many students. These areas were imposed on authority, public exposure, and timed deadlines. She indicated that teachers can lessen the effects of mathematical anxiety by ensuring instructions are clearly stated, avoiding situations that focus on students' misunderstandings, and removing unnecessary time constraints.

Stolpa (2005) proposes that, whenever possible, questions should be met with another question modifying the teacher's role from the all-knowing transfer of knowledge to collaborator and colleague. Woodard (2004) recommended the use of mathematics tests that include justification of the processes involved in arriving at an answer to allow teachers to give partial credit for a correct understanding of the process even if the result is incorrect. He points out that the assessment process for mathematics should be more flexible and include the use of oral questioning and computing devices to accommodate students with different learning styles. Zaslavsky (1999) also indicated that the use of mathematics assessments with no right or wrong answer is beneficial for reducing mathematical anxiety because it reduces pressure on students to obtain the correct answer, allowing the student more opportunity to think freely about a situation and explore alternative solutions. In contrast to Woodard (2004) and Zaslavsky (1999) who advocated altering the mathematics assessment procedure, Cavanaugh (2007) suggested that mathematics teachers should assist students with developing skills to overcome their anxiety in testing situations. This perspective was based on the assumption that regardless of the assessment approach used by an individual teacher or in a school system, many students will eventually have to take a traditional timed multiple-choice mathematics test. To prepare students, teachers should practice taking short versions of this type of tests with students followed by an extensive discussion of

the processes necessary to obtain the answer. This instructional approach, however, is not widely advocated in the literature. Tobias (1993) suggested that a specialized course or clinic is necessary to assist students to overcome severe mathematical anxiety issues. The purpose of the clinic is to provide students with thinking skills. The approach asks students to solve a mathematics problem, followed by extensive peer conversations about their thoughts and emotions during the problem-solving process. The approach is also intended to encourage students to be creative in their approaches to solving mathematics problems. This type of intervention to overcome mathematical anxiety is suggested to be more useful among older students.

2.8.1 Pedagogical interventions

Johnson and VanderSandt (2011) indicated that learning programs can have markedly different effects on anxiety based on the type of student involved in them. In their study, it appeared that additional content and pedagogy classes could have a positive effect on the anxiety and confidence levels of learners. However, this was highly contingent on the subgroup they started in. In general, the subgroups with the most desirable initial traits seemed to gain the most benefit. They stressed that there should not be a 'one size fits all' mentality.

Most students experience mathematical anxiety when teachers do not use appropriate teaching strategies. Some of which include; letting students work in a group in class, giving students working partner in class and outside of class, discussing experiences or difficulties related to mathematics with other students in the class, asking questions in class, and individually reminding oneself of being mentally capable (Sutter, 2006 cited in Ayagikwaga, 2014). A teacher's feeling to stress on only one method of solving a mathematical problem is a likely cause of anxiety. Barnes (2006) revealed that students make several suggestions as to how to reduce mathematical anxiety. They feel teachers

should raise students' confidence in their mathematical abilities, teachers should teach students to develop study habits, as well as move round in the classroom to help students with difficulty and answer questions students ask for clarity. Teachers' should also provide more hands-on activities during mathematics class.

2.8.2 Cognitive and behaviour therapy interventions

Hembree (1990) identified three categories of intervention for mathematical anxiety as, classroom intervention, behaviour therapy, and cognitive therapy. In classroom intervention, students appear to benefit from corrective feedback and highly structured mathematics courses. Aku and Sygi (1988) as cited in Wei (2010) tested the effect of corrective feedback on mathematical anxiety and their result indicated that corrective feedback on quiz papers has a significant positive influence on mathematical anxiety.

According to Norwood (1994), as cited in Wei (2010), high mathematics anxious students are more comfortable in highly structured mathematics courses. Preis and Briggs (2001) as cited in Wie (2010) also argued that poor teaching can be one possible source of mathematical anxiety. They continued to say that learners with mathematics fears need instructors who are patient and encouraging. They need instructors who can help them gain self-confidence in doing mathematics and who can help them come to believe that they are capable of learning mathematics.

Classroom interventions were not particularly effective at reducing mathematical anxiety. Wei (2010) then identify accommodating various learning styles, making mathematics relevant, providing positive mathematics experiences and classroom atmosphere, modelling problem solving and logical thinking in instruction, using instructional games that require original thinking as other anxiety-reducing strategies. There was a moderate success in using cognitive therapy to correct negative

beliefs. There was the most significant drop in anxiety when using systematic desensitization techniques (Hembree, 1990). This seems to confirm Lyons and Beilock (2012) study indicating that mathematical anxiety is primarily caused by the anticipation of mathematics. It is likely that by desensitizing students' to mathematics, the anticipatory response no longer has the same dramatic effect on the students.

Cognitive-behavioural therapy stresses the relationship between thoughts, behaviours, and emotions and aims to help students' to positively cope with their worries (Dugas and Robichaud, 2007 cited in Wie, 2010). Cognitive-behavioural therapies such as cognitive restructuring, relaxation training, anxiety management training, situational exposure, and systematic desensitization are effective methods for treating general anxiety disorder (Gould, Otto, Pollack, & Yap, 1997 cited in Wie, 2010). In addition to that, Dugas and Robichaud (2007) developed a systematic cognitive-behavioural treatment for anxiety disorder as:

- help students to be aware of their anxiety,
- develop a greater tolerance for uncertainty and
- encourage students to approach problematic situations rather than avoiding them.

Karimi and Venkatesan (2009) introduced one of the more recent examples of a cognitive therapy study. Their results were encouraging, as there was a significant improvement in the experimental group compared to the control group. However, their results are hampered by not specifying what cognitive behaviour therapy they introduced exactly, making the results rather unclear. Also, part of the project involved desensitizing mathematics problems. This part of the program seems like perfectly effective work but makes it harder to determine if it was the cognitive therapy that

contributed to the gains or merely more exposure to relevant material. This is an adequate start, but more research must be done before determining the effectiveness of behavioural therapy from modern psychology.

In addition to these larger-scale therapy interventions discussed, some simple techniques from modern psychology have shown assurance for students with high mathematical anxiety. Simply having a student write down their worries and concerns about their mathematics class can alleviate some mathematical anxiety (Maloney, 2012).

2.9 Summary of Reviewed Literature

The literature shows that mathematical anxiety is a complex and long-standing problem in mathematics learning. Students who suffer from mathematical anxiety usually doubt their ability to do mathematics, avoid taking mathematics courses and limit their career choices to areas that do not require mathematics skills. The literature reveals that beliefs, learning environment, and anticipatory response are prevalent causes of mathematical anxiety among Senior High School students. These three variables are probably interwoven and strengthen one another. Beliefs might include negative stereotypes about students' demographic variables such as gender or age. Cognitive restructuring of beliefs could be a partial solution to that condition. Also, research finding indicates that the intuitive physiological effect of anxiety happens while anticipating mathematics. The researcher would assume that cognitive systematic desensitization as identified by Hombree (1990) works to reduce that effect. While certainly incomplete, these seem to be the most significant causes and remedies of anxiety in the literature.

Much more study needs to be done on mathematical anxiety because its effect on students can be intense. The research done on cognitive and behavioural therapy is especially scant and potentially productive. If such therapy is proven successful, then a method of affordably and practically reproducing the effects must be sought after. Besides, the researcher would like to see more innovations that could bring more of the people to the realization that mathematics can be an attractive and interesting subject.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the methodology for the study and comprises the research design, population, sampling procedure and sample, research instruments, validity and reliability of the instrument, piloting test of the instrument, data collection process, data analysis procedure, ethics considerations for the study and how the study contributes to existing knowledge.

3.1 Research Design

The study used a mixed-method approach and survey design. Selecting an appropriate research design depends greatly on the nature and scope of the research, the research problem(s) and question(s) to be addressed, personal skills of the researcher, and the type of participants for the study (Creswell, 2014). According to Kothari (2004), "research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure" (p. 31). Moreover, a research design also opt to address the statements such as what the study is about, why should the study be carried out, where should the study be carried out, what type of data is required for the study, where can those required data for the study be found, what periods will it take to do the study effectively, what will be the sample design for the study from whom data will be collected, what data collection techniques be appropriate to use, how will the data be analysed and in what style will the report be prepared and presented? (Creswell, 2014; Kothari, 2004).

VanderStoep and Johnson (2008) asserted that a survey is the best way to collect a large amount of data from a population in a short time. It is a research design in which the researcher administered questionnaires or interviews' to sample or the entire population of people and statistically analyse the data to describe the attitudes, opinions, behaviours or characteristics of the population (Creswell, 2014). The study is investigative in which the major emphasis is on gaining ideas and insights. Moreover, the overall goal of this study fits well with the general intention of the investigative aspect as it sought to identify the nature and prevalent causes of mathematical anxiety and its relationship with Ghanaian Senior High School students mathematics achievement in academic settings that can be used to conduct further research.

Also, the term 'mixed methods research' is broadly accepted to refer to research that integrates both quantitative and qualitative data within a single study (Wisdom, et al., 2017). The key aspect of this definition is the 'mixing' of the quantitative and qualitative components within the study (Maudsley, 2011; Simons & Lathlean, 2010). According to Johnson and Onwuegbuzie (2004), mixed methods research is "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts, or language into a single study" (p. 17). A mixed-method is also defined as a procedure that utilizes both quantitative and qualitative methods for collecting and analysing data, integrating the findings, and drawing inferences in a single study (Tashakkori & Creswell, 2007).

The rationale for combining two types of data is that quantitative or qualitative research, each by itself, is insufficient to understand the trends and details of situations (Creswell, 2014; Ivankova & Stick, 2007), such as students experiencing mathematical anxiety while in school. The mixed-method design counterbalances the weaknesses of both quantitative and qualitative research and provides additional evidence for

examining a research problem (Creswell & Clark, 2011). This method is appropriate for this study as it offers a practical approach to addressing research problems and questions because these problems and questions are examined in different ways, and also allows the generalization of findings to a larger group, as well as ensuring that participants' (i.e., students) voices are heard.

3.4 Population of the Study

The population of the study comprised all Senior High School students in Agona West Municipality second cycle institutions. It comprises 1,750 students who were not pure (general) science students or offering elective (additional) mathematics. To get the population for this research study, the researcher made use of the student's end of year examination performance in mathematics and followed up to their various programme of study list and found out that majority of the students who do not offer elective mathematics and mostly from the non-science department had low performance in the examination. To justify why the researchers used this sample, a study by Cates and Rhymer (2003) found that students with higher levels of mathematical anxiety had considerably lower computational fluency in all areas of mathematical computations and these students, in turn, had low levels of achievement in mathematics and chose to diverge their programmes of study.

3.5 Sampling procedure and Sample

The population was selected using purposive sampling procedure. Creswell (2014) describe purposive sampling as the sampling method in which the researcher intentionally select participants and sites to engage in a study. This geographical setting was selected mainly because this is where the researcher is currently located and would like to improve their mathematics achievement. Further, as a result of the economic and

social conditions of the researcher, the strong relations of the schools in this setting with the researcher represented good conditions for this proposed study. Also, the research to attain reliable outcome limited the study to Senior High School students in all second cycle institutions in Ghana. This level was chosen because although research indicated that mathematics anxiety starts from primary (Vukovic, Kieffer, Bailey, & Harari, 2013) the researcher noted it severances and also a sharp decline in mathematics achievement at that level affecting their choice of a carrier from that level onwards.

The sample size for the study is 300 students from four public schools (see Table 1).

Table 1

Sample size

Schools	No. of Non-Science students in form 3	Sample size
A	500	115
B	50	13
C	675	155
D	75	17
Total	**1300**	**300**

Gorard (2003) as cited in Cohen et al. (2013) suggests that survey study which contains much likely variability increases the sample size. Moreover, Singh and Masuku (2014) were of the view that where random sampling is used, the sample size needed to reflect the population and the amount of heterogeneity in the population. Further to this Cohen et al. (2013) recommended that confidence level and confidence interval should be considered in determining sample size for a probability sample rather than only considering the population size. They came out with a table of sample sizes for a probability sample (see Appendix C) which was consulted in selecting the sample size for the study from the population.

Besides, a simple random sampling technique was used in selecting the sample size for the survey. This technique was chosen to create room for the equal chance of individuals in each selected institution who is equally qualified to participate and also enable the generalization of finding, the researcher decided to use random sampling in sampling the participants from the various institutions undercover. Random sampling is the sampling technique in which each member of the population under study has an equal opportunity of being selected and the probability of a member of a population being selected is unaffected by the selection of other members of the population (Cohen et al., 2013).

3.6 Research Instruments

As stated, the study adopted a mixed-method (both qualitative data and quantitative data). A survey research method was adopted to address the research questions, using the questionnaire as the main instrument. Survey data was thus obtained through pre-determined questions that were administered to the respondents. Data collection technique available to a qualitative method falls into three categories which are observation, interviews, and focus groups (Gill, Stewart, Treasure, & Chadwick, 2008), but for this study, only the interview method was applied. The semi-structured interview questionnaire consisting of 11 questions was used to gather primary information from the students. A score sheet was also used to collect data on students' examination results in mathematics.

3.6.1 Questionnaire

A questionnaire was the main research instrument employed in this study, intending to elicit as much information as possible from the respondents. The questionnaire was in three sections (A, B and C). Section A covers demographic information such as gender,

parent's educational background, residential status, parent occupation and formal basic school attended. It contained 14 open-ended questions which the respondents were required to fill with their correct responses.

The second section (Section B) is a 5-point Likert Scale item captioned the *Modified Mathematical Anxiety Rating Scale (Mod-MARS)* (see Appendix D). The questions in this part were subdivided into three subsections:

- B1 is on factors that lead to fear and panic towards mathematics tasks. It comprised of 15 closed-ended questions.
- B2 covers factors that trigger negative emotional feeling towards mathematics tasks. It comprised of 15 closed-ended questions.
- B3 is on factors that lead to the exhibition of negative attitudes towards mathematics tasks. It comprised of 10 closed-ended items.

The last section (Section C) is also a 5-point Likert Scale item captioned the *Causes of Mathematical Anxiety Scale (CoMAS)* (see Appendix D). This section comprised six (6) subsections:

- C1 covers questions concerning teacher behaviour and attitude likely to cause mathematical anxiety. It comprised of 20 questions.
- C2 comprises questions on teaching approaches (strategies) that are likely to cause mathematics anxiety. It was made up of 10 questions.
- C3 questions were on parental influence likely to cause mathematical anxiety and comprised 10 questions.
- C4 covers questions related to societal factors likely to cause mathematics anxiety and is made up of 10 questions.

- C5 questions were on assessment practices likely to cause mathematics anxiety. It comprised of 10 questions.
- C6 the last subsection covers personal factors likely to cause mathematics anxiety. It comprised of 10 questions.

In the questionnaire collected from respondents, 270 (90%) out of 300 questionnaires contained valid responses. This was analysed using Statistical Package for the Social Sciences (SPSS), version 21.0.

3.6.1.1 Validity and reliability of the research instrument

Reliability refers to the degree of consistency of the data gathering instrument in measuring that which it is supposed to measure (Polit & Hungler 1999; Uys & Basson, 1991). Also, William (2006) was of the view that reliability is the consistency or dependability of the measurement; or the extent to which an instrument measures the same way each time it is used under the same condition with the same subjects. According to Joppe (2000), validity is when the research instrument measures what it is intended to measure. While validity is concern with the research instrument measuring what it is intended to measure, reliability on the other side looks at the consistent and stable nature of instrument overtime when it is administered repeatedly (Joppe, 2000; Creswell & Clark, 2011).

Cronbach's alpha coefficient (α) discovered by Cronbach in 1951 is a measure of internal consistency (scale reliability) that shows the degree to which all the items in a test measure the same attribute. This is given by the equation:

$$\alpha = \frac{(N^2\overline{COV})}{\sum S^2_{item} + \sum COV_{item}}$$

A scale that is greater than .70 (i.e. $\alpha = .70$) is regarded as a good indicator signifying that the scale is reliable (Fraenkel & Wallen, 2006; Nardi, 2018; Patton, 2002). Moreover, Kline (1999) also noted that although the generally accepted value of $\alpha = .80$ is appropriate for cognitive tests such as intelligence tests, for ability tests a cut-off point of $\alpha = .70$ is more suitable. He further stated that when dealing with psychological constructs, values below even .70 can, realistically, be expected because of the diversity of the constructs being measured. Assessors and researchers must estimate this quantity to add validity and accuracy to the interpretation of their data (Tavakol & Dennick, 2011). It ensures that each test item measures the same latent trait on the same scale.

The degree of consistency for MARS was measured using Cronbach's alpha coefficient and was found to have a strong internal consistency and stability. Betz (1978) reported a reliability coefficient of .92 using the split-half method.

The Cronbach alpha coefficient computed in this study for the 40-item questionnaire in Mod-MARS and 70-item in CoMAS was found to be 0.89 and 0.93 respectively (see Table 2 and 3) which is viable since an acceptable value must be greater than 0.70.

Table 2

Reliability Statistics for Mod-MARS

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.890	.889	40

Table 3

Reliability Statistics for CoMAS

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.939	.939	70

To observe content and face validity, the questionnaire was adapted. All statements were formulated to eliminate the possibility of misinterpretations followed by a critical examination of the items by the researcher's supervisor and other senior lectures in the Department of Mathematics Education, UEW before used. Identified amendments were made to ensure the simplicity and clarity of some questions, making it fully understandable to the participants (Masitsa, 2011).

Interview guide that was used to interview the participants was prepared and scrutinise by UEW senior lecturers from the Mathematics Education Department.

3.6.1.2 Pilot test of the questionnaire

A pilot study was conducted in October, 2017 by administering the questionnaire to 53 students who were excluded from the participants in the main study. As the objective of the pilot study was to ensure that respondents understood the instructions, the questions being asked, the terminologies used, no misleading questions, clarity was observed and that the instruments used were reliable to the subject being studied, the returned questionnaires were looked at thoroughly for more corrective inputs. All inputs in the forms of comments, suggestions, ideas, proposals, corrections and views were taken into consideration to improve and upgrade the level of reliability of the instrument.

