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GENDER AND MATHEMATICS ACHIEVEMENT OF STUDENTS IN BIMBILLA COLLEGE OF EDUCATION. GHANA

YUSSIF ISSAHAQ

2018

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A THESIS IN THE DEPARTMENT OF MATHEMATICS EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF EDUCATION DEGREE IN MATHEMATICS EDUCATION

SEPTEMBER,2018.

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DECLARATION

Student's Declaration

I, hereby declare that this dissertation, 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 Master's degree elsewhere.

NAME OF STUDENT: YUSSIF ISSAHAQ,

SIGNATURE ……………………………………

DATE……………………………………………

Supervisor's Declaration

I hereby declare that the preparation and presentation of this dissertation were done in accordance with the guidelines for supervision of dissertation laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR. J. M. NABIE

SIGNATURE: …………………………………

DATE:…………………………………………

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ACKNOWLEDGEMENTS

My sincere gratitude goes to my supervisor, Dr. J. M. Nabie, who provided an invaluable assistance in guiding me through the completion of this research. I would also want to express gratitude to Mr. A. Abu-Wemah, Principal of Bimbilla College of Education, for his encouragement and support. I cannot forget to thank Mr. Julius .K. Amartey, Academic Affairs Officer of Bimbilla College of Education, for his advice and moral support, and all those who helped me in diverse ways to successfully complete this dissertation.

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DEDICATION

To my lovely wife, Hassan Rafiatu for her encouragement and prayers for the successful completion of the programme.

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ABSTRACT

This study was conducted at Bimbilla College of Education. It examined gender differences in mathematics achievement among students. The descriptive cross-sectional design was employed for this study. Thirty (30) college students were sampled via stratified and simple random sampling techniques for the study. Questionnaire (Cronbach's alpha = 0.73), and mathematics test items were used as data collection instruments. The data collected were analysed quantitatively using descriptive (frequency counts, percentages, mean, standard deviation) and inferential statistics (independent samples t-test) via Statistical Product and Service Solutions (SPSS) version 21. The study reveals a significant gender differences in mathematics achievement among the students ($p \leq .05$) as the male students outperformed their female counterparts in mathematics test. Weak foundation in mathematics as well negative perceptions and attitudes of learners towards mathematics primarily account for the gender differences in mathematics achievement among the students. It is recommended that mathematics tutors in the E. P. College of Education- Bimbilla give female students equal opportunities in the classroom to boost their confidence in the subject. They should also use appropriate media and teaching approaches which are grounded in learner centred pedagogies to make mathematics learning meaningful to the students.

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CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background to the study, statement of the problem, purpose of the study, the objectives of the study, research questions, the significance of the study, hypothesis, delimitation of the study, limitations of the study, and organization of the study.

1.1 Background to the study

The introduction of formal education in Ghana did not advocate discrimination. It is for this reason that children of both sexes are given equal opportunities to pursue formal education. However, since equal opportunity given to males and females does not imply equal achievement, there is the need to assess and compare the academic achievement of males and females in schools (Wilmot, 2001), particularly in mathematics. This is because there are still unjustifiable gender variations in interest in pursuing mathematics and its related disciplines.

Mathematics occupies an important place in schools. This is because, it plays an important role of providing knowledge and skills that every human being, including boys and girls need to acquire in order to become efficient and effective in dealing with real life problems. Also, the development in almost all areas of life is based on effective knowledge of science and mathematics for problem solving. It is for this reason that Eshun, Fameyeh and Ziggah (2009) argue that children need to learn mathematics in order to understand the world around them. Hence, the importance of mathematics in the development of every nation cannot be overemphasized.

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In Ghana, mathematics is a compulsory subject in all pre-tertiary institutions, and even in some tertiary institutions such as Colleges of Education (CoE). At the CoE, the mathematics syllabus builds on the knowledge and competencies developed at the junior and senior high school levels. In realization of the significant role of mathematics education, the Government of the Republic of Ghana made the subject compulsory to ensure the development of mathematics literacy, logical and abstract thinking skills needed for living, problem solving and for advance studies in mathematics related disciplines. For full realization of the objective of mathematics education, subject mastery and demonstrated achievement should be evenly distributed across gender. Unfortunately, mathematics as a subject is mostly considered to be difficult by many students, particularly girls. Consequently, gender inequality and differences in mathematics education and achievement have remained a perennial problem of global scope (UNESCO, 2003; Reid, 2003; Bordo, 2001).

One issue which has generated much debate in educational circles over the years is the question of whether differences in performance exist between males and females in mathematics learning tasks. A definite answer to this question seems to be a complex one. Thus, gender issues are currently the main focus of discussion in the world over. The complexity of gender performance in mathematics arises because empirical and theoretical literatures have produced diverse and contradictory results (Oluwatayo, 2011).

Gender issues abound in all spheres of the society. Gender involves the psychological and socio-cultural dimensions of being male or female (Ewumi, 2012). It is a set of characteristics distinguishing between male and female, particularly in the cases of men and women. Therefore, gender in common usage refers to the sexual distribution between male and female. Social scientists however refer to gender as a social

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construction rather than a biological phenomenon. Depending on the context, the discriminating characteristics vary from sex in the social role to gender identity. Gender role describes a set of expectations that prescribes how females or males should think, act and feel.

Gender differences in mathematics achievement and ability has remained a source of concern because of the under-representation of women in the fields of mathematics, physical sciences and engineering (Asante, 2010). The choice of the topic, "Gender differences in mathematics achievement", is predicated on the current world trend and research emphasis on gender issues following the millennium declaration of September 2000 (United Nations, 2000) which has as its goal as the promotion of gender equity, the empowerment of women and the elimination of gender inequality in basic and secondary education by 2005 and at all levels by 2015.

Mathematics has been a difficult subject for many students to effectively learn. Female students' achievement in mathematics is a widely recognized national concern. Girls who gain university admission usually do not enter into mathematics related faculty as boys do. This view remains strong in the perception of the public, and the quiet hardworking girl is often hidden by her own silence and desire to please. This is a time when girls fall behind as they are not picking up on more efficient mental strategies and also experience a lowering of confidence. Mathematics preparation is at the core of college success.

Girls appear to lose ground in mathematics over time in every family structure, ethnic group, and by socio-economic distribution (Fryer & Levitt, 2010). This is why women are still underrepresented in science, technology, mathematics, and engineering

(STEM) careers despite focused efforts to increase the number of women in such fields (Hill, Corbett, & St. Rose, 2010).

Mathematics is a male-dominated zone (Graham, 2001). In school, one hears female students saying that mathematics is for the boys and this low motivation may further widen the gender gap in mathematics achievement (Mutemeri & Mygweni, 2005). In a study by Opolot-Okurot (2005) it was found that for all the attitudinal variables (anxiety, confidence and motivation), males had higher mean scores than females.

Gender differences in the Science Technology Engineering and Mathematics (STEM) disciplines are widespread in most Economic Co-operation and Development (OECD) countries, and mathematics is the only subject where girls tend to underperform with respect to boys. Ghana is no exemption to this phenomenon. Gender differences are reported among elementary school students (Jacobs, Lanza, Osgood, Eccles & Wigfield, 2002). Whereas prior research on mathematics achievement and gender was in favour of males, today differences seem to disappear all the way through high school (Hyde, Lindberg, Linn, Ellis & William, 2008). There is also no evidence for gender differences in overall aptitude for mathematics (Spelke, 2005).