3.6.2 Interview

To best understand how students interpret the items in the questionnaires, 15 students were interviewed by the researcher. These 15 participants had not seen the questionnaires before the interviews. The interviews were conducted using an interview guide (see Appendix E). The students were asked to respond to each of the items in the interview guide while explaining their responses.

The interview guide approach allowed the researcher to build a conversation within a particular subject area, to word questions spontaneously, and to establish a conversational style but with the focus on a particular subject that has been predetermined (Patton, 2002). Concerning that, I was able to pursue variables as needed while still covering all of the necessary information with each participant. The interview guide included follow-up questions such as, "why did you respond to that item that way?" and "what makes you feel that way?" Students were also encouraged to give examples supporting their decisions and to express any confusion regarding the items' meanings.

3.7 Data Collection Processes

Data collection procedure determines the outcome of this study results. It was, therefore, important to adopt a standard, practical method of collecting the relevant data to ensure that the results of the study would be acceptable. Due to the purpose of this study, two categories of data (i.e. primary and secondary data) were collected. The questionnaire and interview were used as an instrument to collect the primary data whiles the participants' mathematics examination scores was used as the secondary data.

3.7.1 Administration of questionnaires

After the pilot testing and all necessary modifications, the questionnaire was administered to all the chosen sample in the various schools in the classrooms and supervised by the researcher and the class teachers. Three hundred (300) copies of the questionnaire were given out. The research collected 270 (90%) completed questionnaires from the students and entered the valid responses into SPSS version 21. The possibility of retrieving back 90% of the questionnaire was as a result of the class teachers who offered a helping hand.

3.7.2 Conducting interview

The interview was conducted for 15 students' aside from the administration of the questionnaires. It was a face-to-face exercise moderated by the researcher. The semi-structured interview guide contained 11 questions developed by the researcher to elicit from the participants' elaboration on the results from the quantitative part and also to explore the causes of mathematical anxiety among participants and how they overcome or cope with their anxieties. However, interviews designed do not compel participants to tailor their experiences and knowledge into the researchers' classification, rather, they allow respondents to express their understanding in their terms (Patton, 2002).

Many important questions could be answered through surveying and experimenting, but statistical summaries may not communicate, because numbers do not tell a story that people easily understand. Thus, interviews were used to gain insights beyond what was provided through the survey instruments. The benefit of the interview method of data collection in the study was that it allowed students to further elaborate on their past and current experiences, which in turn provided the researcher with a richer description of their perspectives on mathematical anxiety as well as its causes and effect on their academic achievement in mathematics.

3.8 Data Analysis Procedure

Because the study employed a mixed-method approach, the researcher considered the way both quantitative and qualitative data are analysed.

3.8.1 Descriptive Analysis

Descriptive statistics reports generally include summary data tables, graphics and texts to explain what the graphics and tables are showing. Statistical analysis is when a researcher measures the frequency with which an occurrence happens, in addition to the link between two variables (Cowan, 1998). Descriptive statistics help researchers to detect sample characteristics that may influence their conclusions. This section of the report tends to look at the analysis of the demographic information (i.e. gender, age, residential status, basic school attended, educational background of participants' parents etc.), level, and causes of mathematical anxiety.

3.8.2 Inferential statistics (IS)

According to Asadoorian and Kantarelis (2005), inferential statistics is a statistical test used for analysis when a probability technique is employed to examine sample information from a certain population in aid of improving our knowledge about that population. It is largely performed by statistical hypothesis inference-testing, a large component of which is null-hypothesis testing. Moreover, inferential statistics tried to create conclusions that reach beyond the data observed in satisfying specific questions raised in a study (Kern, 2014).

3.8.3 Analysis of questionnaires

Out of the 300 questionnaires administered, 270 participants representing 90% of the total sample size successfully responded to all the items. Section A of the questionnaire relates to the demographic information of those who responded to the questionnaire

($n = 270$) Senior High School. The data collected were keyed into IBM SPSS software, version 21 and processed. The outcome on gender (male or female), age, residential status, JHS attended, father's education background, and mother's education background was presented as participants' demographic information.

Scores for each participant were computed by adding the item values of the Mod-MARS and CoMAS separately. These data were analysed using the methods of descriptive (e.i. frequency count and percentage) to address research question 1 and 2, and inferential statistics (e.i. correlation and regression) to address research question 3 and 4.

3.8.4 Assumptions of Pearson's Correlation

3.8.4.1 Linearity

To test for whether the two variables form a linear relationship, a simple scatterplot was used. According to Field (2013), "a scatterplot is a graph that plots each person's score on one variable against their score on another" (p.494). He further explained that scatterplot tells whether a relationship exists between the variables plotted and also the kind of relationship that existed and whether any extreme cases existed different from the others.

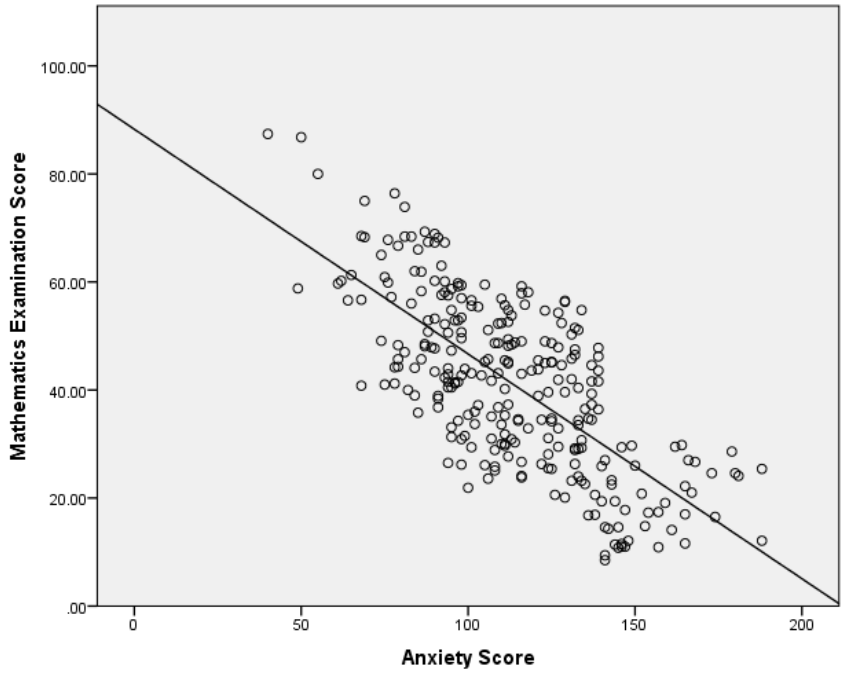

Figure 2: Scatterplot of mathematics anxiety level score and mathematics examination score

From Figure 2, there seems to be clear evidence of linearity in particular with the variable. Hence, scatterplots show that the assumption linear relationship between the two variables had been met.

3.8.4.2 Normality

One important assumption of correlation analysis that needs to be met for the p −values for the t-test to be valid is that the residuals are normally distributed. (http://www.ats.ucla.edu/stat/spss/webbooks/reg/chapter2/spssreg2.htm).

The results from Table 4 suggest that the residuals are normally distributed for the two variables as their skewness and kurtosis are near 0 (0.127 and -.394 respectively for mathematic examination score, and 0.225 and -.112 respectively for mathematical anxiety level score). According to Antonius (2003), If the skewness is larger than 1, the shape starts to look significantly different from that of a normal curve. Moreover, George and Mallery stated that "A kurtosis value between ±1.0 is considered excellent

for most psychometric purposes, but a value between ±2.0 is in many cases also acceptable, depending on the particular application." (George & Mallery, 2012: p.168)

Table 4

Statistics of skewness and kurtosis

		Mathematics Examination Score	Anxiety Score
N	Valid	270	270
	Missing	0	0
Skewness		.127	.225
Std. Error of Skewness		.148	.148
Kurtosis		-.394	-.112
Std. Error of Kurtosis		.295	.295

This is further asserted by observing the shape of each variable's histograms (see Figure 4 and 5) and the normal Q-Q plot (see Figure 6). Based on these results, the residuals from this regression appear to conform to the assumption of being normally distributed. Therefore, the assumption of normality has not been violated.

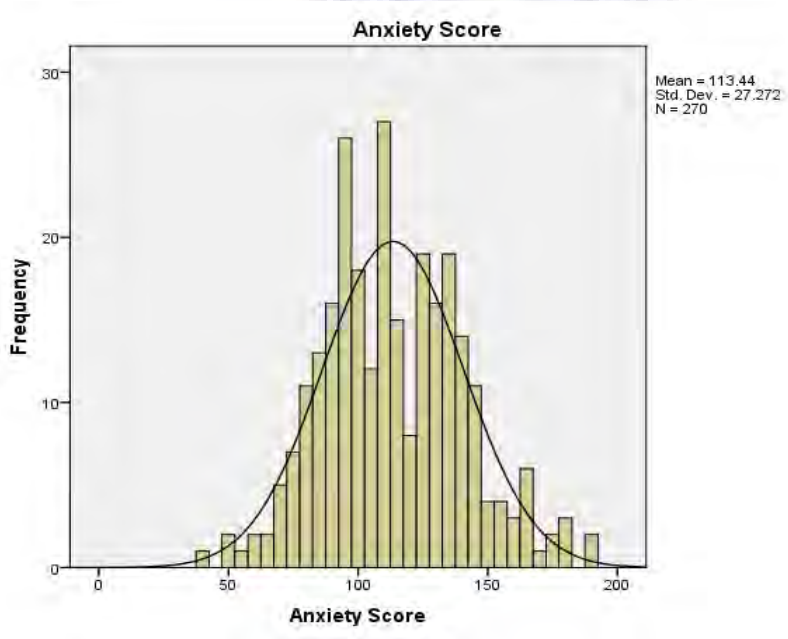

Figure 2: Histogram of mathematics anxiety score

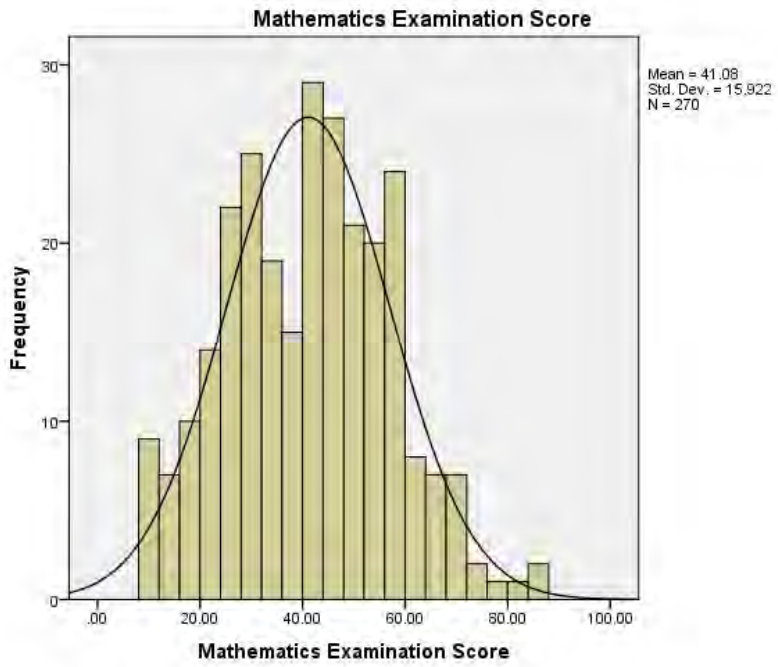

Figure 3: Histogram of mathematics examination score

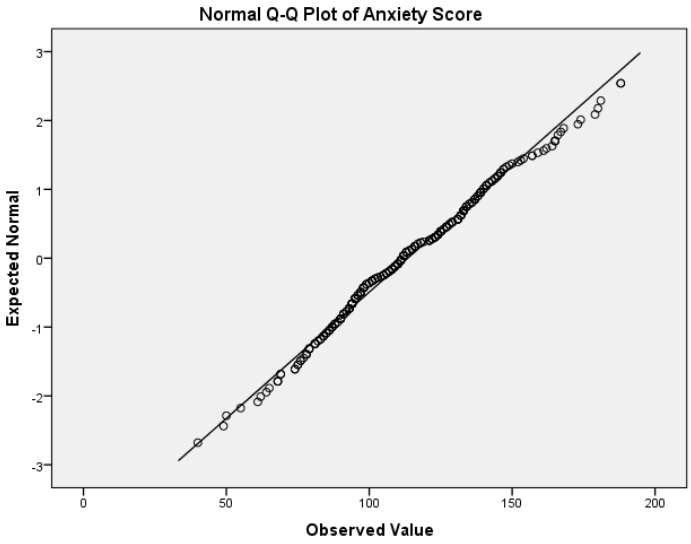

Figure 4: Q-Q plot of anxiety score

3.8.5 Assumptions of the multiple regression model

Before performing a multiple regression analysis, the researcher tested the assumptions of regression namely linearity, normality, homoscedasticity and independence of errors.

3.8.5.1 Model linearity

The linearity assumption of a linear regression assumes that the relationship between the dependent variable and the predictors should be linear. In checking if this relationship is linear, instead of only looking at simple scatterplots which would be suitable in the case of a simple regression, the partial regression plots between the dependent and each independent variables were inspected.

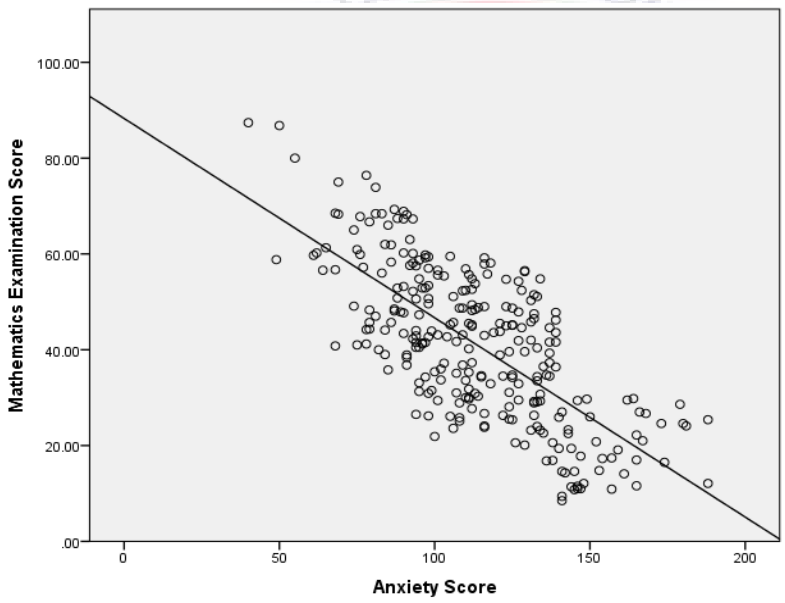

Figure 5: Scatterplot of Mathematics examination score and anxiety level score

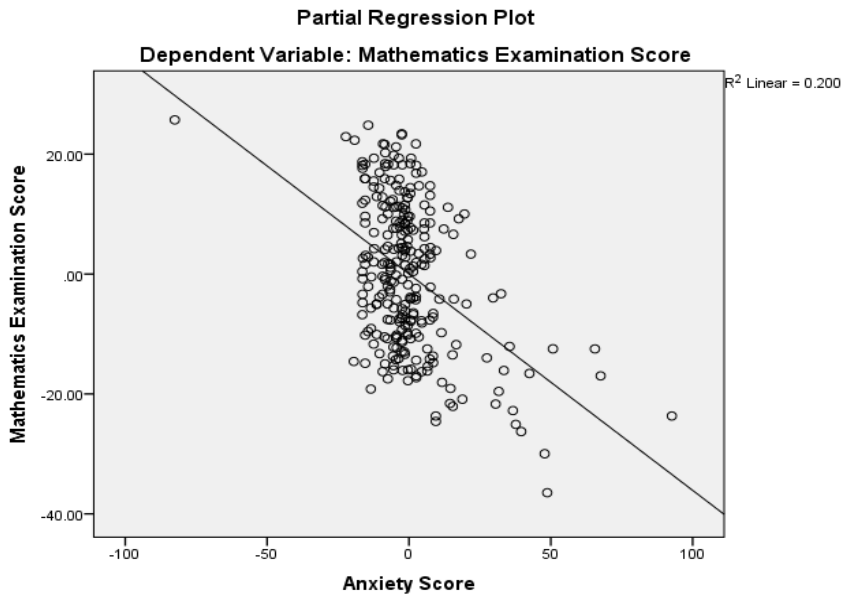

Figure 6: Partial Regression scatterplot of Mathematics exams score and anxiety level score

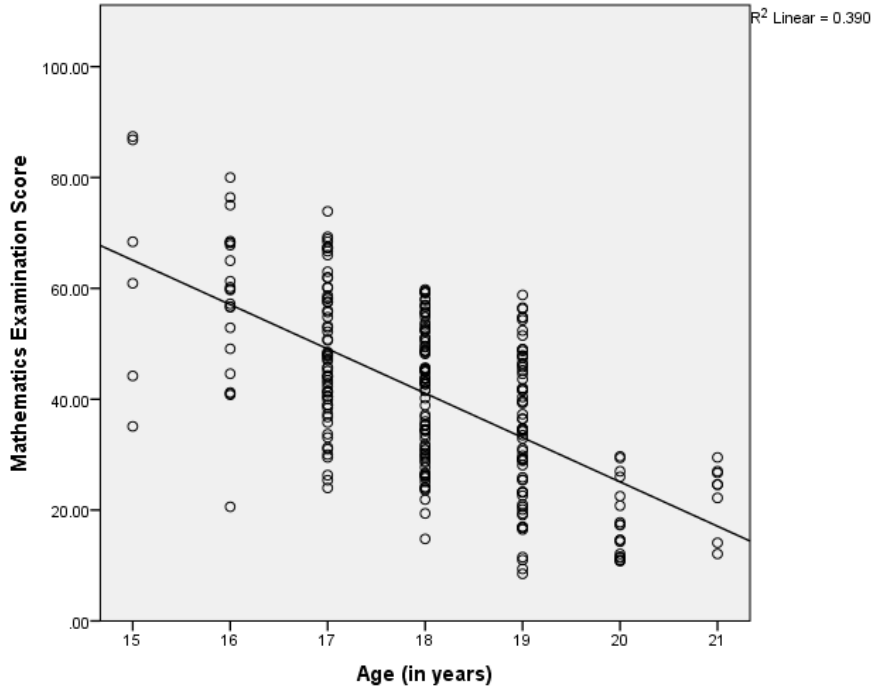

Figure 7: Scatterplot of Mathematics examination score and age

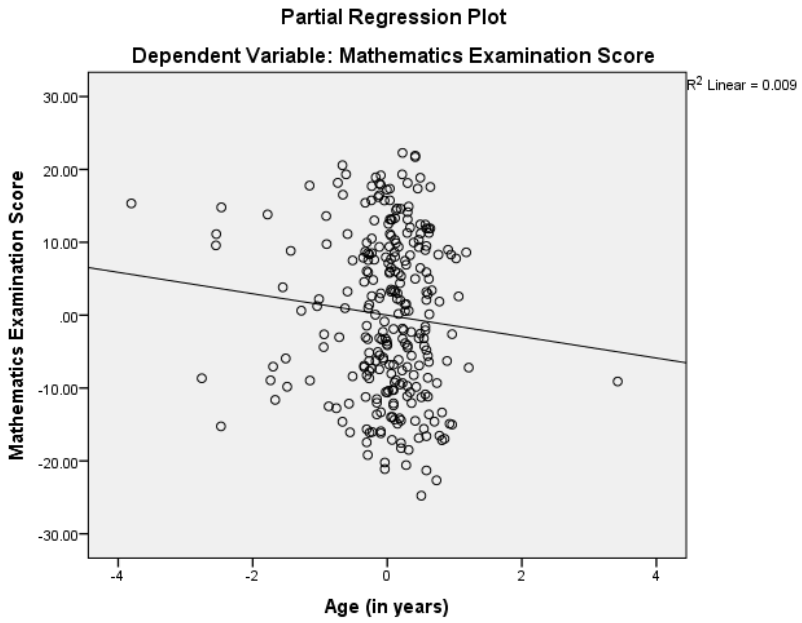

Figure 8: Partial Regression scatterplot of Mathematics exams score and age

From the scatterplots this assumption has been met.

3.8.5.2 Normality of errors

One of the assumptions of linear regression analysis is that the residuals are normally distributed. It is important to meet this assumption for the p-values for the t-tests to be valid (http://www.ats.ucla.edu/stat/spss/webbooks/reg/chapter2/spssreg2.htm).

All of the results suggest that the residuals are normally distributed for all the variables as their skewness and kurtosis are near 0 (0.047 and -.007 respectively for the age, 0.127 and -.394 respectively for the examination score, and 0.225 and -.112 respectively for the anxiety score) (see Table 5). The Kolmogorov-Smirnov and Shapiro-Wilk "tests of normality" (see Table 6) are not significant for examination score and anxiety score but significant for age, and the histogram (see Figure 11) and the Q-Q plot (see Figure 16) looks normal. Based on these results, the residuals from this regression appear to conform to the assumption of being normally distributed. Therefore, the assumption of normality has not been violated.

Table 5

Statistics

		Age (in years)	Mathematics Examination Score	Anxiety Score
N	Valid	270	270	270
	Missing	0	0	0
Skewness		.047	.127	.225
Std. Error of Skewness		.148	.148	.148
Kurtosis		-.007	-.394	-.112
Std. Error of Kurtosis		.295	.295	.295

Table 6

Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age (in years)	.159	270	.000	.942	270	.000
Mathematics Examination Score	.046	270	.200*	.990	270	.048
Anxiety Score	.063	270	.012	.992	270	.144

*. This is a lower bound of the true significance.

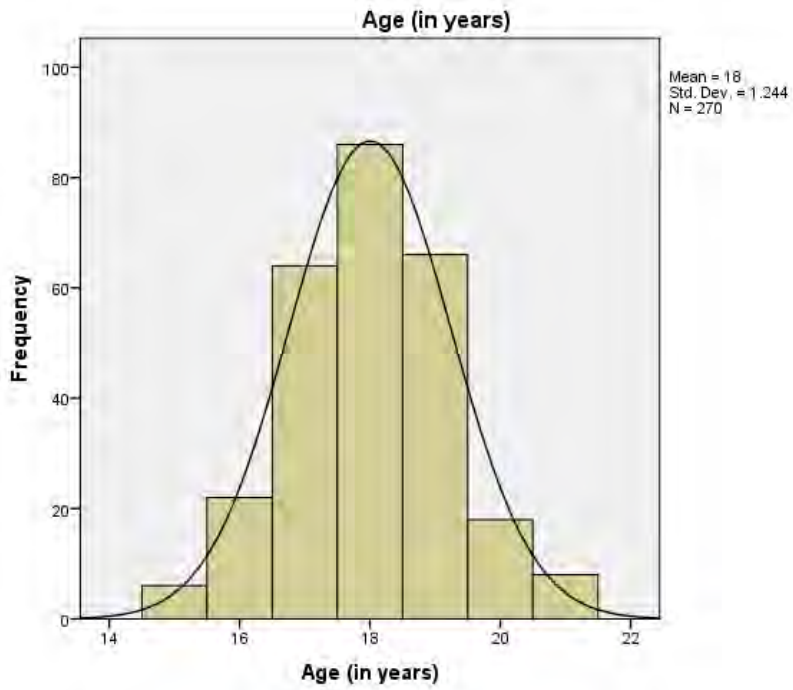

Figure 9: Histogram of age (in years)

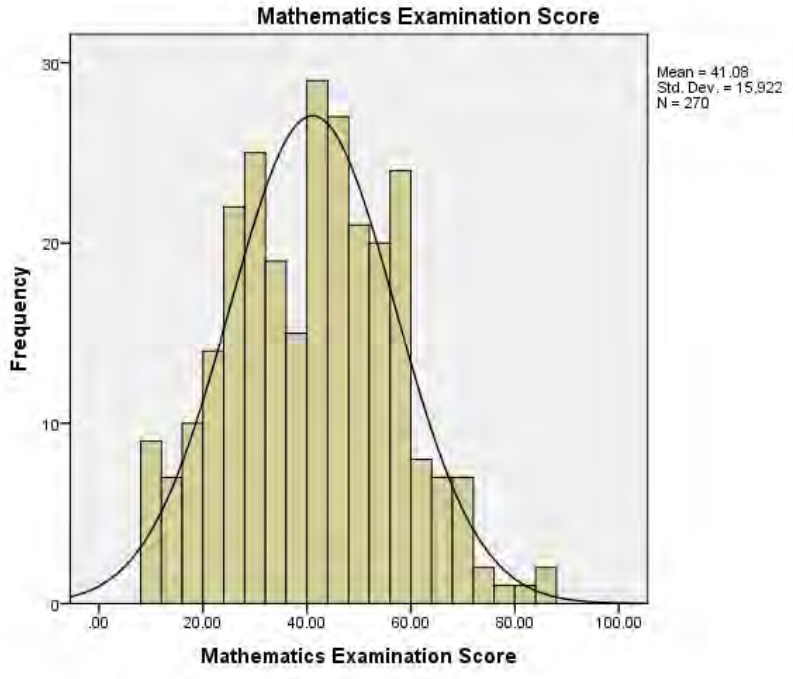

Figure 10: Histogram of mathematics examination scores

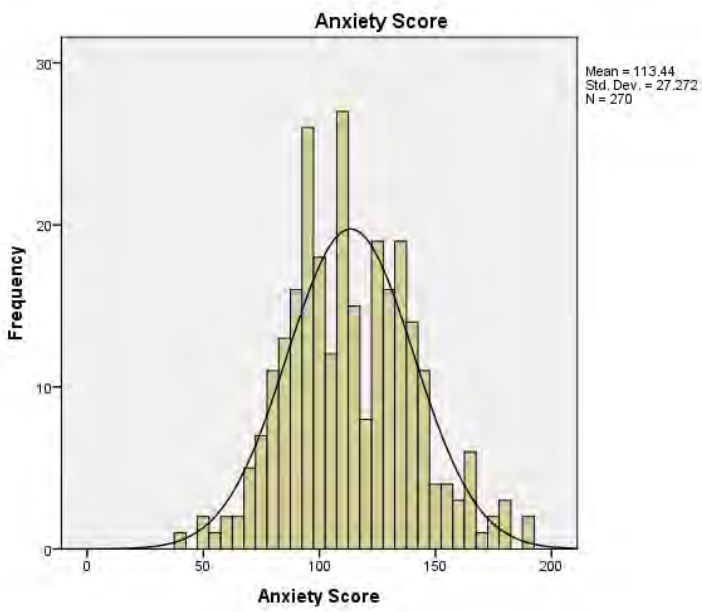

Figure 11: Histogram of mathematics anxiety level scores

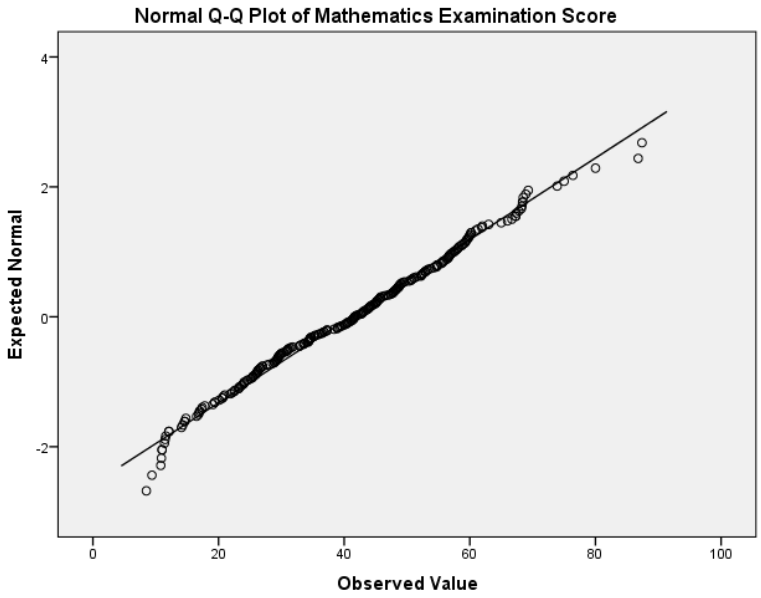

Figure 12: Normal Q-Q plot of mathematics examination score

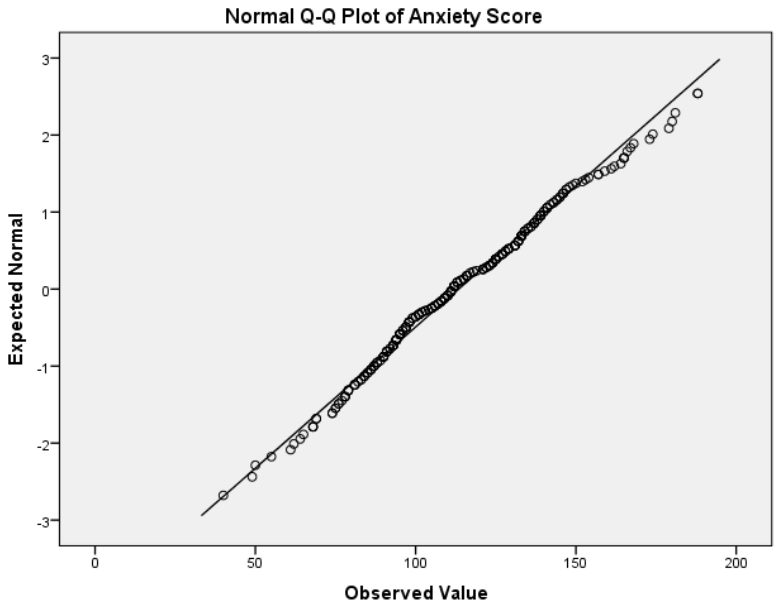

Figure 13: Normal Q-Q plot of mathematics anxiety level score

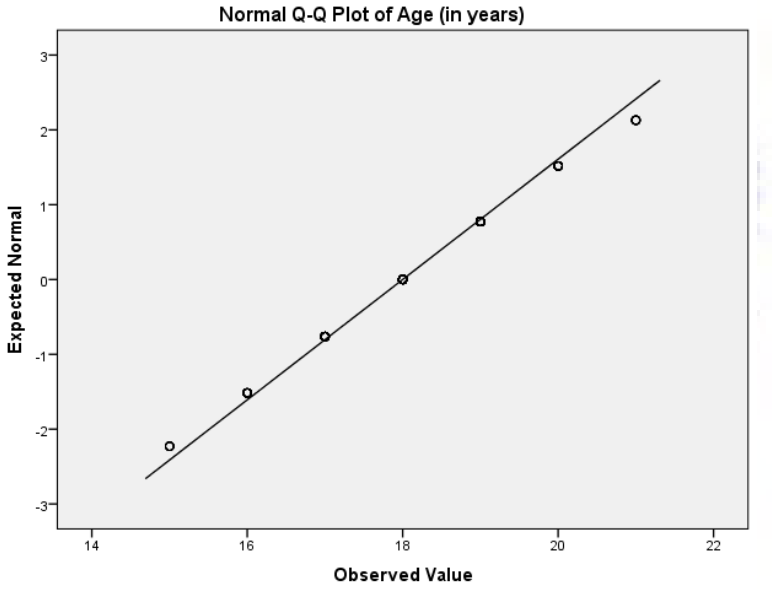

Figure 14: Normal Q-Q plot of age

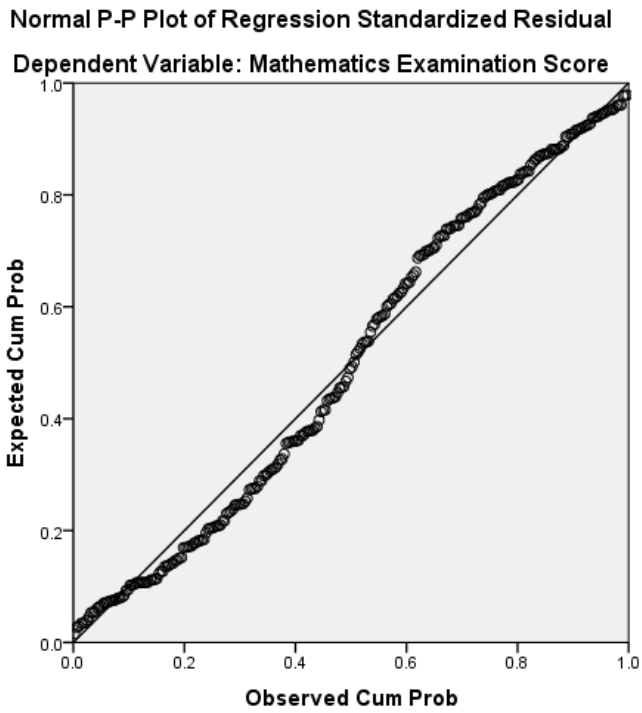

Figure 15: Normal P-P plot of regression standardized residual

3.8.5.3 Homoscedasticity

Another assumption of ordinary least squares regression is that the variance of the residuals is homogeneous across levels of the predicted values, also known as homoscedasticity. If the model is well-fitted, there should be no pattern to the residuals plotted against the fitted values. The plot of standardized residuals verse standardized predicted values in Figure 18 showed no obvious signs of funnelling, suggesting that assumption of homoscedasticity has been met.

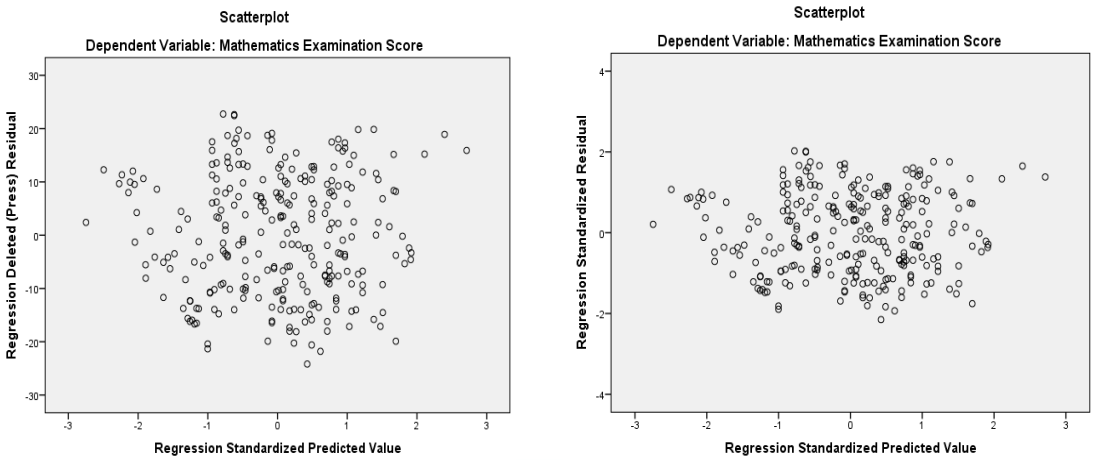

Figure 16: Scatterplot of standardized residuals verse standardized predicted values

3.8.5.4 MultiCollinearity

Multicollinearity implies that more than two variables are near perfect linear combinations of one another. From the correlation table, we can attest that none of the correlation coefficients was more than 0.8 as the highest correlation is $r = -.713$ (see Table 7). When there is a perfect linear relationship among the predictors, the estimates for a regression model cannot be uniquely computed. Multicollinearity tends to inflate the standard error of the coefficients.