As mentioned earlier, women are still less likely to enroll in majors or domains that require taking mathematics courses. For some years concern has been expressed about females' lower participation rates in higher level mathematics courses and in their lower achievements in high cognitive level mathematics tasks. Learning outcomes of mathematics education have become a phenomenon of interest to all, and these account for the reason why scholars having been working hard to unravel factors that militate against good academic performance (Aremu & Sokan, 2002). A number of factors account for gender differences in mathematics education and achievement.

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These factors include, but not limited to attitudinal variables, biological factors and environmental factors.

Culturally, stereotypes about mathematics performance have always been in favour of boys. Researchers have attributed mathematics stereotypes to gender-specific expectations of teachers who are more supportive and who encourage males more than females to achieve in mathematics. Such beliefs and attitudes significantly correlated with mathematics achievement (Jacobs et al., 2005). Such stereotypes still hold true among parents, educators, teachers, peers and even students themselves. Those common held beliefs have affected females' enrollment in mathematics-related courses and careers as well as females performance in mathematics tests (Burkley et al., 2010).

Several explanations on biological factors have been proposed for the existence of the gender gap in mathematics (Baron-Cohen & Wheelwright, 2004; Baron-Cohen et al., 2001). Another myth is the linkage of a mathematics-gene in male. Parents and teachers alike hold lower expectations for girls in mathematics and science than they do for boys. In addition to these myths, most models of orientation to mathematics emphasize on social factors such as gender stereotypes. It is these gender stereotypical attitudes over the years, held by teachers and absorbed by students that play a major role in the future mathematical performance of females (Banaji, Greenwald & Nosek, 2002). However, as shown by international assessments (OECD, 2015; Mullis et al., 2012) the gender gap in mathematics differs substantially across countries. Hence, "nature" cannot be the only account for the females' disadvantage in mathematics; there must be alternative explanations related to societal and cultural factors, supporting the existence of "nurture" effects. In this perspective, some scholars (OECD, 2015; De San Roman & De La Rica Goiricelaya, 2012; Guiso et al., 2008)

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provide evidence that the gender gap in mathematics is negatively related to the country level indexes of gender equality.

Another attributable reason for a gap in mathematics performance between males and females is the inherent unfairness in school-based assessment (Grifith, 2005; Asim, 2007) which may result from teachers' incompetency in assessment (Asim, et al., 2007). Although the causal direction is difficult to assess, girls display less mathematics self-efficacy (self-confidence in solving mathematics related problems) and mathematics self-concept (beliefs in their own abilities), and more anxiety and stress in doing mathematics related activities (OECD, 2015; Heckman & Kautz, 2012, 2014; Lubienski et al., 2013; Twenge & Campbell, 2001).

Although trends in international Mathematics and science study (TIMSS-2003) cited in Amatobi and Amatobi (2013) found no significant difference in the performance of boys and girls in mathematics achievement, they however observed difference between boys and girls in terms of their attitude to the subject. Hence, it is essential that all male and female students receive proper mathematics education.

1.2 Statement of the problem

Mathematics has over the years been seen as preserve for male students of Bimbilla College of Education. There is no gender parity in mathematics achievement in the college. This phenomenon if unchecked will undermine gender equity in mathematics education in the college. Records available at the college, and oral evidence of subject teachers indicate that students, particularly female students do not perform satisfactorily in mathematics. Personal communication with the mathematics teachers in the college further indicated that there are gender differences in students' performance in mathematics. Specifically, there are gender differences in mathematics achievement in Bibilla College of Education with girls performing

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poorly. The unsatisfactory performance of female students in mathematics in the college is a pointer to their difficulty in learning and mastering the subject. The mathematics teachers in the college have cited attitudinal factors such as low interest, and poor attitudes to mathematics learning among others as some of the factors responsible for gender differences in mathematics achievement in the college. Even though several studies conducted over the years on gender differences in mathematics achievement seem to produce conflicting reports (Hyde, 2008; Hyde et al., 2011), no study has been conducted to investigate gender differences in mathematics achievement in the Bimbilla College of Education.

1.3 Purpose of the study

This study was designed to examine gender differences in mathematics achievement among students of Bimbilla College of Education.

1.4 Objectives of the study

The study specifically sought to:

a. Compare mathematics achievements of female with that of male students in Bimbilla College of Education.
b. Explore the factors responsible for gender differences in mathematics achievements among students in the college.
c. Assess students' attitudes to the learning of mathematics in the college.

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1.5 Research questions

The following research questions have been specifically raised as a guide to the study:

a. How different is the mathematics achievements of female students from their male counterparts in Bimbilla College of Education?
b. What factors contribute to the gender differences in mathematics achievement among students in the college?
c. What are the attitudes of students to the study of mathematics in the college?

1.6 Hypothesis

The following hypothesis was formulated to guide the study:

H_0: There is no significant difference between mathematics test scores of male and female students in Bimbilla College of Education.

1.7 Significance of study

The findings would help create awareness on the differences, if any, in mathematics performance of males and females at the college. The findings will also help mathematics teachers to know the factors that contribute to gender differences and learner centred interactive methods that are free from their influence on the said factors. The findings would enable teachers to adopt teaching strategies that will respond to to their attitudes to promote learning. Also, it would enable teachers to adopt pragmatic measures to improve upon students' learning to enhance their mathematics performance in the college. Specifically, it would assist in changing girls' misconception about the study of mathematics at the college. This study would serve as a reference material for future researchers who are interested in investigating gender issues in learning mathematics.

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1.8 Delimitation of the study

The scope of the study is delimited to Bimbilla College of Education in the Northern Region of Ghana even though the scope of the problem demands a country-wide investigation. Content wise, this research focused on gender differences in mathematics achievement of college of education students.

1.9 Limitations of the study

The present study had some limitations which readers should consider.

The study sample, which consists of students who come from one college of education, might not be representative of the overall population. Also, some of the respondents were not accessible and some did not submit their questionnaire. This made the sample size smaller than expected, and hence the sample size was not representative of the population. This might reduce its generalizability to students from other colleges of education in Ghana.

The most significant limitation of the study is that all the measures in the questionnaire are self-reports and thus subject to desirability biases. The current study also used self-report measures to assess mathematics ability, interest and attitudes. Self-report measures in general have several known weaknesses, including the potential for a social desirability response bias, which is defined as "the tendency on the part of individuals to present themselves in a favorable light, regardless of their true feelings about an issue or topic and a tendency for individuals to overgeneralize their responses" (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003, p. 881). Although students were assured that there were no right or wrong answers, potential biases could be further controlled through the use of measures that come from other sources, such as the mathematics test.

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1.10 Organization of the study

This study was organized into five chapters. Chapter one discusses the introduction, the background to the study, statement of the problem, purpose and objectives of the study, research questions, hypothesis, significance of the study, delimitation of the study, limitations and organization of the study. Chapter two discusses the review of related literature. Chapter three describes the research design, study population, sample size and sampling techniques, instrumentation, validity and reliability of instruments, procedures for data collection, data analysis, and ethical considerations. Chapter four also deals with results and discussion. Chapter five gives summary of findings, conclusions and recommendations. This chapter also makes suggestions on relevant areas for further studies.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter is dedicated to literature review. The literature is reviewed under the following themes: theoretical framework, the concepts of gender and academic performance, mathematics achievements of students, factors responsible for gender differences in mathematics achievements, students' attitudes to the learning of mathematics, empirical review, and summary of literature review.