Table 7

SPSS has reported Mathematics Examination Score and Age (in years) verse Mathematical anxiety

		Mathematics Examination Score	Anxiety Score	Age (in years)
Pearson Correlation	Mathematics Examination Score	1.000	-.713	-.625
	Anxiety Score	-.713	1.000	.825
	Age (in years)	-.625	.825	1.000
Sig. (1-tailed)	Mathematics Examination Score	.	.000	.000
	Anxiety Score	.000	.	.000
	Age (in years)	.000	.000	.
N	Mathematics Examination Score	270	270	270
	Anxiety Score	270	270	270
	Age (in years)	270	270	270

Moreover, analysis of collinearity statistics (see Table 8) confirmed that this assumption has been met, as VIF scores, and tolerance scores (statistics = 3.132 and .319 respectively). According to Hair, Anderson, Tatham, and Black (2014), tolerance is the amount of variability of the selected independent variables not explained by the other independent variables and variance inflation factor (VIF) is simply the inverse of the tolerance value. They further stated that, as tolerance value grows smaller, the variable is more highly predicted by the other independent variables and recommend that if VIF value exceeded 4.0, or tolerance value is less than 0.2 then there is a problem with multicollinearity.

Table 8

Coefficient

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	108.468	13.617		7.966	.000		
Anxiety Score	-.361	.044	-.618	-8.168	.000	.319	3.132
Age (in years)	-1.470	.969	-.115	-1.518	.130	.319	3.132

a. Dependent Variable: Mathematics Examination Score

3.8.5.6 Independence of errors

Independent of errors means that the errors associated with one observation are not correlated with the errors of any other observation. The Durbin-Watson test is used to identify issues with the independence of errors. The Durbin-Watson test has a range of 0 to 4 with a midpoint of 2. From Table 9, the Durbin-Watson statistic showed that the assumption of the values of the residuals been independent had been met, as the obtained value was close to 2 (Durbin-Watson = 1.925).

Table 9

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.716[a]	.512	.508	11.16355	1.925

a. Predictors: (Constant), Age (in years), Anxiety Score

b. Dependent Variable: Mathematics Examination Score

3.8.5.7 Assumption of no influential cases biasing model

Cook's Distance values were all under 1, suggesting individual cases were not unduly influencing the model.

3.8.6 Analysis of interview

The researcher transcribed the interviews recorded for each participant. Descriptive words were used to present the qualitative data which was obtained from the interview after it has been transcribed.

3.9 Ethics Consideration

Ethics has become a cornerstone for conducting effective and meaningful research. As such the ethical behaviour of individual researchers is under unprecedented scrutiny (Best & Kahn, 2006; Trimble & Fisher, 2006). To have effective and meaningful research conducted, there is a need for ethical consideration by the researcher. The Ethical Standards of the American Educational Research Association (AERA) states:

> It is of paramount importance that educational researchers respect the rights, privacy, dignity, and sensitivities of their research populations and also the integrity of the institutions within which the research occurs. Educational researchers should be especially careful in working with children and other vulnerable populations (American Educational Research Association, 2002, p.3).

Also, one of the purposes of the University of Ghana's Research Ethical Policy (2013: p3) was for the researcher to ensure that ethical standards for the care and protection of both human and non-human subjects are abide by. The policy referred to human subjects as "human beings in a research process for investigation of a specific question which incorporates data collection and analysis" (UG Research Ethical Policy, 2013: p4). The University of Education, Winneba, Research Ethics Policy (2018) defined the

responsibilities of the researcher as having the sole concern for the safeguard of human and non-human subjects in research, respect and provide confidentiality of research subjects at all times as well as ensure enough involvement and collaboration with all research quality assurance reviews in the process of conducting research. Due to the importance of ethical consideration, the researcher gave agreed to undertake the ethical guidelines as set out in the following paragraphs.

Because the Senior High School students are considered minors, permission was required for all participants in the study. The researcher collected an introductory letter (see Appendix A) from the Department of Mathematics Education in UEW, which serves as authentic evidence for sampled schools and allowed him to introduce himself as well as disclosing the purpose of the study to the Municipal Director of Education and request to engaged Senior High School institutions in that municipality in data collection exercise. A letter was then released from the municipal director's office to all heads of Senior High institution to offer any further assistance to the researcher in collecting data successfully. The researcher submitted these letters to the various Senior High Schools in the municipality and patiently made follow-up until given the approval from the various institution heads and academic heads to embark on the exercise.

The participants were briefed fully on the purpose and conduct of the research. It was made very clear to them that participation was voluntary. The rationale behind the study was explained. Data collection and analysis were also clearly described to them so that they know what they were doing. All participants then agreed to participate in the study before the instruments were administered.

All personal information of the participants was treated as highly confidential, remains confidential throughout the study and, after the project has been completed, will be

destroyed. Personal data such as recordings of the interview session and relevant personal information was not used without first obtaining consent from the relevant individuals. Also, to protect the privacy of those involved, participants were restricted from writing their names and contact on any part of the instruments.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.0 Overview

The primary purpose of this study was to investigate the nature and causes of mathematical anxiety among Senior High School students. The study also examined the relationship between students' mathematical anxiety and achievement in mathematics. This chapter presents the data analysis and findings from the study. Descriptive statistics, such as frequencies and graphs (e.g. pie chart, bar chart, etc.) were used to categorize, summarize, and visually present results based on the quantitative data, while inferential statistics, such as Pearson's product-moment correlation coefficient and multiple regression, were used to determine the relationship between the participant's mathematical anxiety, age, and academic achievement in mathematics. Finally, a model was evolved to predict the academic achievement of participants using his/her age, and anxiety score. The sections that follow in Chapter 4 begin with the demographic information of the participants of the study followed by the results presented under the research questions.

4.1 Demographic information

4.1.1 Gender

Table 10 shows a summary of the distribution of participants' gender. It can be seen in Table 10 that 99 (37%) of the participants were males and 171 (63%) females. This shows that majority of the participants were females.

Table 10

Frequency distribution of gender of respondents

Gender	Frequency
Male	99 (37)*
Female	171 (63)
Total	**270 (100)**

* **Percentages in parenthesis**

4.1.2 Age category

Table 11 shows the classification of information related to the participants' age categories. Out of the 270 students surveyed, the majority of them were within the age category of 18 – 20 years representing 63.0% (f = 170) approximately of the total sample. However, the age category of 15 – 17 years comes after with 34.1% (f = 92) and those within 21 – 23 years were so minimal accounting for about 2.9% (f = 8) of the total sample.

Table 11

Frequency distribution of age groups of respondents

Age	Frequency
15 - 17 years	92 (34.1)*
18 - 20 years	170 (63.0)
21 - 23 years	8 (2.9)
Total	**270 (100)**

* **Percentages in parenthesis**

4.1.3 Residential status

A larger number of the participants' resident at hostel representing 57% (f = 154) out of the total sample (as shown in Table 12) as compared to 31% (f = 84) of the participants' who were accommodated at the boarding house. However, 32 of the participants representing 12% were day students.

Table 12

Frequency distribution of Residential Status of participants

Type of Residence	Frequency
Boarder	84 (31)*
Day	32 (12)
Hostel	154 (57)
Total	**270 (100)**

* **Percentages in parenthesis**

4.1.4 Basic school (JHS) attended

The analysis of information concerning JHS attended by the participants showed that 153 of the participants were from Government JHS representing 57% of the total sample while 117 students representing 43% of the sample had their basic education at Private schools as in Table 13.

Table 13

Frequency distribution of Basic School (JHS) attended by participants

JHS Attended	Frequency
Government	153 (57)*
Private	117 (43)
Total	**270 (100)**

* **Percentages in parenthesis**

4.1.5 Father's educational background

Table 14 presents the results of the participants' father's educational background. Secondary education was the highest educational level for the majority of the participants' fathers with a frequency of 125 (46%). This was followed by fathers with Basic education background with a frequency of 60 (22%). It was observed that about 45 (17%) respondents' fathers were university leavers whilst those participants' fathers with Polytechnic/ College of Educ./ Nursing Training College education and non-formal education were 28 (10%) and 12 (5%) respectively.

Table 14

Frequency distribution of participants' father's educational background

Father's Educ. Background	Frequency
No Formal Education	12 (5)*
Basic Education	60 (22)
Secondary Education	125 (46)
Polytechnic/ College of Educ./ Nursing Training College	28 (10)
University Education	45 (17)
Total	**270 (100)**

* **Percentages in parenthesis**

4.1.6 Mother's educational background

From Table 15, basic education was the highest educational background for 134 participants' mothers representing 49% of the total sample. Moreover, 78 participants' mothers' were secondary education leavers' representing 29% whiles 26 students mothers' representing 10% had no formal education. However, 19 participant's mothers hold Polytechnic/ College of Education/ Nursing Training College certificates representing 7% as 13 participant's mothers were university graduates.

Table 15

Frequency distribution of participants' mother's educational background

Mother's Educ. Background	Frequency
No Formal Education	26 (10)
Basic Education	134 (49)
Secondary Education	78 (29)
Polytechnic/ College of Educ./ Nursing Training College	19 (7)
University Education	13 (5)
Total	**270 (100)**

* **Percentages in parenthesis**

4.2 Research Question 1

What is the level of mathematical anxiety among Senior High School students' in Agona West Municipality of Ghana?

The purpose of this question was to determine the level of mathematical anxiety among SHS students based on their fear and panic towards mathematics tasks, negative emotional attitude, negative attitude towards mathematics tasks.

4.2.1 Fear and panic towards mathematics tasks

Fifteen (15) items were extracted from literature as factors associated with individual's mathematical anxiety and the results are shown in Table 16.

Table 16

Analysis of responses on fear and panic towards mathematics tasks

Questions	Responses				
	Never	Rarely	Sometimes	Most of the time	Always
1. I become disturbed when I have to go to the mathematics class.	73(27.0)*	5(1.9)	145(53.7)	30(11.1)	17(6.3)
2. I feel uncomfortable when asked to go to the board or being called to answer a question in a mathematics class.	48(17.8)	20(7.4)	112(41.5)	45(16.7)	45(16.7)
3. I am afraid to ask my teacher questions in mathematics class	132(48.9)	17(6.3)	62(23.0)	28(10.4)	31(11.5)
4. I tend to lose my attention in mathematics class.	90(33.3)	16(5.9)	105(38.9)	30(11.1)	29(10.7)
5. I fear mathematics tests more than any other subjects.	52(19.3)	23(8.5)	78(28.9)	40(14.8)	77(28.5)
6. I am afraid I would not be able to keep up with the rest of my colleagues in mathematics in the class.	93(34.4)	23(8.5)	81(30.0)	35(13.0)	38(14.1)
7. I do not know how to study for mathematics tests.	44(16.3)	25(9.3)	86(31.9)	49(18.1)	66(24.4)
8. I understand what is taught clearly in mathematics class but when I go home it is like I have never attended mathematics class.	41(15.2)	25(9.3)	81(30.0)	48(17.8)	75(27.8)

Questions	Responses				
	Never	Rarely	Sometimes	Most of the time	Always
9. I feel worried about buying a mathematics textbook.	151(55.9)	15(5.6)	49(18.1)	23(8.5)	32(11.9)
10.I become more confused when I picked my mathematics homework book to work on.	85(31.5)	21(7.8)	100(37.0)	29(10.7)	35(13.0)
11.I fear to discuss mathematics issues with my colleagues.	130(48.1)	25(9.3)	54(20.0)	29(10.7)	32(11.9)
12.When I hear the word 'mathematics' I become disturbed.	89(33.0)	18(6.7)	84(31.1)	32(11.9)	47(17.4)
13.I panic when I see my mathematics teacher coming to class.	96(35.6)	19(7.0)	86(31.9)	30(11.1)	39(14.4)
14.Mathematics has been my worst subject in life.	44(16.3)	30(11.1)	56(20.7)	35(13.0)	105(38.9)
15.I am much worried about mathematics than any other subject.	25(9.3)	28(10.4)	66(24.4)	29(10.7)	122(45.2)

* **Percentages in parenthesis**

Two items, "worried about mathematics than any other subject" and "mathematics has been my worst subject in life", appears to top the list, as most of the respondents 45.2% (f = 122) and 38.9% (f = 105) respectively referred to them as matters postulated to cause fear and panic towards mathematics tasks leading to stirring one's level of mathematical anxiety. Also, other items that include: fear for mathematics tests more

than any other subjects, not knowing how to study for mathematics tests, and understands what was taught clearly in mathematics class but when at home it appears as if one has never attended mathematics class.

However, majority of the respondents, 53.7% voiced out that occasionally they become disturbed when asked to go to mathematics class, 41.5% mentioned that they sometimes feel uncomfortable when asked to go to the board or being called to answer a question in a mathematics class, 38.9% shared their view that they on occasion tend to lose attention in mathematics class, and 37.0% become more confused every so often when they picked mathematics homework book to work on.

However, 48.9% of the respondents said they are never afraid to ask their teacher questions in mathematics class, 55.9% said they never feel worried buying mathematics textbook, and 48.1% said they certainly do not panic to discuss mathematics issues with their colleagues.

4.2.2 Negative emotional feelings towards mathematics tasks

To examine the negative emotional feelings of an individual towards mathematics task, 15 items were extracted from literature and the results are shown in Table 17.

Table 17

Descriptive statistics of responses on negative emotional feeling towards mathematics task

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
1. I am sure I cannot learn mathematics.	111(41.1)*	89(33.0)	36(13.3)	22(8.1)	12(4.4)
2. I will never go in for any mathematics-related programme in my further education.	52(19.3)	77(28.5)	47(17.4)	47(17.4)	47(17.4)
3. No teacher can make be like mathematics.	100(37)	99(36.7)	29(10.7)	23(8.5)	19(7.0)
4. I am not sure I can do mathematics myself.	84(31.1)	71(26.3)	32(11.9)	52(19.3)	31(11.1)
5. I study mathematics because it is a compulsory subject.	38(14.1)	42(15.6)	29(10.7)	93(34.4)	68(25.2)
6. There is little need for mathematics in most job places.	59(21.9)	36(13.3)	32(11.9)	81(30.0)	62(23.0)
7. Most of the ideas in mathematics are not very useful.	61(22.6)	72(26.6)	37(13.7)	54(20.0)	46(17.0)
8. No matter how hard I try, I cannot understand mathematics.	104(38.5)	74(27.4)	34(12.6)	31(11.5)	27(10.0)
9. I will like a job that does not use any mathematical knowledge.	40(14.8)	69(25.6)	357(13.7)	65(24.1)	59(21.9)
10.I can get along perfectly well in everyday life without mathematics.	53(19.6)	81(30.0)	35(13.0)	58(21.5)	43(15.9)
11.Mathematics is for smart people.	91(33.7)	55(20.4)	32(11.9)	45(16.7)	47(17.4)
12.I worried that other students might understand mathematics problems better than me.	48(17.8)	54(20.0)	30(11.1)	88(32.6)	50(18.5)
13.I worried that I will not be able to complete every	64(23.7)	73(27.0)	40(14.8)	54(20.0)	39(14.4)

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
assignment in a mathematics course.					
14.I worried that I will not be able to get 'A' in my mathematics course.	78(28.9)	54(20.0)	28(10.4)	59(21.9)	51(18.9)
15.Everyone's mathematics ability is determined at birth.	112(41.5)	67(24.8)	30(11.1)	32(11.9)	29(10.7)

* **Percentages in parenthesis**

From the analysis in Table 17, it has always been an emotional feeling for most of the respondents (59.6%) as they thought they study mathematics because it is a compulsory subject. Also, 53.0% of the respondents always have the feeling that there is little need for mathematics in most job places, 46.0% at all times feels they will like a job that does not use any mathematical knowledge, and 51.1% feel worried continuously that other students might understand mathematics problems better than they do.

Meanwhile, 74.1% of the respondents never feels they cannot learn mathematics, 73.7% disagreed to the feeling that no teacher can make them like mathematics, and 57.4% of the respondents said they have never had any feeling of not been sure that they can do mathematics themselves. Also, 65.9% of the respondents had never felt that no matter how hard they try, they cannot understand mathematics, 54.1% on no occasion feels mathematics is for smart people and 66.3% of the respondents under no circumstances feel everyone's mathematics ability is determined at birth.

4.2.3 Negative attitude towards mathematics tasks

Some researchers (Elizabeth, 2008; Bessant, 1995; Mathison, 1977) asserted that a negative attitude towards mathematics tasks is a result of one's mathematical anxiety portrayed. To investigate an individual's negative attitude towards mathematics task, 10 items were extracted from literature and the results are shown in Table 18.

Table 18

Descriptive statistics of negative attitude towards mathematics tasks as a result of portraying mathematical anxiety

	Responses				
Questions	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
1. Mathematics as a subject during my Primary and Junior High school years was my least favourite.	42(15.6)*	58(21.5	29(10.7)	88(32.6)	53(19.6)
2. I have always struggled with anything that involves numeracy from my primary school days.	63(23.3)	68(25.2	41(15.2)	62(23.0)	36(13.3)
3. My performance in mathematics during my early school years was hardly above average.	50(18.5)	54(20.0	21(7.8)	99(36.7)	46(17.0)
4. I often do not like mathematics lesson periods because it bores me.	53(19.6)	66(24.4	38(14.1)	67(24.8)	46(17.0)
5. Mathematics course during my Junior High school years was easier to understand compared to mathematics at Senior High.	26(9.6)	37(13.7	30(11.1)	103(38.1)	74(27.4)
6. Mathematics during my basic school years has never been interesting to me.	79(29.3)	86(31.9	28(10.4)	47(17.4)	30(11.1)

Questions	Responses				
	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
7. I will like to spend less time learning mathematics at school.	59(21.9)	70(25.9	32(11.9)	74(27.4)	35(13.0)
8. I am never bordered to learn mathematics.	49(18.1)	79(29.3	34(12.6)	72(26.7)	36(13.3)
9. I hardly read my mathematics textbook before coming to class.	46(17.0)	57(21.1	34(12.6)	86(31.9)	47(17.4)
10. Someone does my homework for me most times or else I copy from my colleagues.	70(25.9)	60(22.2	38(14.1)	61(22.6)	41(15.2)

* **Percentages in parenthesis**

The result of this analysis revealed that more than half of the respondents agreed to the fact that mathematics as a subject during their Primary and Junior High school years was the least favourite, their performance in mathematics during early school years was hardly above average, and mathematics course during Junior High school years was easier to understand compared to mathematics at Senior High were the top negative attitudes exhibited as a result of mathematical anxiety.

However, 61.2% of the respondents disagreed that mathematics during their basic school years has never been interesting, 48.1% differed on the attitude of someone doing homework for them most times or else copied from colleagues and 47.8% respondents also were upset of like to spend less time learning mathematics at school.

4.2.4 Summary of the findings for research question 1

Table 19 displays the descriptive statistics of the accumulated Mod-MARS scores for 270 Senior High School participants. The highest accumulated score obtained was 188

and the lowest was 40 out of the possible 200. Participants were categorised into three mathematical anxiety levels. In the first category were participants whose Mod-MARS overall scores were at most sixty (60) and they were considered as having low mathematical anxiety. In the second category are those whose Mod-MARS overall scores were less than one hundred (100) and greater than sixty (60) and were categorised as having moderate mathematical anxiety. In the third category were those with overall scores been at least one hundred (100) and they were considered as having high mathematical anxiety.

Table 19

Results on levels of Mathematics anxiety experienced by participants

Accumulated scores (x)	Frequency	Status
100 and above	174 (64)*	High
99 - 61	92 (34)	Moderate
60 and below	4 (2)	Low
Total	**270 (100)**	

* **Percentages in parenthesis**

The results indicated that 174 (64%) of the 270 participants experienced a high level of mathematical anxiety, 92 (34%) experienced moderate level, and 4 (2%) experienced a low level of mathematical anxiety.

4.3 Research Question 2:

What are the prevalent causes of mathematical anxiety among Senior High School students' in Agona West Municipality of Ghana?

The primary demand of research question two is to find out the prevalent causes of mathematical anxiety among Senior High School students in Ghana. First, the

researcher presented the analysis on data collected for the individual variable under consideration by using frequency distribution tables and percentages followed by the analysis and discussion of overall results of the data obtained from the questionnaire across all the variables in summary. There are six (6) sub-sections under this section.

4.3.1 Teacher behaviour and attitude likely to cause mathematics anxiety

This section relates to some behaviours and attitudes which are likely to cause mathematics anxiety among Senior High School students. In investigating this, 20 possible related items were chosen to apply to this variable and the results are shown in Table 20 below.

Table 20

Teacher Behaviour and Attitude

	Responses				
Questions	Never	Rarely	Sometimes	Most at times	Always
1. My mathematics teacher fears and panics when teaching.	194(71.9)*	15(5.6)	41(15.2)	11(4.1)	9(3.3)
2. My teacher forces students to work questions on board which we are not sure of.	133(49.3)	24(8.9)	75(27.8)	16(5.9)	22(8.1)
3. My teacher uses threatening comments on us.	169(62.6)	19(7.0)	51(18.9)	15(5.6)	16(5.9)
4. My teacher does not explain concepts fully to our understanding.	97(5.9)	24(8.9)	92(34.1)	34(12.6)	23(8.5)
5. My teacher fails to consider students feelings both in class when teaching, outside class and school setting.	108(40.0)	29(10.7)	87(32.2)	26(9.6)	20(7.4)
6. My teacher ignores us and avoids eye conduct with us.	161(59.6)	29(10.7)	51(18.9)	19(7.0)	10(3.7)

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
7. My teacher lacks patience with us.	148(54.8)	18(6.7)	65(24.1)	17(6.3)	22(8.1)
8. My teacher is so unsympathetic and incorrectly assumes that computational processes are simple.	137(50.7)	23(8.5)	71(26.3)	20(7.4)	19(7.0)
9. My teacher embarrasses and humiliates us for solving mathematics questions wrongly on the board.	150(55.6)	16(5.9)	56(20.7)	22(8.1)	26(9.6)
10. My teacher sometimes demonstrates anger in class when teaching mathematics.	137(50.7)	21(7.8)	69(25.6)	23(8.5)	20(7.4)
11. My teacher never does remedial on the areas we do not understand in mathematics.	101(37.4)	35(13.0)	64(23.7)	29(10.7)	41(15.2)
12. My teacher demonstrates an uncaring attitude towards students in mathematics class.	153(56.7)	25(9.3)	48(17.8)	23(8.5)	21(7.8)
13. My teacher does not respond to our mistakes and misunderstandings with explanations in mathematics.	146(54.1)	21(7.8)	61(22.6)	20(7.4)	22(8.1)
14. My teacher responds negatively to questions from students.	174(64.4)	16(5.9)	40(14.8)	26(9.6)	14(5.2)
15. My teacher lacks interest in and enthusiasm for teaching mathematics.	171(63.3)	17(6.3)	50(18.5)	15(5.6)	17(6.3)
16. My teacher thinks mathematics ability is inborn, rather than a skill which can be developed.	147(54.4)	30(11.1)	54(20.0)	24(8.9)	15(5.6)
17. My teacher treats students unfairly in mathematics class.	162(60.0)	21(7.8)	57(21.1)	15(5.6)	15(5.6)

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
18. My teacher lacks the necessary communication needed for mathematics.	130(48.1)	34(12.6)	59(21.9)	26(9.6)	21(7.8)
19. My teacher provides little motivational support during mathematics lessons.	101(37.4)	24(8.9)	68(25.2)	31(11.5)	46(17.0)
20. My teacher does not know when we are having trouble with our mathematics work.	92(34.1)	26(9.6)	78(28.9)	26(9.6)	48(17.8)

* **Percentages in parenthesis**

The finding from this analysis disagreed strongly with some of the research findings by Tobias (1987) and Adimora, Nwokenna, Omeje, and Eze (2015) when they noted that the origins of students' mathematical anxiety can emanate from some teacher-related behaviours. The participants connected their mathematical anxiety to teacher-related behaviour in a more neutral opinion than expected. However, it was evidenced that close to 50% of the respondents show dissatisfaction to few mathematics teachers behaviours such as not knowing when students' have trouble with their mathematics work, not explaining concepts fully to students' understanding (Plaisance, 2007), never organises remedial on the areas students' do not understand in mathematics (Jackson & Leffingwell, 1999), not providing little motivational support during mathematics lessons and lacks the necessary communication needed for mathematics (Kesici & Ahmet, 2009) which could connect to students developing mathematical anxiety.

In an apparent contradiction to previous studies, 71% of the participants appeared to strongly disagree that their teacher's fears and panics when teaching, 62.2% stated that their teachers never use threatening comments on them. Moreover, 59.6% admitted that

their teachers have never ignored them and avoid eye conduct with them while teaching, 54.8% affirmed that their teachers never lacks patience with them while 50.7% asserted that their teachers never relate so unsympathetic and incorrectly assumes that computational processes are simple. Also, 55.6% are strongly not in agreement that their teachers embarrasses and humiliates them for solving mathematics questions wrongly on the board, 50.7% confessed that their teachers in no circumstance demonstrate anger in class when teaching mathematics, 56.7% strongly differ that their teachers had never demonstrated uncaring attitude towards students in mathematics class and 54.1% likewise strongly do not support the claim that their teachers do not respond to their mistakes and misunderstandings with explanations in mathematics. Further, 64.4% strongly disagree that teachers respond negatively to questions from students, 63.3% also, stated that mathematics teachers never lack interest in and enthusiasm for teaching mathematics, 54.4% strongly do not agree that their teachers think mathematics ability is inborn, rather than a skill which can be developed as 60.0% strongly discard the claim that teachers treat students unfairly in mathematics class.

Responses to the interview question: What are some of the classroom practices which your teacher exhibits that makes you anxious?

All the students interviewed seems to be comfortable with the behaviour and attitudes of their mathematics teachers. Some of the representative responses given by the participants in this interview question include:

- ✓ My mathematics teacher does not announce test scores for outstanding performers to embarrass us.
- ✓ My teacher gives encouraging comments like “work hard” and “good work, keep it up” which motivates us.

- ✓ I think my mathematics teacher believes I can perform well in mathematics since I am in the best class.
- ✓ I remember one day when my teacher was teaching the tangent to a circle, I was struggling and he came to assist me and offer me a chance for a remedial lesson.
- ✓ My mathematics teacher does not use a cane when teaching neither does he assault us in class when we performed unsatisfactorily.

The responses show that most mathematics teachers in these schools have a lot of patience with students due to several professional training and for other reasons unrevealed. It can be frustrating for the teachers when they feel like they have taught a certain concept properly but the students do not understand or grasp the concept. This could explain why a teacher must develop that cordial reliable, enabling, and conducive environment for learners to accommodation and assimilation concepts taught and learnt.

4.3.2 Teaching approaches likely to cause mathematics anxiety

Literature was particular with teaching approaches likely to cause mathematical anxiety among Senior High School students. To investigate this, 10 possible items were extracted from literature to determine this conjecture and the results are presented in Table 21.

Table 21

Teaching Approaches (strategies)

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
1. My teacher gives us individual competitive mathematics tasks	84(31.1)*	23(8.5)	105(38.9)	27(10.0)	31(11.5)
2. My teacher likes independent mathematics work than a group.	36(13.3)	22(8.1)	68(25.2)	55(20.4)	89(33.0)
3. Teacher gives as too much mathematics homework problems.	111(41.1)	28(10.4)	74(27.4)	26(9.6)	31(11.5)
4. We are given a lot of mathematics work.	97(35.9)	36(13.3)	85(31.5)	26(9.6)	26(9.6)
5. We are given mathematics written (word problem) as class work.	77(28.5)	32(11.9)	101(37.4)	27(10.0)	33(12.2)
6. My teacher follows the textbook exactly and does not add any knowledge from a new source when teaching.	130(48.1)	23(8.5)	63(23.3)	25(9.3)	29(10.7)
7. My teacher insists on only one way of solving a problem in mathematics.	151(55.9)	19(7.0)	57(21.1)	22(8.1)	21(7.8)
8. My teacher emphasises on drill and practice (memorization of formula).	80(29.6)	27(10.0)	95(35.2)	30(11.1)	38(14.1)
9. My teacher teaches very fast.	80(29.6)	25(9.3)	96(35.6)	31(11.5)	38(14.1)
10. My teacher prepares us for examination rather than for understanding the concept.	110(40.7)	27(10.0)	65(24.1)	24(8.9)	44(16.3)

* **Percentages in parenthesis**

From the analysis, it appeared that the item "Teacher like independent mathematics work than group" topped the table with 33.0% ($f = 89$) responses. Also mentioned are

other activities initiated by the teacher that include: teacher emphasises on drill and practice (memorization of formula), the teacher teaches very fast, the teacher gives more of mathematics word problem as classwork, and the teacher gives more of individual competitive mathematics tasks.

The results of teaching approaches involving individual competitive mathematics activities are consistent with Sheilds (2006) who reported that individual competitive mathematics and independent mathematics activities as employed by teachers as a teaching strategies tend to result in students having higher mathematical anxiety. The findings also verified the work of some prior researchers such as Oberlin, (1982), Skemp, (1986), Arem (1993), Furner and Duffy (2002), Shields (2006), and McNaught (2007) which concluded that some classroom activities initiated by the teacher such as assigning mathematics homework as punishment for misbehaviour, giving written work every day in Mathematics and speed in getting answers could be the root cause of Mathematical anxiety.

Also, participants responses to the items that have to do with mathematics teachers who emphasize on drill and practice and those who focus on correct answers only without any room for justification were consistent with research studies by Skemp (1986), Shields (2006) and, Mtetwa and Garofalo (1989). However, the respondents have not connected their mathematical anxiety to teaching approaches in a greater context since the rate of disagreement was of a greater proportion to that of agreement on most of the items analysed.

Responses to the interview question: What are some of the ways your teacher normally teaches mathematics that makes you anxious?

These are representative of some common responses to the interview question.

- ✓ Most times, my teacher does not slow down during mathematics lessons. This made him just to concentrate on a few students. Certain topics are new to us and teachers should not just rush to complete them.
- ✓ When we have to memorise certain formulas like Almighty formula for a quadratic equation or trigonometry equations without much understanding to it, this pulls out my spirit from learning mathematics.
- ✓ This time, my teachers emphasize too much of work problems which some of us find difficult to solve. This makes me anxious because I always end up getting my answer wrong.
- ✓ Severally, my teacher uses one way of presenting his concept. This makes it difficult for us to sometimes understand difficult concepts. At least if he should have to vary it maybe we might have understood most things taught.
- ✓ Most of the teaching is abstract. Even illustrations sometimes are not used.

The argument that the beginning of mathematical anxiety can often be traced to negative classroom experiences perpetuated by the teacher seems particularly strong and well-documented by several researchers (Shields, 2006; Tobias, 1987; Stodolsky, 1985). From the responses, respondents suggested that some classroom practices likely to cause mathematics anxiety include teachers teaching fast, the demand for memorizing formulas, too much use of word problems while students find difficulty in working with it, adopting only a particular method of teaching always and abstract delivering. The reason why teachers may be rushing might be to complete the syllabus. The researcher finds no reason for teachers to rush in completing the syllabus since their primary objective in teaching should be that students understand the concepts taught properly and also should be able to apply them in solving daily problems in the society.

4.3.3 Parental influences likely to cause mathematical anxiety

Other studies are very optimistic about the influence of parents as connected to the students' mathematical anxiety. To investigate the influence of parents on mathematical anxiety, ten possible items were extracted from literature as shown in Table 22.

Table 22

Parental Influence

	Responses				
Questions	Never	Rarely	Sometimes	Most at times	Always
1. My parents' are too concern about my results in mathematics.	29(10.7)*	17(6.3)	38(14.1)	33(12.2)	153(56.7)
2. My parents' tell me not to worry because mathematics has been their problem.	170(63.0)	11(4.1)	45(16.7)	13(4.8)	31(11.5)
3. My parent gets angry when I did not succeed in mathematics.	49(18.1)	20(7.4)	73(27.0)	34(12.6)	94(34.8)
4. My parents gives low status to mathematics.	157(58.1)	21(7.8)	48(17.8)	19(7.0)	25(9.3)
5. My parents' pressurize me too much in learning mathematics.	63(23.3)	18(6.7)	71(26.3)	24(8.9)	94(34.8)
6. My parent expresses much disappointment and hopelessness towards anything mathematics and this demoralizes me.	119(44.1)	26(9.6)	53(19.6)	23(8.5)	49(18.1)
7. My parent shows a negative attitude toward mathematical tasks.	165(61.1)	28(10.4)	36(13.3)	16(5.9)	25(9.3)
8. My parent demonstrates their fear of mathematics.	155(57.4)	23(8.5)	51(18.9)	17(6.3)	24(8.9)
9. My parent thinks some people have a mathematical mind and I do not.	149(55.2)	23(8.5)	41(15.2)	25(9.3)	32(11.9)
10. My parent punishes me for bad scores in mathematics.	112(41.5)	16(5.9)	64(23.7)	25(9.3)	53(19.6)

* **Percentages in parenthesis**

The result revealed that 56.7% of the participants were of the view that their Mathematical anxiety stemmed from a situation where their parents always show concern about results in mathematics. Other factors that were also identified include a lack of support in mathematics from parents or guardians (Bulmahn & Young, 2000). Also, participants, closed to 50% acknowledged parents pressure on learning mathematics, and parents getting angry when they did not succeed in mathematics as potential causes of their mathematics anxiety (Fraser & Honeyford, 2000). However, a larger number of the participants 58.1% admitted that their parents never give low status to mathematics, 61.1% stated that their parents' never showed a negative attitude towards Mathematics which contradict with the findings of Lazarus (1974). Maybe this is because of the setup of the school and the social and economic status of the parents since most of them are working class. Eccles (1994) strengthens this argument by maintaining that parents who have traditional opinions about the abilities of their children may provide unnecessary anxieties in them.

4.3.4 Societal factors likely to cause mathematics anxiety

Society's myths about mathematics difficulties (Kogelman & Warren, 1978) is at the top of the list as 50% of the respondents were simply made to always believe that mathematics is a very difficult subject and that it has been the reason for their anxiety in mathematics.

Table 23

Societal Factors

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
1. My society has the perception that mathematics is difficult.	56(20.7)*	21(7.8)	58(21.5)	44(16.3)	91(33.7)
2. My society places low value (status) on mathematics.	87(32.2)	15(5.6)	85(31.5)	36(13.3)	47(17.4)
3. My society views a lack of mathematics skills as adequate or just enough to get by.	86(31.9)	26(9.6)	85(31.5)	36(13.3)	37(13.7)
4. My society does not support me to learn mathematics.	114(42.2)	25(9.3)	49(18.1)	33(12.2)	49(18.1)
5. My society believes that mathematics ability is inborn.	116(43.0)	13(4.8)	58(21.5)	34(12.6)	49(18.1)
6. My society believes that mathematics required a good memory.	47(17.4)	20(7.4)	68(25.2)	41(15.2)	94(34.8)
7. My society believes that men are better at mathematics than women.	92(34.1)	19(7.0)	54(20.0)	39(14.4)	66(24.4)
8. My society believes that mathematicians solve problems quickly in their heads.	55(20.4)	18(6.7)	60(22.2)	48(17.8)	89(33.0)
9. My society uses a variety of negative adjectives like boring, difficult, dry, hard etc. to describe mathematics.	66(24.4)	21(7.8)	72(26.7)	36(13.3)	75(27.8)
10. My society shows a negative attitude toward mathematical tasks.	73(27.0)	19(7.0)	85(31.5)	30(11.1)	63(23.3)

* **Percentages in parenthesis**

Also, more than 50% of the respondents most at the time perceived that society's beliefs that mathematics required a good memory, and mathematicians solve problems quickly in their heads can cause anxiety among students. Moreover, 41.1% of them always felt some negative adjectives used by society to describe mathematics can cause mathematical anxiety among students (Stolpa, 2005).