2.1 Theoretical framework

There are a range of theories which account for gender differences and achievement.

This research is rooted on five theories, namely: equality or equity, deficit theory, feminist theory, expectancy-value theory of achievement, and the implicit theory.

Equality or equity theory

Bishop and Forgasz (2007) discussed the meanings of equity in education, and in so doing mapped the theoretical development of these ideas through research concerned with particular social groups, including gender. In one sense, equity is the outcome of education with equal access to learning a condition for achieving equity. This meaning of equity is associated with equality and the three aspects that Fennema (1995) originally identified with respect to gender: equal outcomes, equal opportunities and equal treatment. In another sense, equity is considered as a criterion for evaluating many aspects of education including outcomes, access, disposition, and the quality of teaching. Thus, equity is a quality involving fairness and justice, Bishop and Forgasz (2007) cited a number of studies to show that in this sense equity is not

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the same as equality. Anthony and Walshaw (2007) argued that equity is "relational" and situated. In their view, "Equity is about interactions between contexts and people; it is not about equal outcomes and approaches. Neither is it about equal access to people and curriculum materials. Setting up equitable arrangements for learners requires different pedagogical strategies and paying attention to the different needs that result from different home environments, different mathematical identifications, and different perspectives" (p. 10). The theories and paradigms of researchers of gender equity as described by Kaiser and Rogers (1995) and by Jungwirth (2003) were used to critique previous studies on gender and mathematics (Vale et al., 2004).

Deficit theory

According to deficit theory Eller, (1989), the differences in educational outcomes occur because of inherent deficiencies or weaknesses in girls' experiences, knowledge, and skills. Liberal feminist researchers argue, however, that these deficiencies are due to socialisation and that by attending to these deficiencies through particular educational programmes equality of outcomes could be achieved. Radical feminist researchers, on the other hand, embrace differences between genders and argue that patriarchal structure denies women the opportunity to use these differences as strengths for learning and achieving in mathematics. Radical feminists argue for changes to curriculum and teaching approaches. Post-modern researchers are critical of difference theory because it essentialised learners. They argue that groups of learners are not homogenous, rather individuals have multiple and shifting identities and these are shaped by the context in which they are situated. Analysing the relationships and the power within these relationships in mathematics classroom explained differences in learning behaviours and outcomes and the identities formed by learners in these classrooms. According to this theory, paying attention to the

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relationships within the classroom, the different identities, and hence the different needs of students in the mathematics classroom, are central to equity. In their review of research of mathematics education, Anthony .and Walshaw (2007) drew attention to pedagogies that meet these requirements and are effective for student learning. More recently, critical theorists have questioned the notion of shifting identity and its implications for choice. The gendered social norms that underpin the choices that girls make, they have argued, deny girls agency, that is, the power to make a difference in their lives (Hirschmann, 2003).

Feminist theory

A theoretical development worth noting in the context of this review is feminist theory, in various guises, appears as a theoretical tool in work in which issues other than gender differences are explored. For example, drawing on feminist post-structuralist theory, Klein (2006) explored pre-service primary teachers' constructions of what constitutes an engaging pedagogy in mathematics.

Atweh (2004) also drew on the ideas of feminist theorists when writing about international collaborations in mathematics education. This "mainstreaming" of feminist theory is to be welcomed. Like the shift away from an emphasis on the deficiencies of girls and women in relation to mathematics, it provides evidence that the *ghettoisation* of the female experience is fading. "Gender issues" and "feminist theories" are increasingly regarded as being of relevance to many concerned with mathematics education.

As Leder (2004) observed, liberal feminism, with an emphasis on helping females to assimilate, is perhaps still the dominant perspective in research on gender and mathematics education. A number of researchers remained concerned with persuading

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girls of the value of studying mathematics to a high level (Watt, 2004), but others are beginning to question the basic assumptions underlying such work, and instead investigating the valid decisions that girls make in relation to mathematics (Shannon, 2004). Such a move away from a deficit view of gender differences in mathematics is also evident in the increasing prevalence of studies in which the interplay of a range of factors in shaping the experiences of girls and boys in mathematics classrooms are explored. The influence of post-modern perspectives is evident in the reluctance of some researchers to treat gender as a straightforward and stable category for the purposes of analysis (Barnes, 2005).

The expectancy-value theory of achievement

Eccles, Wigfield, Harold and Blamenfield (1983) propounded the Expectancy Value Theory which was first studied in mathematics. The theory of Eccles et al. was folded in three major components (expectancies for success, beliefs about ability and subjective tasks value) and the subjective tasks value is broken into four elements (attainment value, intrinsic value, utility value and cost). The theory explains that differences in performance in mathematics according to gender are important at the highest grade levels than at the least levels. The theory therefore suggests that examining male and female performance at different ability levels gives a clear picture of the relationship between the gender of the student and academic achievement than is achieved by merely considering group averages.

The expectancy-value theory of achievement proposed by Eccles and her colleagues (Wigfield & Eccles, 2000) is an expansion of Atkinson's expectancy-value model (Atkinson, 1957). In this theory, various achievement-related influences (variables) that have an impact on individuals' expectancies and values are included in the model which makes it more social cognitive in nature (Wigfield, 1994). These variables

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include previous achievement-related expectancies, socialization experiences, perceived task difficulty, individuals' goals, self-schema, perceptions of significance of others' beliefs and behaviours, the cultural milieu, and historical events. This model implies that, mathematics students' performance, effort, persistence, their thinking, their ability of reasoning and how they choose various tasks are determined by expectancy-related beliefs and subjective task values that they place on it in order to achieve tasks, after previous performance has been controlled (Eccles, Wigfield, Harold & Blumenfeld, 2007).

Eccles and colleagues explain expectancies for success as individuals' beliefs about how well they will do on upcoming tasks, either in the short or longer term future. Expectancies for success refer to how individuals view their probability for success at a specific task. These expectancy beliefs are quantified in a manner to match Bandura's (1997) personal efficacy expectations. Thus, in contrast to Bandura's claim, expectancy-value theories focus on performance expectations, the concentration in this model is on personal or efficacy expectations. In mathematics education, expectancy-related beliefs about different tasks have been reported to be very crucial in predicting students' achievement outcomes, such as effort/persistence and performance (McBride, & Bruene, 2006; Xiang, Chen, & Bruene, 2005).

Implicit theories

Implicit theories are the views or beliefs that people hold about their various personal traits, such as intelligence or mathematics ability (Burkley et al., 2010). According to Dweck and Leggett (1988), there are two types of implicit theories: an entity theory and an incremental theory. Individuals with an entity view of their intelligence believe it is "fixed" or that they have a set amount of intelligence that cannot be changed.

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Individuals with an incremental view of their intelligence believe it is malleable and can be further developed through hard work and effort.

Research suggests that younger children typically hold an incremental theory of intelligence and beginning at 10 to 12 years of age may begin to adopt an entity theory of intelligence (Dweck, 2000). Gender differences in implicit theories of intelligence have been found in some studies. In one study, high-achieving (defined by grades) eighth-grade boys were more likely to have an incremental theory of intelligence while high-achieving eighth-grade girls were more likely to have an entity view of intelligence (Henderson & Dweck, 1990).