Likewise, a considerable number of participants, responses also opposes the findings from some studies. Approximately 42.2% of the respondents opposed the claim that the society does not support them to learn mathematics and 43.0% strongly disagree with the idea that their social beliefs that mathematics ability is inborn.

Responses to the interview question: In which way or what goes on in your society or your parent do which you think can cause mathematical anxiety?

Quite some respondents could not respond to this interview question. Eight representative comments include:

- ✓ My father normally sees no reason why I should fail mathematics exam.
- ✓ My parents are much worried about my performance in mathematics. They always asked me to go to an extra class in mathematics when I get home and it is sometimes boring.
- ✓ Comments such as "imagine the number of people out there without mathematics", "mathematics is very tricky" etc. that comes from the society sometimes demotivate me.
- ✓ My relatives and friends out there always describe mathematics as the most difficult discipline in the educational sector.
- ✓ The first question asked by most people in the society when I return from school was "have you excel in mathematics" and this sometimes discourages me from going home most especially when I found out that I didn't do well in mathematics.
- ✓ I get all the necessary support from my parents but I don't know why my performance in mathematics is still not encouraging.

- ✓ There is pressure on me in studying mathematics almost every day which to me is unnecessary pressure because sometimes I won't be feeling like doing it.
- ✓ When I see a lot of people going for remedial classes in mathematics I feel that there is something peculiar with this subject. My sister wrote mathematics more than five (5) times and still could not get even a pass mark.

Some of the responses confirmed research studies by Stolpa (2005) when he stated that the negative predispositions of the parent are a possible cause of mathematical anxiety. From the analysis, it could be realised that the respondents connect their mathematical anxiety to some comments like "imagine the number of people out there without mathematics", "mathematics is very tricky" and many more. Further, it is interesting to note that some participants still believe that one needs a mathematical mind to do well at mathematics and that to be good at the arts means one cannot be good at mathematics. Tobias (1987) questions whether one must have a mathematics mink for mathematics achievement.

This research has also unearthed parents or societies who believe mathematics is a very difficult subject and therefore requires more time with a teacher. Such desperate concern with results in mathematics ends up resorting to sending their children for extra lessons outside the school without consultation. Most students feel this could be another source of their unnecessary pressure on them.

4.3.5 Assessment practices likely to cause mathematics anxiety

To investigate the influence of assessment practices on mathematics anxiety, 10 possible causes were extracted from previous research literature as shown in Table 24.

The analysis, 70% of the respondents revealed that thinking about how to write final Mathematics examination has always been a possible cause of mathematical anxiety

among students. This is consistent with findings from literature which suggests that thinking about to write the mathematics final examination has an impact on the learners' mathematics anxiety (Shields, 2006). Also, 68.9% of the respondents unveiled that they had always been worried about poor test scores in mathematics. This finding is in line with situations suggested in the literature (Chinn, 2009; Shields, 2006) which are likely to cause mathematics anxiety amongst students.

Table 24

Assessment Practices

	Responses				
Questions	Never	Rarely	Sometimes	Most at times	Always
1. I am thinking about how to write my final Mathematics examination.	22(8.1)*	16(5.9)	43(15.9)	32(11.9)	157(58.1)
2. I am worried about my poor test scores in Mathematics.	17(6.3)	17(6.3)	50(18.5)	34(12.6)	152(56.3)
3. I am thinking about a surprise test in Mathematics which I might not be aware of.	30(11.1)	20(7.4)	76(28.1)	50(18.5)	94(34.8)
4. My Mathematics teachers place too much emphasis on timed tests.	50(18.5)	20(7.4)	97(35.9)	43(15.9)	60(22.2)
5. Knowing of wanting to write a Mathematics test shortly kept me worried.	43(15.9)	21(7.8)	75(27.8)	38(14.1)	93(34.4)
6. Writing a Mathematics test in competitive environments with peers makes me uncomfortable.	52(19.3)	20(7.4)	81(30.0)	32(11.9)	85(31.5)
7. I become nervous when studying for a Mathematics test.	47(17.4)	24(8.9)	94(34.8)	45(16.7)	60(22.2)
8. Our mathematics examination questions are too loaded.	40(14.8)	20(7.4)	79(29.3)	43(15.9)	88(32.6)

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
9. We are not given the chance to do a practical test in mathematics.	77(28.5)	27(10.0)	65(24.1)	38(14.1)	63(23.3)
10. Questions that are given in mathematics examination and test demand the use of formula, rather than my methods.	37(13.7)	22(8.1)	71(26.3)	49(18.1)	91(33.7)

* **Percentages in parenthesis**

Moreover, 51.8% of the students always find challenges with questions given in mathematics examination and test as it demands the use of formula, rather than their methods as 48.5% were of the view that mathematics examination questions were most at a time too loaded. Also, 43.4% of the participants suggested that mathematics test within competitive environments (Shields, 2006) with peers make them uncomfortable and has been a possible cause of their mathematical anxiety.

4.3.6 Personal factors likely to cause mathematical anxiety

Based on findings from previous literature, certain personal factors have been suggested to cause mathematical anxiety. As shown in Table 25, of the 10 possible causes of mathematical anxiety related to personal factors that were extracted from literature and surveyed, three (3) appeared to apply to participants. 64.5% of the respondents identified failure to complete Mathematics tasks making them worried always been their leading cause of mathematical anxiety. More than 50% of the participants connected their mathematical anxiety to being unable to work certain topics in mathematics making them uncomfortable, and impractical application of mathematics is problem-solving.

Table 25

Personal Factors

Questions	Responses				
	Never	Rarely	Sometimes	Most at times	Always
1. My failure to complete Mathematics tasks make me worried.	28(10.4)*	13(4.8)	55(20.4)	32(11.9)	142(52.6)
2. I am unable to work certain topics in Mathematics make me uncomfortable.	25(9.3)	13(4.8)	67(24.8)	38(14.1)	127(47.0)
3. I fail to ask my mathematics teacher questions in class.	61(22.6)	20(7.4)	83(30.7)	38(14.1)	68(25.2)
4. My attitude towards mathematics is not encouraging.	39(14.1)	26(9.6)	90(33.3)	35(13.0)	80(29.6)
5. I am not persistence in mathematics classes.	113(41.9)	28(10.4)	73(27.0)	23(8.5)	33(12.2)
6. I show low esteem in mathematics.	56(20.7)	26(9.6)	107(39.6)	30(11.1)	51(18.9)
7. I lack confidence (self-doubt) in mathematics.	50(18.5)	20(7.4)	94(34.8)	43(15.9)	63(23.3)
8. I lack positive perception about mathematics.	53(19.6)	23(8.5)	96(35.6)	36(13.3)	62(23.0)
9. I inadequately prepare for mathematics lessons.	51(18.9)	23(8.5)	95(35.2)	42(15.6)	59(21.9)
10. The impractical application of mathematics is my problem.	34(12.6)	19(7.0)	80(29.6)	49(18.1)	88(32.6)

* **Percentages in parenthesis**

However, 52.3% of the respondents disagreed attributing not been persistence in mathematics classes to their causes of mathematical anxiety.

Responses to the interview question: Tell me some personal factors which makes you feel anxious with mathematics?

Although just a few participants responded to this question, seven of their comments were related. Some of the representative responses include the following:

- ✓ I hardly have enough time to revise other subjects because mathematics takes almost all my time.
- ✓ I do not remember when I last enjoy mathematics lesson or even passed in mathematics. It looks like I always fail in mathematics examinations and tests.
- ✓ Personally, most concepts learnt for example logarithm, surd, trigonometry, indices etc. in mathematics are meaningless to me.
- ✓ Sometimes I feel very uncomfortable in mathematics class when I realised I can't contribute to what was going on. Even asking a question in the class is a problem.
- ✓ My anxiety made me not to devote enough time for mathematics.
- ✓ I feel I do not have what it takes to pass mathematics.
- ✓ I have been trying to practice mathematics on my own but of no avail. Sometimes it's because the concepts are too difficult.

From the various responses, the researcher deduced that mathematical anxiety of participants originated from their lack of confidence in mathematics. This lack of confidence could stemmed from a frequent failure in mathematics test or exam, or parents, or teachers comments or attitude. It appears that most students no longer have any hope of passing mathematics. Besides, poor test grades, lack of motivation and encouragement could also be led to students' loss of that zeal for learning mathematics.

The abstractness of the subject (Ferguson, 1986; Tobias, 1987) has also been suggested as another possible cause of mathematical anxiety among the students at their various schools such that students feel the subject demands more time while others feel

mathematics must be scrapped off from the core subjects or as a requirement for gaining admission into tertiary institutions.

4.3.7 Summary of the findings for research question 2

Figure 2 displays the summary of the accumulated CoMAS score for 270 Senior High School students per their responses on items at section C of the instrument.

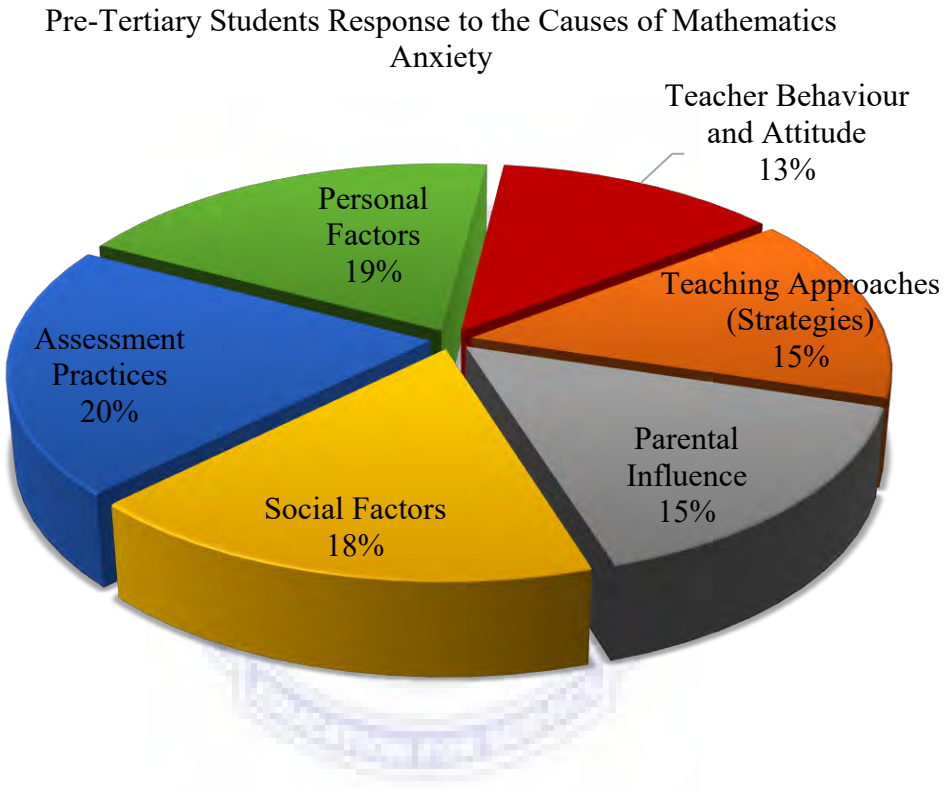

*Figure 17:*Result on prevalent causes of mathematics anxiety among Senior High School students

The result revealed that respondents asserted that assessment practices (20%) were the leading factor that possibly causes mathematical anxiety among them, followed by personal factors which rated 19%, and then social factors being 18%. It was also unveiled that the factor which students selected to be the least possible relating to the cause of mathematical anxiety is the teacher behaviour and attitude with was 13%. However, teaching approaches and parental influence tie on the chart.

4.4 Research Question 3

Does a significant correlation exist between students' mathematical anxiety and mathematics achievement?

To investigate if there was a statistically significant relationship between students' mathematical anxiety level, and their academic performance in mathematics, a Pearson correlation coefficient was computed.

4.4.2 Correlation coefficient for Mathematical Anxiety and Mathematics Achievement

The main analysis was performed with students' mathematical anxiety scores as the independent variable and their examination scores in mathematics as the dependent variable (see Table 26). There was a negative correlation between mathematical anxiety of students and their performance in mathematics, $r(268) = -.713,\ p < .05$. According to Nardi (2018), r values below $\pm.30$ are deemed to be weak, $\pm.30$ to $\pm.70$ are regarded as moderate, and above $\pm.70$ are considered as strong. The relationship was statistically significant; therefore we reject the null hypothesis and conclude that there is a negatively strong relationship between mathematics achievement and mathematical anxiety for Senior High School students. This implies that the more anxiety one has the lower one's mathematics achievement.

Table 26

SPSS has reported Mathematics Examination Score verse Mathematical anxiety

		Mathematics Examination Score	Anxiety Score
Mathematics Examination Score	Pearson Correlation	1	-.713**
	Sig. (2-tailed)		.000
	N	270	270
Anxiety Score	Pearson Correlation	-.713**	1
	Sig. (2-tailed)	.000	
	N	270	270

**. Correlation is significant at the 0.05 level (2-tailed).

4.5 Research Question 4

Do students' age and their mathematical anxiety predict their mathematics achievement?

4.5.2 The regression model

Table 27

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34921.643	2	17460.821	140.107	.000[b]
	Residual	33274.809	267	124.625		
	Total	**68196.452**	**269**			

a. Dependent Variable: Mathematics Examination Score

b. Predictors: (Constant), Age (in years), Anxiety Score

Table 28

Regression Model

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	108.468	13.617		7.966	.000		
Anxiety Score	-.361	.044	-.618	-8.168	.000	.319	3.132
Age (in years)	-1.470	.969	-.115	-1.518	.130	.319	3.132

A multiple linear regression analysis was conducted to evaluate how well students' mathematical anxiety level score and their age predicted their achievement in mathematics. The linear combination of these independent variables was significantly related to students' mathematics achievement, $F(2, 267) = 140.107,\ p < .05$ (see Table 27). From Table 9 the coefficient of determination (R) was 0.72, indicating that approximately 72% of the variance of students' achievement in mathematics can be accounted for by the linear combination of the mathematical anxiety level score and age. The R square (R^2) is the explanatory power which shows that 0.51 of the achievement in mathematics is explained by mathematical anxiety, and age (in years).

The B values tell the relationship between mathematics achievement and each predictor (anxiety score and age) (see Table 28). If the value is positive it indicates a positive relationship between the predictor and the outcome whereas a negative coefficient represents a negative relationship. For this model, both predictors have negative B values indicating a negative relationship. So, as anxiety score increases mathematics achievement decreases and as age increases mathematics achievement also decreases. Besides, from the analysis anxiety score, $t(267) = -8.168, p < .05$ is a significant predictor of mathematics achievement and contribute significantly to mathematics

achievement while age did not contribute significantly to mathematics achievement ($p = 0.130 > 0.05$).

4.6 Discussion of findings

The purpose of this study was to investigate the nature (levels, prevalent causes, and influence) of mathematical anxiety among Senior High School students and the extent to which age and anxiety level of students' can predict their academic achievement in mathematics. From the descriptive analysis, it appears that of the 270 participants questionnaires retrieved from various Senior High School institutions in the research area, 171 representing approximately 63% of the participants were females and 99 representing approximately 37% being males. The reason for such a large portion of female respondents to male was due to the programme pursued by the participants engaged which were non-science related programme. This implied that most females will prefer going for non-science related courses than science-related causes due to the anxiety they have towards mathematics (Adamu, 2014; Maloney, 2012). Researchers have found that there is a significant relationship between mathematical anxiety and gender since girl's experience higher mathematical anxiety than that of boys (Sahin, 2008; Woodard, 2004). Nevertheless, the gender distribution was not bias since the difference between the numbers of male to female was not too large.

Moreover, none of the participants aged below 15, with the majority of the students within 15 to 20 years representing 97.1% of the participants and just few 2.9% was within the ages of 21 to 23. This age category for the students is the average age category for learners in Senior High School institution who can comprehend and express their opinions as to the nature of their anxiety towards mathematics and how it influence their academic performance in mathematics. Student participants were

sampled from form three (third-year students) and non-science departments only. The reason was that the final year candidates had stayed longer in the school and had also sat for several mathematics examinations.

Further to that, most of the participants' residents at the hostel than boarding and day. Also, more than half of the participants attended government basic schools. Findings from the analysis also revealed that the educational level for the majority of the respondents' fathers was secondary education and that of their mothers was basic.

Research question one investigate the levels of mathematical anxiety among Senior High School students. From the analysis, it was discovered that students' had high mathematical anxiety. This high mathematical anxiety level of students was attributed to some behavioural, emotional and negative attitudes and beliefs students' exhibits and hold towards mathematics task. This was revealed when most of the respondents perceived mathematics to be the worse subject in their life and are much worried about mathematics than any other subject. This finding was supported by findings from other researches such as Umay (1996). He discovered that mathematics was perceived as a difficult subject by many people out there due to its nature and also individuals' preconceived notions about mathematics and the anxiety individuals have for the subject. However, Furner and Duffy (2002) pointed out that certain practices such as assigning mathematics work as punishment for misbehaving in a mathematics class can cause students to hate or dislike the subject. Moreover, literature also revealed that teacher's attitude and approach is crucial in developing the student's interest or dislike for mathematics (Schwartz, 2000).

Other beliefs and attitudes which emerged from the findings which create panic, fear, negative emotional, and negative attitude in participants connecting to the high

mathematical anxiety level of students' include being asked to go to mathematics class, feeling uncomfortable when asked to solve mathematics question on the board, loss of attention in mathematics class, perceiving studying mathematics just because it is a compulsory subject, feeling that there is little need for mathematics in most job places, feeling worried continuously that other colleagues might understand mathematics better than you, and many more. However, a larger proportion of respondents disclosed that mathematics during their basic school years has been interesting and they like to spend more time learning mathematics as well as do their homework by themselves.

In connection with these findings, research question two probed into the prevalent causes of mathematical anxiety among Senior High School students in Ghana. The findings from the analysis revealed that assessment practices top the chart as the prevailing causes of students' mathematical anxiety. This was much attributed to practices such as always been thinking about how to write final mathematics examination (Shield, 2006), worried about poor test scores in mathematics (Chinn, 2009; Shields, 2006), challenges with questions give in mathematics examination and test as it demands formula use rather than their methods, mathematics test within competitive environments with peers makes them uncomfortable, and impractical application of mathematics problem-solving. Following assessment practices are personal factors which were connected students' failure to complete mathematics tasks on time, and unable to work certain topics in mathematics. Next to personal factors is societal factors, then parental influence and teaching approach recording the same percentage, while the least factor was teacher behaviour and attitude. This finding contradict with that of Bush (1989) when he conducted a study to determine if a statistically significant relationship exists between mathematical anxiety and classroom practice. The study's findings showed a statistically significant relationship between

mathematically anxious teachers and their classroom practices. He concluded that mathematically anxious teachers tend to use more traditional teaching methods than non-traditional methods.

Research question three sought to find if mathematical anxiety influence students' performance in mathematics examination. A Pearson's product-moment coefficient was computed using the anxiety score as the independent variable. The test was statistically significant at $p < 0.05$ leading to the rejection of the null hypothesis and concluding that there is a significant relationship between these two variables. The result indicated a strong negative correlation between students' mathematical anxiety and their performance in mathematics. This implies that students who have higher mathematical anxiety are likely to perform worse in mathematics examination. This finding affirmed a meta-analysis study on mathematics anxiety conducted by Hembree (1990) which indicated that there was a negative relationship between mathematics anxiety and mathematics performance. Furthermore, research has also found that mathematics anxiety, coupled with poor mathematics skills, is interlinked as a possible causal relationship (Bai, Wang, Pan, & Frey, 2009). Moreover, the finding all agree with the result of Gierl and Bisanz (1995) when they surveyed students in grade 3 and 6 by using mathematics anxiety survey and collected the results of an achievement test in mathematics from school records and found that correlations between mathematics achievement and mathematical anxiety were moderate and negative for students in both grades such that students' mathematical anxiety accounted for a small but significant portion of the variability in mathematics achievement in grade 3 and grade 6.

Further to this, research question three also investigate if there was a significant relationship between students' mathematical anxiety and their age (in years). A Pearson's product-moment coefficient was computed using the age as the independent

variable. The test was statistically significant at $p < 0.05$ leading to the rejection of the null hypothesis and concluding that there is a significant relationship between these two variables. The result indicated a strong positive correlation between students' age and their mathematical anxiety. This infers that, as students grow in age, their mathematical anxiety level is likely to be increasing (Gierl & Bisanz 1995).

Lastly, a regression analysis was conducted to find out the extent to which age and mathematical anxiety score can predict students' academic performance in mathematics. The test was significant indicating that 72% of the variance of students' achievement in mathematics can be accounted for by the linear combination of their mathematical anxiety score and age. These findings conformed to the research of Cheema and Galluzzo (2013) when multiple regression framework was used to predict mathematics achievement from different variables (gender, mathematical anxiety and mathematics self-efficacy). They found out that, when mathematics self-efficacy and mathematical anxiety are properly controlled, students tend to attain high mathematics achievement despite their gender (Williams, 2015).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents a summary of major findings emanating from the analysis of the study, conclusions of findings and recommendation of the study

5.1 Summary of the Study

This research was conducted in government Senior High Schools of Agona West Municipal of Swedru, in the Central region of Ghana. The objective of this study was to investigate the nature (levels, prevalent causes, influence) of mathematical anxiety and the extent to which age and mathematical anxiety score can predict academic achievement in mathematics among Senior High School students. To attain these objectives all the three government senior high schools in the municipality were used for the study. This study aimed to address the following research questions:

1. What is the level of mathematical anxiety among Senior High School students' in Agona West Municipality of Ghana?
2. What are the prevalent causes of mathematical anxiety among Senior High School students in Agona West Municipality of Ghana?
3. Does a significant correlation exist between students' mathematical anxiety and mathematics achievement?
4. Do students' age and their mathematical anxiety predict their mathematics achievement?

The study adopted a cross-sectional survey design and mixed-method approach to collect both qualitative and quantitative data. The survey focused on Senior High School students in all public institutions in Ghana as the target population but used Agona West Municipality as the accessible population. Moreover, the sample of this study was taken from the three SHSs in the municipality using a simple random sampling technique. In all 270 participants were sampled for the study. The instrument for data collection was both close-ended questionnaire, a semi-structured interview guide, and a score sheet for collecting secondary data on students' mathematics examination scores. Frequency counts and percentages were the test statistics used to analyze and present the responses to the questionnaire. Besides this, the researcher used Pearson's product-moment correlation coefficient to determine the relationship between mathematical anxiety, mathematics performance and age. A regression analysis was also used to develop a model for predicting mathematics performance using mathematical anxiety score and age. Moreover, the interviews were transcribed and the common responses were presented using descriptive words.

5.1.1 The level of mathematics anxiety among Senior High School students in Agona West Municipal

Mathematical anxiety is a genuine issue which can have negative effects in the future of the student. Research has shown that mathematics anxiety is negatively correlated with mathematics performance and as such should be addressed if educators want to improve the product in the education system. This current study investigated the mathematical anxiety level among Senior High School students in Agona West Municipality of Ghana.

The results show that the participants in the study experience different levels of mathematical anxiety. However, the level of mathematics anxiety is high among Senior High School students in general as it has recorded 64% being the highest among the three states. These findings are consistent with previous studies (Hadley & Dorward, 2011; McAnallen, 2010) that reported varying levels of mathematical anxiety among participants from the elementary schools. The panic, fear, negative emotional attitude that students exhibits such as perceiving mathematics as the most difficult and abstract subject develops worries in their memory which evolve their mathematics anxiety. As stated by Schwartz (2000) attitude and approach is crucial in developing the students' interest or dislike for mathematics. Meaning if the students' perception and attitude towards mathematics remain unchanged they will continue to develop into higher levels of mathematics anxiety. These findings are also supported by Cemen (1987), and Miller and Mitchell (1994) when they found out that mathematics anxiety originates from intellectual factors such as being taught with uneven learning styles, student attitude and lack of persistence, self-doubt, lack of confidence in mathematical ability, and lack of perceived usefulness of mathematics. Teachers must, therefore, devices mechanisms to limit such fear, panic and emotional attitude among students. Forgasz (1995) believed that interactions between students and teachers greatly influence a student's abilities, weaknesses, strengths, and mathematical journey. This means students' beliefs and attitudes towards mathematics can be shaped from the beliefs held by their teachers.

5.1.2 The prevalent causes of mathematics anxiety among Senior High School students

The findings from the analysis unearthed that the prevalent causes of students' mathematics anxiety stemmed from assessment practices. This finding is consistent with previous studies (Shields, 2006) which reported that poor test scores and too much emphasis on timed tests propagate mathematics anxiety. Moreover, Hamamunda (2016) in his study also identified assessment practices as one of the four major factors which cause mathematics anxiety among learners. Woodard (2004) recommended the use of mathematics tests that include justification of the processes involved in arriving at an answer to allow teachers to give partial credit for a correct understanding of the process even if the result is incorrect. He pointed out that the assessment process for mathematics should be more flexible and include the use of oral questioning and computing devices to accommodate students with different learning styles.

Next to assessment practices is personal factors, then followed by societal factors, parental influence, teaching approaches and lastly teachers' behaviour and attitude.

5.1.3 The influence of mathematics anxiety on students' academic performance in mathematics.

The result of Pearson's' correlation coefficient indicated a strong negative relationship between mathematics anxiety and achievement in mathematics. This finding is consistent with the literature (Christie, 2011; Paul & Hlanganipai, 2014) when it was previous research has shown that a serious and common obstacle for many children's poor performance in mathematics across all grade levels is mathematical anxiety. This signified that once anxiety levels increase outside a point, performances disintegrates quickly leading to the deterioration of concentration, loss of the ability to perform

coordinated physical and mental activities, and ceases a person from having control over the task in hand. However, Hembre (1990) found out from his study that reducing mathematics anxiety also improves mathematics performance.

5.1.4 Predicting mathematics achievement using anxiety score, and age

In addition to finding out the various relationships that exist between mathematics anxiety, age, and mathematics achievement, the result also attests that anxiety score and age could be used as a predictor variable in predicting students' mathematics achievement. This finding is consistent with other studies findings (Cheema & Galluzzo. 2013; Williams, 2015) when they came out with a model that predicts students mathematics achievement using independent variables such as gender, mathematics anxiety score, mathematics self-efficacy etc.

5.2 Conclusion

This research has verified the nature of mathematics anxiety and the extent to which age and anxiety score can be used to predict students' academic performance as stated in the literature. Though the current research may have some similarities, some notable differences to the prior studies could be noticed. For instance, previous literature identified teachers' behaviour and attitude as the principal causes or the originated causes of mathematics anxiety among learners which has contradicted with these research findings. The result shows that Senior High School students have a higher level of mathematics anxiety which stemmed from assessment practices and have an inverse relationship with students performance in mathematics as well as directly proportional to students' age such that age and anxiety score can be used to predict students' academic performance.

The study, therefore, concludes that;

- ✓ Senior High School students have a high level of mathematical anxiety
- ✓ The prevalent causes of their mathematical anxiety are highly connected to assessment practices such as poor test preparation and taking, test item structure, assessment administration conditions and environment, mode of assessment items, scoring strategies etc., followed by personal factors, societal influence, parental influence, teaching approaches and teachers' behaviour and attitude.
- ✓ There is an inverse relationship between Senior High School students' mathematical anxiety and mathematics achievement.
- ✓ Mathematical anxiety score can be used to predict the mathematics achievement of a Senior High School student.

These research findings have consequences both for future research on mathematical anxiety and for teaching and learning of mathematics in Senior High School institutions.

5.3 Recommendations

Based on the findings of this research, the researcher makes the following recommendations:

- Positive attitudes towards learning and performing well in mathematics are necessary for Senior High School mathematics education. Therefore there is the need for teachers, parents and any other education stakeholder to enhance these positive attitudes.

- There is a successive connection between attitudes, learning, performance and practical utility of mathematics. So, this connection should be established early enough in Senior High School students' mathematics education.
- The adverse attitudes demonstrated by students towards mathematics learning should be truncated professionally and early enough before students utterly give up in learning and or performance in mathematics.
- Mathematics teachers should utilize available learning resources to enhance positive attitudes, reinforce neutral attitudes, if any, and neutralize any negative attitude towards learning and performance in mathematics.
- Efforts should be made to ensure age does not hinder learning and or performance in mathematics among Senior High School students. Teachers, parents, society, and all stakeholders should encourage both young and aged, female and male learners to equally embrace mathematics.
- The enabling environment in which students do not feel threatened should be created for mathematics teaching and learning.
- The use of cooperative learning groups should be encouraged to assure students that some of their peers have the same problems as they do.
- Teachers should teach at a slower pace to help create a better understanding of the materials being taught.
- The study has established that there is a relationship between students' mathematical anxiety and their academic performance as well as their ages. It is therefore recommended that further study should be done to probe into the effect of students' mathematical anxiety on their performance in other disciplines.

5.4 Suggestion for Further Research

This study was carried out in a municipality. Similar studies could be carried out in other parts of the country to gather adequate information on the subject so that the findings can be generalized.

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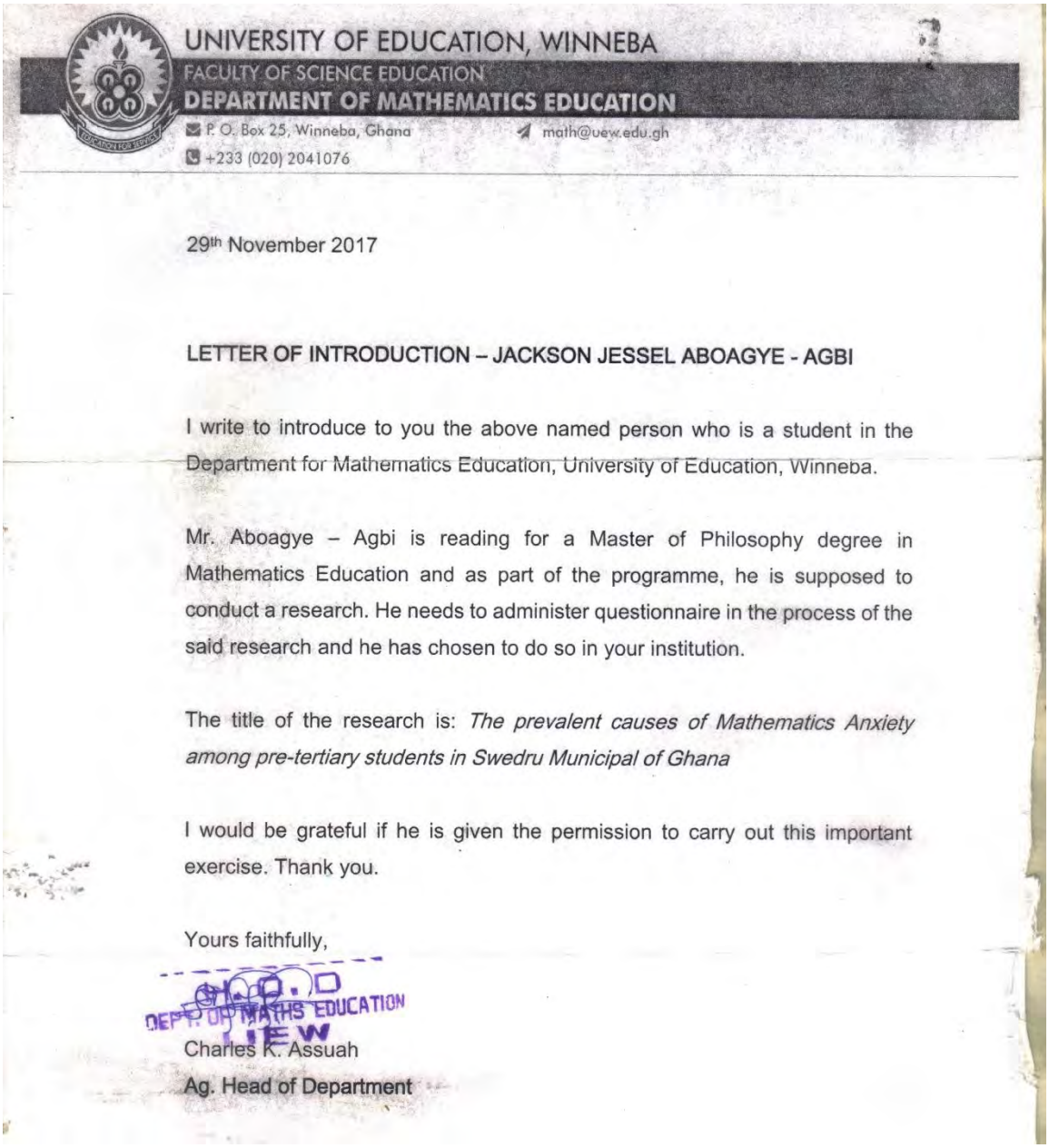
APPENDIX A

INTRODUCTION LETTER FROM UEW

A scanned copy of an introductory letter from the Department of Mathematics Education, UEW



UNIVERSITY OF EDUCATION, WINNEBA
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DEPARTMENT OF MATHEMATICS EDUCATION
P. O. Box 25, Winneba, Ghana
math@uew.edu.gh
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29th November 2017

LETTER OF INTRODUCTION – JACKSON JESSEL ABOAGYE - AGBI

I write to introduce to you the above named person who is a student in the Department for Mathematics Education, University of Education, Winneba.

Mr. Aboagye – Agbi is reading for a Master of Philosophy degree in Mathematics Education and as part of the programme, he is supposed to conduct a research. He needs to administer questionnaire in the process of the said research and he has chosen to do so in your institution.

The title of the research is: *The prevalent causes of Mathematics Anxiety among pre-tertiary students in Swedru Municipal of Ghana*

I would be grateful if he is given the permission to carry out this important exercise. Thank you.