Findings of gender differences in implicit theories of intelligence are important because research indicates that entity and incremental theories of intelligence lead to different achievement outcomes (Dweck, 2000). Holding a fixed entity belief has been shown to be negatively related with high performance in academics (Siegle, Rubenstein, Pollard, & Romey, 2010). Among junior high school students, having an incremental theory of intelligence was shown to predict higher mathematics grades and having an entity theory of intelligence predicted stagnation in math grades (Blackwell, Trzesniewski, & Dweck, 2007).

2.2 The concepts of gender and academic performance

Gender is a social construction rather than a biological phenomenon. It refers to the sexual distribution between male and female. Gender involves the psychological and socio-cultural dimensions of being male or female (Ewumi, 2012). It is a set of characteristics distinguishing between male and female, particularly in the cases of men and women. A gender role is a set of expectations that prescribes how females or males should think, act and feel.

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Gender relates to the difference in sex (that is, either male or female) and how this quality affects their dispositions and perception toward life and academic activities (Okeke, 2003). Gender therefore refers to the sex-role identity used by humans to emphasize the distinctions between males and females. The words gender and sex are often used interchangeably, but *sex* relates specifically to the biological, physical characteristics which make a person male or female at birth, whereas gender refers to a social construct associated with members of that sex.

Umoh (2003) also defines gender as a psychological term used in describing behaviours and attributes expected of individuals on the basis of being born as either male or female. According to Okeke (2003), the study of gender is not just mere identification of male and female sexes. Scholars have gone further to identify responsibilities assigned to opposite sexes and to analyze the conditions under which those responsibilities are assigned. Furthermore, Okeke (2003) specifically notes that the study of gender means the analysis of the relationship of men and women including the division of labour, access to resources and other factors which are determined by society as opposed to being determined by sex. It further involves the study of the socio-cultural environment under which responsibilities are assigned and the relationships emanating from it. Thus, gender equally projects the properties that distinguish and classify organisms on the basis of their reproductive and cultural expectant roles. It relates to the cultural and psychological attributes of men and women through their socio-economic contributions, expectations and limitations. Thus, the concept of gender does not support or suggest the dominance of male over female or vice versa in academics and other human resource development areas but it stresses equality and equity in enhancing effective and efficient recognition, development and utilization of competencies and endowed capabilities of both sexes.

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Gender, is a significant contributor to student achievement (McCoy, 2005). From the statements of McCoy and Peng and Hall it can be deduced that gender plays an important role in the academic performance of students.

Academic performance

Performance is the end-product of all educational activities. In fact, it appears as if the whole educational system pivot round the academic achievement of students despite the fact that other outcomes are also expected from the system. According to Otu-Danquah (2002), academic performance is what a student is capable of achieving when he is tested on what he/she has been taught. It is how well a student meets standards set out to be attained in an educational institution or in a formal way. This means that it is the level of accomplishment by a student on a given academic task. This implies that academic performance is determined after the student has been taught specified courses of academic studies or curriculum. According to Adams and Hayes (2001), academic performance really means three things: the ability to study and remember facts; being able to study effectively and see how facts fit together to form larger patterns of knowledge and being able to think for oneself in relation to facts and thirdly; being able to communicate knowledge verbally or writing it down on paper.

Gender academic performance of students in mathematics refers to the knowledge attained and skills developed by male and female students in school mathematics. Gender academic performance is defined by Crow and Crow (1969) as the degree to which a learner is profiting from instructions in a given area of learning that is, performance is resolved by the extent to which skill and knowledge has been imparted to him or her. Good (1959) asserted that gender academic performance is the

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knowledge attained or skills developed by the student in the school subjects usually designed by test scores or marks awarded by the teacher.

Sinha (1970) stated that those students whose academic performance is superior in the form of high percentage of marks are taken as successful candidates. On the other hand those students who fail in the previous examination and obtain low divisions in their examination are considered as individuals who have failed on their achievements. It is believed that accounting students' academic performance is influenced by personality, motivation, opportunities, education and training.

Although, majority of studies show that male students seem to be wrestling with underperformance in school, some others find no difference between females and males in terms of academic performance (Xiang, McBride, & Bruene, 2006; Xiang, Chen, & Bruene, 2005). In fact, males have traditionally had higher marks than females (Khwaileh & Zaza, 2011). Likewise the study of Sue and Abe (Khwaileh & Zaza, 2011) carried out in the University of California, which among other predictors included gender, found out that there was no major gender difference among students for academic performance.

A number of studies have indicated how male and female students perform. Some revealed that males perform better than their female counterparts (Abdu-Raheem, 2012; Udoukpong, Emah & Umoren, 2012), other studies are indicating that females perform better than their male counterparts (Hyde & Mertz, 2009). A few studies, on the other hand, are also of the view that male and female students perform equally.

The influence of gender on academic performance of students

The relationship between gender and the academic achievement of students has been discussed for decades (Eitle, 2005). In one of the earliest studies Morris (1959) referring to the psychic and social differences between sexes, claims that the education outcomes of men and women will, at least in part, be different at the collegiate and graduate level. The debate on gender differences in cognitive abilities has actually evolved out of the debate on biological vs. social determinism. The biological perspective on sex differences and cognitive performance considers social factors to be trivial or subordinate to biological factors like brain structure. Lynn in several of his studies (Colom & Lynn, 2004) asserts that males have larger average brain sizes than females and therefore, would be expected to have higher average IQs. Hence, males are expected to perform better than females. This is very controversial and it is one of the reasons why this study sought to find out whether there is a difference in the academic performance of males and females.

Young and Fisler (2000) examining SAT-M scores of high school students, find males to score better than females. However, they noted that males generally come from households where the parents' socioeconomic status as measured by examinee reported educational levels and income, is higher. In contrast, female test takers are more diverse and include more low-income students than the boys group. Others have argued that the content of the test or of its administration favours males (Bridgeman & Wendler, 1991). Yet other researchers have explained the gap by adhering to such factors as differences in course taking behaviour, classroom experiences and cognitive processing (Young & Fisler, 2000).

Examining sex-related difference in classroom grades, Kimball (1989) finds that in contrast to standardized measures of Mathematics achievement tests like SAT-M (Scholastic Assessment Test-Mathematics), female students outperform males in math classes. Wilberg and Lynn (1999) arrive at a similar conclusion for history classes vs. history tests. The authors explain this pattern by stating that females tend to work

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more conscientiously and have a stronger work ethic than males. They also tend to have better language abilities including essay writing skills, vocabulary and word fluency which contribute to better course work (Stage & Kloosterman, 1995). This was supported by Chambers & Schreiber (2004) when they said, a gap between the achievement of boys and girls has been found, with girls showing better performance than boys in certain instances.

Most studies show that, on average, girls do better in school than boys. Girls get higher grades and complete high school at a higher rate compared to boys (Jacobs, 2002). Standardized achievement tests also show that females are better at spelling and perform better on tests of literacy, writing, and general knowledge (National Center for Education Statistics, 2003). An international aptitude test administered to fourth graders in 35 countries, for example, showed that females outscored males on reading literacy in every country. Although there were no differences between boys and girls in fourth grade on mathematics, boys began to perform better than girls on science tests in fourth grade (International Association for the Evaluation of Education Achievement, n.d.). Girls continue to exhibit higher verbal ability throughout high school, but they begin to lose ground to boys after fourth grade on tests of both mathematical and science ability. These gender differences in math and science achievement have implications for girls' future careers and have been a source of concern for educators everywhere.

Gender differences in mathematics achievement

The influence of sex (gender) on academic performance has been an issue of concern in most studies. This is because 'gender' appears to have some powerful effect on learning. Orton (1987) asserted that mathematics is the gate and key of science -

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neglect of mathematics works injury of all knowledge since he who is ignorant of it cannot view the other sciences or the things in the world. From the foregoing, it is clear that female, like male; need mathematics in their private life, working life, socio– economic and political life of the country of which they are citizens (Cockcroft, 1993). He further asserted that mathematics is a strategic subject in the development of science and technology and it's fundamental in the study of physical sciences and engineering of all types. Van Den Heuvel-Panhuizen (2003) also asserted that mathematics plays an important role in character building, boosting self–esteem and providing opportunities for developing curiosity and creativity. From the above statement it can be deduced that mathematics is very vital in the life of every individual irrespective of the gender and therefore must be taken serious by both males and females. Gender differences in mathematics performance has been a contentious issue in educational domain and research documents show great inconsistencies among girls and boys performance in school mathematics (Sprigler & Alsup (2003).

Concerns about gender differences in mathematics achievement began in the 1970s (Hyde, Fennema, Ryan, Frost, & Hopp, 1990). According to Hyde (2005), studies from the 1970s through 1990 indicated that gender differences in mathematics performance were small or non-existent during the elementary school years and the gender.

Globally, mathematics has been viewed as a subject favouring male students (Fennemma, & Leder, 1990). They went on to support the idea that there were differences between female and male students and learning of mathematics, tend to exist particularly in activities that required complex reasoning; that the differences increases with the onset of adolescence; and that the difference were recognized by

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many leading mathematics educators. The same experience is realized in Africa according to Africa Academy of Sciences (AAS) in collaboration with the Association for the Development of Education in Africa (ADEA) on issues of women's performance in mathematics to which it also applies to Ghana, and for that matter, students in Bimbilla College of Education. The differences in mathematics achievement that occur in the early years are in favour of females whereas differences in mathematics achievements as well as in attitudes favouring males generally occur during the senior high school years. O'Connor-Petruso, Schiering, Hayes and Serrano (2004) have also shown that gender differences in mathematics achievement become visible at the secondary level when female students begin to exhibit less confidence in their mathematics ability and perform lower than males on problem solving and higher level mathematics tasks. Such differences are well documented for Britain as well as many other countries of the world.

Many studies have found that boys show slightly greater variability in their scores (Hyde et al., 2008). The greater male variability hypothesis was proposed in the 1800s to explain why there are more males at both tails of the distribution of scores. It suggests that the disproportionate number of males scoring at each end of the distribution is due to a combination of a small average difference in mathematics performance favouring males and a larger standard deviation for males. Gender differences favouring boys in science and mathematics achievement and ability are indeed smaller for individuals of average achievement and ability than they are for those with the highest levels of achievement and ability (Halpern et al., 2007). However, even at the highest levels this difference remains small (Hyde & Mertz, 2009).

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Some researchers have offered evidence against the greater variability hypothesis (Hyde & Mertz, 2009). These studies suggest females have reached parity with males, with a considerably reduced difference in mean achievement scores between girls and boys (Hyde et al., 2008; Hyde & Linn, 2006). Achievement scores at the low end of the distribution are now essentially equal between the two sexes (Hyde & Mertz, 2009). Under the greater variability hypothesis, one would expect to see differences at both ends of the distribution, not just one. Hyde and Mertz argue that research indicates that greater male variability in regards to mathematics is not universal and that greater male variability correlates with several measures of gender inequality.

The study of gender differences in academic performance in the senior secondary school students has been explored with some results (Ajai & Imoko, 2015; Adeyemi, 2014; Atovigba, Vershima, O'Kwu & Ijenkeli's, 2012; Awofala, 2011; Weerakkody & Ediriweera, 2008) generally indicating that gender is influential in academic performance, whilst other studies (Kiptum, Rono, Too, Bii, Too, 2013; Adeleke, 2007) are also indicating that there are no gender differences in academic performance.

Weerakkody and Ediriweera (2008) conducted a comparative study on the influence of gender on academic performance between commerce and management students. Independent sample t-test was used to compare the academic performance of two gender categories. Results indicated that there is no difference between commerce and management students but differences could be seen between the academic performance of the male and female students in their study.

Amir Zaman (2011) concluded that male students' mean score was better than that of female students' in all aspect of the mathematical thinking and mathematics

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achievements. The Third International Mathematics and Science Study (TIMSS) of 2002-2003 and the Program of International Student Assessment (PISA) of 2003 revealed gender equality in mean scores in mathematics and mathematics literacy of Australian and New Zealand primary and secondary males and females. That is, there were no significant gender differences in the mean scores of nine year-old or 13 year-old students in mathematics (Thomson & Fleming, 2004), or among 15 year-old students in mathematical literacy (Thomson, Creswell, & De Bortolli, 2004). However, three years later, the PISA 2006 results revealed significant gender differences favouring 15 year-old boys in mathematical literacy in Australia and New Zealand (OECD, 2007). In Australia the gender difference was greater than the OECD average, and gender differences favouring males were also apparent in the results for each state/territory. However, the overall gender difference (14 points) was much smaller than the significant difference in scores between students from low and high socio-economic status groups [78 points] (Thomson & De Bortoli, 2008).

Males were consistently more highly represented among the highest achievers in mathematics for studies involving primary, junior secondary and senior secondary students (Thomson et al., 2004; Thomson & Fleming, 2004). Almost twice as many 15 year-old Australian male as female students performed at the highest level in mathematical literacy (PISA) in 2003 and 2006 (Thomson et al., 2004; Thomson & De Bortoli, 2008).

Horne (2004) found that significant gender differences favouring males in average performance of students emerged during the first three years of primary schooling for number, although there were no differences in the other content domains of space and measurement. For senior secondary mathematics in Victoria, Cox et al. (2004)

reported that females received higher mean scores than males on the vast majority of comparisons made, although no inferential statistics accompanied these findings.

In the greater male variability hypothesis, the spread of boys' results in mathematics is greater than for girls, and hence there are more boys than girls in the top and bottom 5% and 1% of any assessment. This is found in the large international tests and US college entrance tests as well as in assessments that identify gifted mathematicians (OECD, 2014; Halpern et al., 2007). However this result is not stable across time, countries or ethnic groups.

The gender similarities hypothesis maintains that males and females are similar in most of their abilities, including mathematics ability (Hyde, 2005). Hyde (2005) reviewed meta-analyses and found evidence to support the gender similarities hypothesis. Hyde et al. (2008) found that no gender difference in math skills is found for the general population for students in grades 2 through 11.

Research suggests that gender differences favouring boys in mathematics achievement are thought to appear at the end of middle school and beginning of high school, although such gender differences have been found in early elementary school by some studies (Penner & Paret, 2008). Researchers have found that boys show higher achievement in mathematics beginning as early as first grade (Penner & Paret, 2008). Penner and Paret (2008) argued that even if these early gender differences are small compared to gender differences found later in school, their existence is important because such early gaps could lead to even larger gaps later. Therefore, research on the nature and extent of gender differences in math achievement is of great value.