Yours faithfully,

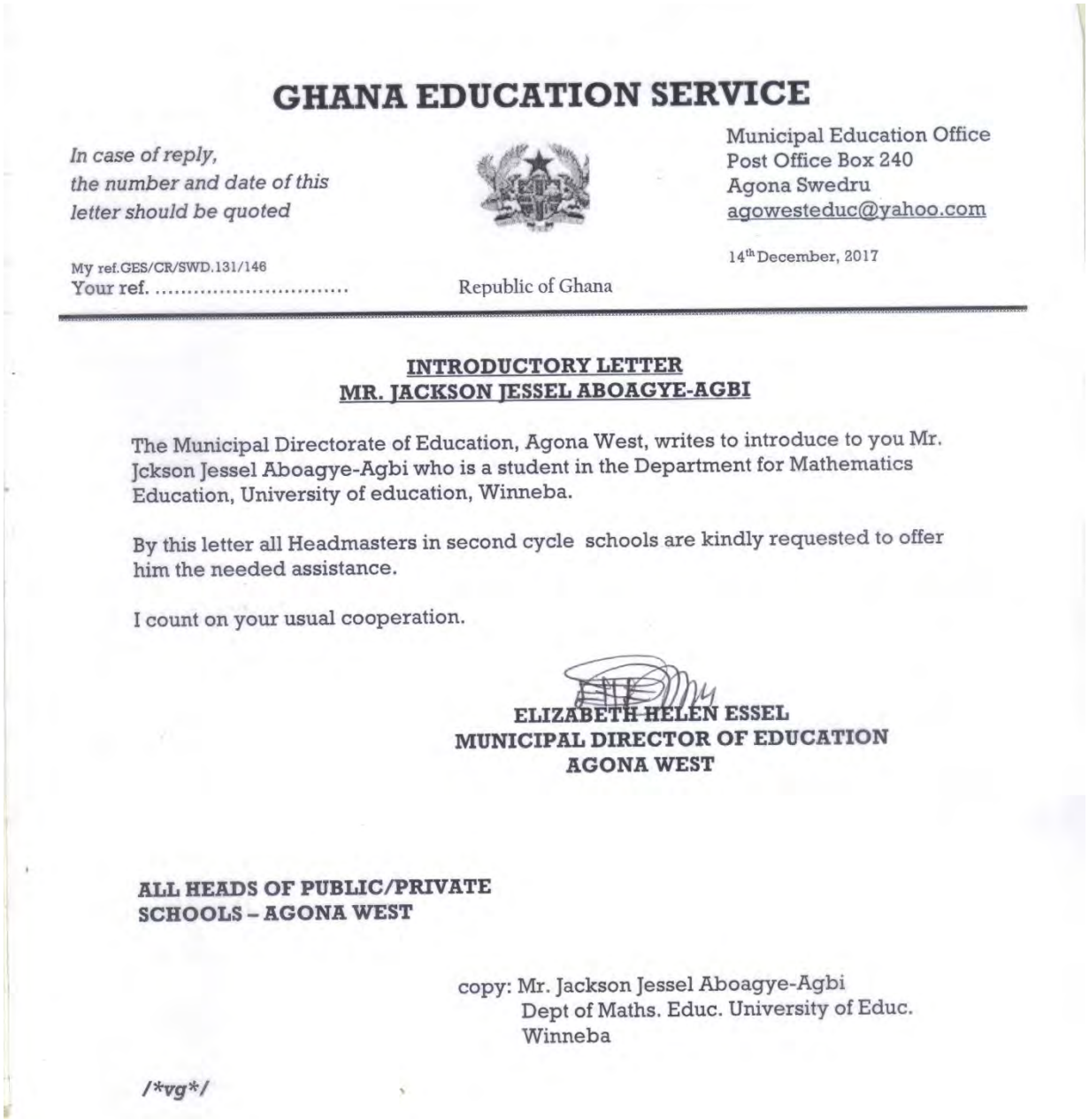
DEPT. OF MATHS EDUCATION
UEW

Charles K. Assuah
Ag. Head of Department

APPENDIX B

INTRODUCTORY LETTER FROM GES

A scanned copy of an introductory letter from Agona West Municipal Director of Education.



GHANA EDUCATION SERVICE

In case of reply, the number and date of this letter should be quoted

My ref.GES/CR/SWD.131/146
Your ref. .....

Republic of Ghana

Municipal Education Office
Post Office Box 240
Agona Swedru
agowesteduc@yahoo.com

14th December, 2017

INTRODUCTORY LETTER
MR. JACKSON JESSEL ABOAGYE-AGBI

The Municipal Directorate of Education, Agona West, writes to introduce to you Mr. Jckson Jessel Aboagye-Agbi who is a student in the Department for Mathematics Education, University of education, Winneba.

By this letter all Headmasters in second cycle schools are kindly requested to offer him the needed assistance.

I count on your usual cooperation.

ELIZABETH HELEN ESSEL
MUNICIPAL DIRECTOR OF EDUCATION
AGONA WEST

ALL HEADS OF PUBLIC/PRIVATE SCHOOLS – AGONA WEST

copy: Mr. Jackson Jessel Aboagye-Agbi
Dept of Maths. Educ. University of Educ.
Winneba

/*vg*/

APPENDIX C

SAMPLE SIZE CHART

Sample size, confidence levels and confidence intervals for random samples

Population	Confidence level 90 per cent			Confidence level 95 per cent			Confidence level 99 per cent		
	Confi-dence	Confi-dence	Confi-dence	Confi-dence	Confi-dence	Confi-dence	Confi-dence	Confi-dence	Confi-dence
30	27	28	29	28	29	29	29	29	30
50	42	45	47	44	46	48	46	48	49
75	59	64	68	63	67	70	67	70	72
100	73	81	88	79	86	91	87	91	95
120	83	94	104	91	100	108	102	108	113
150	97	111	125	108	120	132	122	131	139
200	115	136	158	132	150	168	154	168	180
250	130	157	188	151	176	203	182	201	220
300	143	176	215	168	200	234	207	233	258
350	153	192	239	183	221	264	229	262	294
400	162	206	262	196	240	291	250	289	329
450	170	219	282	207	257	317	268	314	362
500	176	230	301	217	273	340	285	337	393
600	187	249	335	234	300	384	315	380	453
650	192	257	350	241	312	404	328	400	481
700	196	265	364	248	323	423	341	418	507
800	203	278	389	260	343	457	363	452	558
900	209	289	411	269	360	488	382	482	605
1,000	214	298	431	278	375	516	399	509	648
1,100	218	307	448	285	388	542	414	534	689
1,200	222	314	464	291	400	565	427	556	727
1,300	225	321	478	297	411	586	439	577	762
1,400	228	326	491	301	420	606	450	596	796
1,500	230	331	503	306	429	624	460	613	827
2,000	240	351	549	322	462	696	498	683	959
2,500	246	364	581	333	484	749	524	733	1,061
5,000	258	392	657	357	536	879	586	859	1,347
7,500	263	403	687	365	556	934	610	911	1,480
10,000	265	408	703	370	566	964	622	939	1,556
20,000	269	417	729	377	583	1,013	642	986	1,688
30,000	270	419	738	379	588	1,030	649	1,002	1,737
40,000	270	421	742	381	591	1,039	653	1,011	1,762
50,000	271	422	745	381	593	1,045	655	1,016	1,778
100,000	272	424	751	383	597	1,056	659	1,026	1,810
150,000	272	424	752	383	598	1,060	661	1,030	1,821
200,000	272	424	753	383	598	1,061	661	1,031	1,826
250,000	272	425	754	384	599	1,063	662	1,033	1,830
500,000	272	425	755	384	600	1,065	663	1,035	1,837
1,000,000	272	425	756	384	600	1,066	663	1,036	1,840

APPENDIX D

MATHEMATICAL ANXIETY LEVEL AND PREVALENT CAUSES SURVEY QUESTIONNAIRES FOR STUDENTS

I appreciate your effort in taking time to complete this questionnaire. The researcher wishes to thank you in advance for your input in making this research a success. The questionnaire is divided into sections **A, B** and **C**. Please read each section **carefully** and provide your response in relation to the instruction that may be given as a guideline.

SECTION A: Bio Data

1. Name of Institution (School): ……
2. Gender (tick): Male [ ] Female [ ]
3. Age (in years): ……..…...
4. Programme of study: ……..……..
5. Residential status: Boarder [ ] Hostel [ ] Day [ ]
6. Best subject in High School: ……..…….……..
7. Worst subject in High School: …….…….
8. What will you like to study for Degree if you pass: ……..……...
9. Educational level of Father:
    a. No formal education [ ]
    b. Basic [ ]
    c. Secondary [ ]
    d. Polytechnic/College of Education/Nursing Training [ ]
    e. University [ ]
10. Educational level of Mother:

a. No formal education [ ]

b. Basic [ ]

c. Secondary [ ]

d. Polytechnic/College of Education/Nursing Training [ ]

e. University [ ]

11. Father's occupation: ……...……..

12. Mother's occupation: ……..……..

13. Basic school attended: Government [ ] Private [ ]

14. Which year have you completed JHS?.....

SECTION B: Measuring Mathematical Anxiety Level using Modified Mathematics Anxiety Rating Scale (Mod-MARS)

Below is a list of statements with responses. The items in this section describes variables such as **fear, negative emotional feeling and negative attitudes** that we exhibit as a result of mathematics anxiety as identified by literature. I hope and believe you will address each statement to the **best** of your ability. Your cooperation would be highly appreciated and all information given will be kept strictly confidential. Please do not write **your name** or any other personal **contact number** on any part of this booklet. Tick (√) the option that **best** describe your level of **agreement** with the statement.

B1: Fear and panic towards mathematics tasks

At the responses column**, N = Never; R = Rarely; ST = Sometimes; MT = Most of the time; AL = Always.**

Questions	Responses				
	N	R	ST	MT	AL
1. I become disturbed when I have to go to mathematics class.					
2. I feel uncomfortable when asked to go to the board or being called to answer question in a mathematics class.					
3. I am afraid to ask my teacher questions in mathematics class					
4. I tend to lose my attention in mathematics class.					
5. I fear mathematics tests more than any other subjects.					
6. I am afraid I would not be able to keep up with the rest of my colleagues in mathematics in the class.					
7. I do not know how to study for mathematics tests.					
8. I understand what is taught clearly in mathematics class but when I go home it is like I have never attended mathematics class.					
9. I feel worried buying mathematics textbook.					
10. I become more confused when I picked my mathematics homework book to work on.					
11. I fear to discuss mathematics issues with my colleagues.					
12. When I hear the word ‘mathematics’ I become disturbed.					
13. I panic when I see my mathematics teacher coming to class.					
14. Mathematics has been my worst subject in life.					
15. I am much worried about mathematics than any other subject.					

B2: Negative emotional feeling towards mathematics task

At the responses column**, SD = Strongly Disagree; D = Disagree; N = Neither Agree nor Disagree; A = Agree; SA = Strongly Agree.**

Questions	Responses				
	SD	D	N	A	SA
1. I am sure I cannot learn mathematics.					
2. I will never go in for any mathematics related programme in my further education.					
3. No teacher can make be like mathematics.					
4. I am not sure I can do mathematics myself.					
5. I study mathematics because it is a compulsory subject.					
6. There is little need for mathematics in most job places.					
7. Most of the ideas in mathematics are not very useful.					
8. No matter how hard I try, I cannot understand mathematics.					
9. I will like a job that does not use any mathematical knowledge.					
10. I can get along perfectly well in everyday life without mathematics.					
11. Mathematics is for smart people.					
12. I worried that other students might understand mathematics problems better than me.					
13. I worried that I will not be able to complete every assignment in a mathematics course.					
14. I worried that I will not be able to get 'A' in my mathematics course.					
15. Everyone's mathematics ability is determined at birth.					

B3: Negative attitude towards mathematics tasks.

At the responses column**, SD = Strongly Disagree; D = Disagree; N = Neither Agree nor Disagree; A = Agree; SA = Strongly Agree.**

Questions	Responses				
	SD	D	N	A	SA
1. Mathematics as a subject during my Primary and Junior High school years was my least favourite.					
2. I have always struggled with anything that involves numeracy from my primary school days.					

3. My performance in mathematics during my early school years was hardly above average.					
4. I often do not like mathematics lesson periods because it bores me.					
5. Mathematics course during my Junior High school years was easier to understand compared to mathematics at Senior High.					
6. Mathematics during my basic school years has never been interesting to me.					
7. I will like to spend less time learning mathematics at school.					
8. I am never bordered to learn mathematics.					
9. I hardly read my mathematics textbook before coming to class.					
10. Someone does my homework for me most times or else I copy from my colleagues.					

SECTION C: Causes of Mathematical Anxiety Scale (CoMAS)

Below are lists of common factors that could made you develop **fear and panic, negative emotional feeling, and negative attitude** towards mathematics and are related to your mathematics experience in and outside the classroom. I hope and believe you will address each statement to the best of your ability. Your cooperation would be highly appreciated and all information given will be kept strictly confidential. Please do not write your **name** or any other personal **contact number** of any part of this booklet. Tick (√) the option that best describe your level of agreement with the statement.

C1: Teacher Behaviour and Attitude

At the responses column**, N = Never; R = Rarely; ST = Sometimes; MT = Most of the time; AL = Always.**

Questions	Responses				
	N	R	ST	MT	AL
1. My mathematics teacher fears and panics when teaching.					

2. My teacher forces students to work questions on board which we are not sure of.					
3. My teacher uses threatening comments on us.					
4. My teacher does not explain concepts fully to our understanding.					
5. My teacher fails to consider students feelings both in class when teaching, outside class and outside school setting.					
6. My teacher ignores us and avoids eye conduct with us.					
7. My teacher lacks patience with us.					
8. My teacher is so unsympathetic and incorrectly assumes that computational processes are simple.					
9. My teacher embarrasses and humiliates us for solving mathematics questions wrongly on the board.					
10. My teacher sometimes demonstrates anger in class when teaching mathematics.					
11. My teacher never does remedial on the areas we do not understand in mathematics.					
12. My teacher demonstrate uncaring attitude towards students in mathematics class.					
13. My teacher does not respond to our mistakes and misunderstandings with explanations in mathematics.					
14. My teacher responds negatively to questions from students.					
15. My teacher lacks interest in and enthusiasm for teaching mathematics.					
16. My teacher thinks mathematics ability is inborn, rather than a skill which can be developed.					
17. My teacher treats students unfairly in mathematics class.					
18. My teacher lacks the necessary communication needed for mathematics.					
19. My teacher provides little motivational support during mathematics lessons.					
20. My teacher does not know when we are having trouble with our mathematics work.					

C2: Teaching Approaches (strategies)

At the responses column**, N = Never; R = Rarely; ST = Sometimes; MT = Most of the time; AL = Always.**

Questions	Responses				
	N	R	ST	MT	AL

1. My teacher gives us individual competitive mathematics tasks					
2. My teacher like independent mathematics work than group.					
3. Teacher gives as too much mathematics homework problems.					
4. We are given high volumes of mathematics work.					
5. We are given mathematics written (word problem) as class work.					
6. My teacher follows the textbook exactly and does not add any knowledge from new source when teaching.					
7. My teacher insists on only one way of solving a problem in mathematics.					
8. My teacher emphasises on drill and practice (memorization of formula).					
9. My teacher teaches very fast.					
10. My teacher prepares us for examination rather than for understanding the concept.					

C3: Parental Influence

At the responses column**, N = Never; R = Rarely; ST = Sometimes; MT = Most of the time; AL = Always.**

Questions	Responses				
	N	R	ST	MT	AL
1. My parents are too concern about results in mathematics.					
2. My parents tell me not to worry because mathematics has been their problem.					
3. My parents gets angry when I did not succeed in mathematics.					
4. My parents gives low status to mathematics.					
5. My parents pressurize me too much in learning mathematics.					
6. My parents expresses much disappointment and hopelessness towards anything mathematics and this demoralizes me.					
7. My parents show negative attitude towards mathematical tasks.					
8. My parents demonstrates their own fear with mathematics.					

Questions	Responses				
	N	R	ST	MT	AL
9. My parents think some people have mathematical mind and I do not.					
10. My parents punish me for bad scores in mathematics.					

C4: Societal Factors

At the responses column, **N = Never; R = Rarely; ST = Sometimes; MT = Most of the time; AL = Always.**

Questions	Responses				
	N	R	ST	MT	AL
1. My society has the perception that mathematics is difficult.					
2. My society place low value (status) on mathematics.					
3. My society views lack of mathematics skills as adequate or just enough to get by.					
4. My society does not support me to learn mathematics.					
5. My society beliefs that mathematics ability is inborn.					
6. My society beliefs that mathematics required a good memory.					
7. My society beliefs that men are better at mathematics than women.					
8. My society beliefs that mathematicians solve problems quickly in their heads.					
9. My society uses a variety of negative adjectives like boring, difficult, dry, hard etc. to describe mathematics.					
10. My society shows negative attitude towards mathematical tasks.					

C5: Assessment Practices

At the responses column, **N = Never; R = Rarely; ST = Sometimes; MT = Most of the time; AL = Always.**

Questions	Responses				
	N	R	ST	MT	AL
1. I am thinking about how to write my final Mathematics examination.					
2. I am worried about my poor test scores in Mathematics.					

3. I am thinking about a surprise tests in Mathematics which I might not be aware of.					
4. My Mathematics teachers place too much emphasis on timed tests.					
5. Knowing of wanting to write Mathematics test in the near future kept me worried.					
6. Writing a Mathematics test within competitive environments with peers make me uncomfortable.					
7. I become nervous when studying for a Mathematics test.					
8. Our mathematics examination questions are too loaded.					
9. We are not given chance to do practical test in mathematics.					
10. Questions given in mathematics examination and test demand for formula use rather than my own methods.					

C6: Personal Factors

At the responses column**, N = Never; R = Rarely; ST = Sometimes; MT = Most of the time; AL = Always.**

Questions	Responses				
	N	R	ST	MT	AL
1. My failure to complete Mathematics tasks make me worried.					
2. I am unable to work certain topics in Mathematics make me uncomfortable.					
3. I fail to ask my mathematics teacher questions in class.					
4. My attitude towards mathematics is not encouraging.					
5. I am not persistence in mathematics classes.					
6. I show low esteem in mathematics.					
7. I lack confidence (self-doubt) in mathematics.					
8. I lack positive perception about mathematics.					
9. I inadequately prepare for mathematics lessons.					
10. The impractical application of mathematics is my problem.					

APPENDIX E

SEMI-STRUCTURED INTERVIEW PROTOCOL

Introduction

I appreciate your effort in taking time to respond to this interview. The researcher wishes to thank you in advance for your input in making this research a success. The interview is designed to collect information from you concerning our feelings, attitude, and some basic factors that influence those variables. Please listen to each question that will be asked carefully and provide you response to the instruction that may be given as a guideline.

Interview guide

1. Do you like mathematics? Why yes or no?
2. Did you like mathematics when you were in basic school? Explain.
3. What makes mathematics easy or difficult for you?
4. Have you ever had a really bad experience with mathematics? If so, what happened?
5. How do you feel using or doing mathematics either in or out of school?
6. Describe how you feel in a mathematics environment.
7. How will you describe mathematics to someone?
8. What are some of the classroom practices which your teacher exhibits that makes you anxious?
9. What are some of the ways your teacher normally teaches mathematics that makes you anxious?
10. In which way or what goes on in your society or your parent do which you think can cause mathematical anxiety?
11. Tell me some personal factors which makes you feel anxious about mathematics?

Thank you for your cooperation.