Gender performance in mathematics has been investigated on a large scale in two ways. If there is a construct such as overall mathematics performance being measured by all these studies, then it is the same for girls and boys. Data has been analysed from TIMSS or PISA 2003 (Else-Quest, Hyde & Linn, 2010), TIMSS 2007 and PISA 2009 (Kane & Mertz, 2012) and PISA 2012 (OECD, 2014). There is considerable variation between countries, with many more countries whose boys do slightly better than girls in mathematics rather than vice versa. No statistically significant gender gap existed overall in the mean scores of fourth and eighth graders on the 2003 and 2007 TIMSS (Kane & Mertz, 2012). Where statistically significant differences have been found, they have very small effect sizes.

Koller, Baumert and Schnabel (2001) studied gender differences in mathematics achievement, which favoured males in achievement, interest, and placement in advanced mathematics courses. According to Hyde et al. (2008), a meta-analytic findings from 1990s indicated that gender differences in math performance in the general population were trivial, $d = -0.05$, where the effect size, d, is the mean for males minus the mean for females, divided by the pooled within-gender standard deviation.

Over the past decade, many researchers (Xiang, McBride, Guan & Solomon, 2003) have conducted a study on gender differences in expectancy-related beliefs. Generally, male students were identified to hold higher ability beliefs and expectancies for success in education than female students (Xiang et al. 2006; Jacobs et al., 2002). Furthermore, empirical evidence proved that gender differences among students are as a result of perceived gender appropriateness of the activities performed (Solomon, Lee, Belcher, Harrison, & Wells, 2003). That is, when students engaged in works deemed as gender appropriate, their expectancy-related beliefs tend to grow.

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Xiang et al. (2004) examined but found no gender differences in expectancy-related beliefs among fourth graders (primary four) in a running program. Gender differences are also observed on subjective task values. Many researchers (Fredricks & Eccles, 2002) who have examined gender differences have shown that, compared with females, males like arithmetic more hence they place higher importance on attending accounting class (Lee et al., 1999).

On the other hand, Xiang et al. (2003) and Xiang, McBride and Bruene (2004; 2006) came out with a finding that male students and female students did not differ significantly in their subjective task values toward accounting as a subject area and participating as a specific activity. In this view, it is not amazing that gender differences in students' motivational beliefs were found most often in gender-role related activities such as doing class assignment and physical activities.

During the past decade, there has been a concerted effort to find out why there is a shortage of women in the science, mathematics, engineering, and technical fields (AAUW, 1992). In 1995, 22% of America's scientists and engineers were women, compared to half of the social scientists. Women who do pursue careers in science, engineering, and mathematics most often choose fields in the biological sciences, where they represent 40% of the workforce, with smaller percentages found in mathematics or computer science (33%), the physical sciences (22%), and engineering [9%] (National Science Foundation, 2005). Part of the explanation can be traced to gender differences in the cognitive abilities of middle-school students. In late elementary school, females outperform males on several verbal skills tasks: verbal reasoning, verbal fluency, comprehension, and understanding logical relations (Hedges & Nowell, 1995).

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Males, on the other hand, outperform females on spatial skills tasks such as mental rotation, spatial perception, and spatial visualization (Voyer, Voyer, & Bryden, 1995). Males also perform better on mathematical achievement tests than females. However, gender differences do not apply to all aspects of mathematical skill. Males and females do equally well in basic Mathematics knowledge, and girls actually have better computational skills. Performance in mathematical reasoning and geometry shows the greatest difference (Fennema & Leder 1990). Males also display greater confidence in their math skills, which is a strong predictor of mathematics performance (Casey, Nuttall, & Pezaris, 2001).

The poorer mathematical reasoning skills exhibited by many female adolescents have several educational implications. Beginning at age 12, girls begin to like Mathematics and Science less and to like Language Arts and Social Studies more than do boys (Kahle & Lakes, 2003). They also do not expect to do as well in these subjects and attribute their failures to lack of ability (Eccles, Barber, Jozefowicz, Malenchuk, & Vida, 1999). By high school, girls self-select out of higher-level, “academic-track” mathematics and science courses, such as calculus and chemistry. One of the long-term consequences of these choices is that girls lack the prerequisite high school mathematics and science courses necessary to pursue certain majors in college (for example, engineering, computer science). Consequently, the number of women who pursue advanced degrees in these fields is significantly reduced (Halpern, 2004). Tonah (2009) note that although gender differences in Mathematics achievement continue to exist on high cognitive level tasks at the high school level, such differences appear to be declining.

Research history in this area (gender and achievements in mathematics) shows that male advantage in mathematics achievement is a common phenomenon (Mullis et al.,

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2000). While early research by Fennema and Leder, (1990) indicated that males outperformed females in mathematics achievement at the junior high and senior high school levels, there were also significant differences in attitudes toward mathematics between the two groups. Gallagher and Kaufman (2006) recognized that the mathematics achievement and interest of boys are better than the girls. However, they explained that they do not know the main cause of these differences.

Despite these research evidences for male's superiority in mathematics achievement, some research findings do not support the difference between these two genders in mathematics achievement. As an example, Sprigler and Alsup (2003) refer to researcher indications that show no gender difference on the mathematical reasoning ability at elementary level. Findings from longitudinal study about gender differences in mathematics show that there is no difference among boys and girls in Mathematics achievement (Ding, Song & Richardson, 2007). This study shows that growth trend in mathematics among two genders was the same during the study times. According to an international study conducted by IEA, on average across all countries, there was basically no difference in achievement between boys and girls at either the eighth or fourth grade (Mullis et al., 2004). Finding of two consecutive international studies (TIMSS, 2003) in Iranian educational system (a system that co-education is prohibited and female teachers teach in the girls' schools and male teachers teach in the boys' schools) also confirms that there is no significant differences between boys and girls in mathematics achievement. Data from these studies show the significant decrease in the boys' Mathematics achievement score from the time of TIMSS (1999) and the significant improvement in the girls' achievement over the same period. Teacher job satisfaction and the positive perspective of female teachers regarding teaching of

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mathematics may be the factors behind the better Mathematics performance of Iranian girls than boys at Grade 8 in Iran (Kiamanesh, 2006).

Mathematics is a science subject and some gender-based science researchers (Howes, 2002; Sinnes, 2006) have reported that females in principle will produce exactly the same scientific knowledge as males, if sufficient rigor is undertaken in scientific inquiry. Though the issue of gender inequality in science, technology, and mathematics education (STME) is global, it is believed that bridging gender gap is one major way of achieving egalitarianism and enhancing human development. There is need therefore to give boys and girls exactly the same opportunities and challenges.

Gender differences in mathematics in relation to content and cognitive process

Reilly, Neumann and Andrews (2016) conducted a study on gender differences in spatial ability: Implications for STEM (Science, Technology, Engineering, and Mathematics) education and approaches to reducing the gender gap for parents and educators. The study revealed that men and women do not differ in levels of general intelligence; the differences do exist in spatial ability, which forms the largest of all gender differences in cognitive abilities. They observed that the development of spatial ability lays the foundation for quantitative reasoning, a collective term for mathematical and science skills. For this reason, a growing number of educational psychologists have argued that early education of spatial intelligence is necessary as a matter of equity for all students, and that it may offer substantial benefits for the later development of mathematical and scientific skills across all ability levels.

Miller and Halpern (2013) observed that cognitive sex differences are changing, decreasing for some tasks whereas remaining stable or increasing for other tasks. Some sex differences are detected in infancy, but the data are complex and depend on

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task characteristics. They revealed that diverse disciplines have updated their understanding of why these differences exist. They used fraternal-twin studies with earlier literature as an instance to establish the role of prenatal androgens and datasets to explain how cultural factors such as economic prosperity and gender equity affect females and males differently. They also revealed that understanding how biological and environmental factors interact could help maximize cognitive potential and address pressing societal issues.

Lakin (2013) studied sex differences in cognitive abilities and noted some important implications for the participation of men and women in highly valued and technical career fields. He noted that although negligible mean differences have been found in many domains, differences in variability and high ratios of males to females in the tails of the ability distribution have been found in a number of studies and across domains. He noted that studies have observed trends over time, with some noting the decreasing ratios of boys to girls in the highest levels of mathematics test performance. In this study, the researcher evaluated sex differences in performance in verbal, quantitative, and figural reasoning domains as measured by the Cognitive Abilities Test. Samples included US students in grades 3–11. He reported that the results were consistent with previous research, showing small mean differences in the three domains, but considerably greater variability for males. He however observed that, contrary to related research, the ratio of males to females in higher quantitative reasoning distribution seemed to increase over time.

David (2012) conducted a study on gender, culture, and sex-typed cognitive abilities. The study results revealed that cross-national variation in gender differences provides useful information about the environmental conditions that foster, or inhibit, gender differences in domains such as mathematics. He observed that whiles gender

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differences in mathematics are frequently found at a national level, they are not found universally across all nations. Social roles for women vary greatly from culture to culture, with some cultures promoting higher standards of gender equality and access to education than others. Even those nations that have progressive attitudes towards women may still have strongly-held cultural stereotypes that constrain them. Cultural stereotypes that girls and women are less able than boys and men in mathematics and science still endure and these stereotypes have damaging consequences for the self-efficacy of young girls.

Bal (2014) argued that attitude is an important predictor in the context of success in geometry and gender is an important factor affecting success due to the fact that cultural factors are dominant over the biological factors. He explained that gender differences in mathematics are varied at middle school levels.

Alex and Mammen (2014) conducted a study on gender differences in geometrical thinking levels of South African grade 10 learners. The study revealed that both male and female showed similar thinking levels in geometry from Van Hiele geometry test. The results also revealed that the levels of thinking were lower than what was expected of the learners who participated in the study. They observed that the phenomenon of low geometry knowledge might be due to the inadequate geometrical experiences from the lower grades. Furthermore, the study found that although the mean score of female learners' Van Hiele levels was higher than that of males, this difference was not statistically significant.

Halpern et al. (2007) conducted a study on the science of sex differences in science and mathematics due to public speculation about the reasons for sex differences in careers in science and mathematics. The researchers observed that males

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outperformed females on most measures of visuo-spatial abilities, which have been attributed to as a contributory factor to sex differences in mathematics and science achievement. They opined that although sex differences in math and science performance have not directly evolved, but could be indirectly related to differences in interests and specific brain and cognitive systems. They reviewed the brain basis for sex differences in science and mathematics and identified several possible correlates. They observed that experience alters brain structures and functioning, so causal statements about brain differences and success in math and science are possible. They also explained that there is a wide range of sociocultural factors that contribute to sex differences in mathematics and science achievement and ability, which include the effects of family, neighbourhood, peer, and school influences; training and experience; and cultural practices. They concluded that early experience, biological factors, educational policy, and cultural context affect the number of women and men who pursue advanced study in science and math and that these effects add and interact in complex ways.

Weiss et al (2003) have pointed out that psychological studies have been relatively consistent on gender differences in cognitive skills and processes over decades. As such studies have established a sound theoretical foundation that clearly acknowledges gender differences in a variety of cognitive functions between males and females.

Casey, Nuttal, and Pezaris (2001) have recorded that girls' poorer spatial-mechanical skills may contribute to a lack of success in areas of mathematics in which boys do well. Whether or not their problems with spatial skills contribute to the difficulties that women have in mathematics, females believe that they do and that belief affects their performance in mathematics.

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Halphern (2000) stated that it has long been accepted that females are more verbal than males. He explained that very young girls can say more words clearly than young boys and more girls are ready to read at time of school entrance than boys. By the time students get to college, these differences are no longer as extreme.

Girls have less confidence in mathematics ability than boys even when no gender differences are measured in mathematic (Watt, 2006). Self-confidence usually brings changes in learning achievements. There is difference in confidence level between male and female students.

Literature about gender and academic performance in mathematics exist with different views and findings. Studies conducted in countries of the North have shown that boys performed better than girls in mathematics (Fennema, 2000). Asante (2010) cited studies (Hedges & Nowell, 1995) showing that boys generally achieved higher than girls on standardized math tests. However, an interesting body of international literature suggests that female students perform better than male students (Hydea & Mertzb, 2009). A large scale study in the U.S.A. by Hydea and Mertzb (2009) revealed that girls have reached parity with boys in mathematics performance, including at high school where a gap existed in earlier decades. They affirmed that girls are doing better than boys even for tasks that require complex problem solving.

The Second Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) Survey (2000-2002) by International Institute for Educational Planning (HEP)-UNESCO (2004) shows no significant gender differences among students in South Africa. The same study shows that girls scored significantly higher than boys only in Seychelles. On the other hand, in Tanzania, Kenya, Mozambique, Zanzibar and Malawi, boys scored significantly higher than girls did. In the other

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school systems, including the ones in South Africa, the differences were not significant.

An alternate body of research has shown that the gender differences in mathematical performance are diminishing. Perie, Moran, and Lutkus (2005) found that the gap has been narrowing in the United States of America. Research in Australia indicates that gender differences in mathematics achievement are reducing and shifting (Forgasz et al., 2000). Vale (2009) found that many studies conducted between 2000 and 2004 in Australasia showed no significant differences in achievement in mathematics between male and female students, though males were more likely to obtain higher mean scores.

In spite of research evidences for male's superiority in mathematics achievement, some research findings do not support the difference between two genders in mathematics achievement. As an example, Sprigler and Alsup (2003) refer to researcher indications that shown no gender difference on the mathematical reasoning ability at elementary level. Finding from longitudinal study about gender differences in mathematics show that there is no difference among boys and girls in mathematics achievement (Ding, Song and Richardson; 2007). This study argues that growth trend in mathematics among two genders was equivalent during the study times. According to a recent international study conducted by IEA, on average across all countries, there was essentially no difference in achievement between boys and girls at either the eighth or fourth grade (Mullis et al., 2004).

2.3 Factors responsible for gender differences in mathematics achievement

Academic performance is of paramount importance to the current study because it has been revealed that a good number of variables such as: personality characteristics of the learners, the organizational climate of the school, curriculum planning, teaching learning setup, variables arising out of home, determine students' performance in different degrees (Sharmistha, 2008). A study by Weerakkody and Ediriweera (2008) revealed that some of the factors that lead to differences in performance were attendance of lectures, knowledge of English, income of the parents, perceptions of learning, attitudes of students and lecturers towards education, teaching aids and method and environmental factors.

Over the last three decades, diverse theories and frameworks have been developed and many have tried to identify factors that influence mathematics performance in order to reduce gender inequality in mathematics achievement (O'Connor-Petruso & Miranda, 2004). Research evidences show that gender differences in mathematics achievement are due to various factors such as biological factors (Geary et al., 2000), Mathematics learning strategies (Carr & Jessup, 1997), sex hormones on brain organization (Kimura, 2002) and symbolic gender (Nielsen, 2003). The studies above also attribute students' performance in mathematics to biological factors, learning strategies. This is why this current study is seeking to provide empirical evidence as to whether gender differences in mathematics achievement in Bimbilla College of Education.

Gender differences in mathematics performance has been a great controversy issue in educational domain and research documents show great discrepancies among girls and boys performance in school mathematics (Sprigler & Alsup (2003). Long research history in this area has shows that male advantage in mathematics

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achievement is a universal phenomenon (Mullis et al., 2000). While early research (Fennema & Sherman, 1977) indicated that males outperformed females in math achievement at the junior high and high school levels, there were also significant differences in attitudes toward mathematics between the two groups. Gallagher and Kaufman (2006) recognized that the mathematics achievement and interest of boys are better than the girls. However they explained that they don't know the main cause of these differences.

O'Connor-Petruso, Schiering, Hayes and Serrano (2004) have shown that gender differences in mathematics achievement become apparent at the secondary level when female students begin to exhibit less confidence in their math ability and perform lower than males on problem solving and higher level mathematics tasks.

Research findings show that students' performance in mathematics are due to factors such attitude towards mathematics (Hammouri, 2004; Kiamanesh, 2004, self-concept (Bryen & Shavelson, 1987), home environment (Howi , 2005; Fullarton, 2004), parental education (Alomar, 2006), schools climate and culture (Fullan, 2001), and school connectedness or engagement (Blum & Libbey, 2004). Several studies have revealed that the educational level of students' parents (Engheta, 2004), home educational resources (Mullis et al. 2000), socioeconomic status of the family (Marjoribanks, 2002), home language versus language of test (Howie, 2002) and providing quality homework assistance by parents (Engheta, 2004) are among factors that can explain variance in academic achievement. Home is the backbone of children's personality development, and influences them both directly and indirectly through the kind of relationship the family members have among themselves as well as through helping them to get in contact with the society (Weiss & Krappmann,

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1993). Fullarton (2004) indicates that "at the student level, home background index …is a strong predictor of achievement in mathematics" (p-24).

The relationship between mathematics self-concept and mathematics achievement is an area that has been investigated by researchers (Hamachek, 1995). Low self-concept tends to appear together with students' underachievement. Most findings in this area showed that those who have higher self-concept, that is, having more confidence in math, gain higher scores in mathematics (Wilhite, 1990). Not only self-concept influences students' mathematics achievement (Bryen & Shavelson, 1987), but also as Franken (1994) concludes, it forms the basis of all motivated behaviors. Many investigators consider the improvement of a student's academic self-concept as the basic educational outcome (Koutsoulis & Campbell, 2001).

Although many factors inside and outside of school influence students' level of achievement, the quality of teaching is important for improving students' learning (Hammouri, 2004, Antonijevic, 2005). According to Butty (2001) instructional practices has impact on mathematics' achievement as well as attitude toward mathematics.

Some research findings indicated that instructional practices have positive effect on students' mathematics achievement and attitude toward mathematics (Butty, 2001). Attitude towards mathematics has significant direct negative effects on math achievement for the girls' and boys' model and the effects for girls' model is more than the boys' one. This finding is similar to the finding of Papanastasius (2002).

Various demographic factors are known to be related to mathematics achievement. Gender, duration of course and residential status are some factors or predictors of mathematics achievement. Many variables have long been studied as predictors of mathematics achievement. However, gender issues on mathematics achievement are studied most frequently by researchers. For example, a study through a meta-analysis reveals that males tend to do better on mathematics tests that involve problem-solving (Hyde, Fennema & Lamon, 1990). Females tend to do better in computation, and there is no significant gender difference in understanding mathematics concepts. Another study shows that females tend to earn better grades than males in mathematics (Kimball, 1989). Some recent studies by Campbell, Gray and Mullis, et al have revealed that gender differences in Mathematics education seem to be narrowing in many countries. However, studies indicate that as students reach higher grades, gender differences favour increase in mathematics achievement by males (Mullis, et al., 2000). For instance, the results from the Third International Mathematics and Science Study showed that Mathematics achievement scores of each gender group were close to each other at the primary and middle school years (Beaton et al., 1996).

However, in the final year of secondary school, evidence was found for gender differences in mathematics achievement. Another study, which was conducted to analyze factors that affect mathematics achievement of 11th-graders in mathematics classes with an identified gender gap, also showed that males scored higher than females on 11th grade mathematics achievement test, but this difference decreased from 10th grade (Campbell, 1995). In addition, gender differences in attitudes and perceptions of the usefulness of mathematics for middle school students were found statistically important (Oakes, 1990). For example, female students show less interest in mathematics and have negative attitude toward mathematics. It is also reported that girls tend to learn mathematical concepts by means of rules or cooperative activities, while boys have a tendency to be in a competition to master mathematical concepts

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(Hopkins et al., 1997). The literature on gender differences provides evidences that gender issues impact achievement in mathematics. Hence, it is crucial for educators and researchers to pay attention to gender differences in the design of mathematics instruction.

2.3.1 Gender differences in mathematics in relation to biological make-up

Geschwind's theory of pre-natal hormonal effects (Halpern, Wai & Saw, 2005) assumed that higher level of pre-natal testosterone in males could result in a greater level of right brain dominance, with which males would develop cognitive ability patterns that were more closely associated with right hemisphere functioning. Therefore both mathematical reasoning and spatial abilities were under great control by the hemisphere, hence male's ability to outperform females on mathematical reasoning and spatial tasks.

Some researchers such as Saults, Lui, and Hoard (2000), Royer, Rath, Transky and Marchant (2002) came up with their similar findings that male-female difference in mathematics were due to biological differences in girls' and boys' brain as perceived by the observation that girls are in general better with language and writing and that boys are better at mathematics due to better spatial abilities. This implies that gender differences in mathematics may not be challengeable.

In some societies, mathematics ability is gendered. That is many people believe that boys and men are better at mathematics than girls and women and, further that this differences is biological (hormonal, neurological or somehow encoded on the Y chromosome (Wade, 2010).

2.3.2 Gender differences in mathematics in relation to environment

Marcus and Joakim (2016) investigated on whether there were gender differences with respect to students' perceptions of the classroom setting, their relationship to mathematics and how perceptions of the classroom setting were related to performance in mathematics. According to the classroom setting, they found that boys feel that they use group work more than the girls do. Boys also feel that they have an influence over the content and are more involved during the lesson than girls. As regard relationship to mathematics, they found that boys perceive mathematics to be more important than girls do.

Gherasim, Butnaru, and Mairean (2013) found gender effects in such variables as achievement goals, classroom environments and achievement in mathematics among young adolescents showing that girls obtained higher grades in mathematics than boys in a highly classroom support with lower performance-avoidance goals.

Whereas parental homework helps positively predicted students' mathematics achievement, parents' child-school discussion negatively predicted students' mathematics achievement. This finding about child-help negatively predicting students achievement is in line with the literature (Desimone, 1999). The positive relationship between parental home-work help and students achievements is also is in line with the literature (Sui-Chu & Willms, 1996). The possible cause of the negative relationship between parent-child discussion and achievement is maybe that the help that the parents gives their children is unsolicited, and may have negative effects on children's self-perceptions (Graham, 1990). This finding also indicates the bidirectional nature of parent-child influences (Jacobs & Bleeker, 2004). It also indicates that as parents see that their children are failing behind in mathematics, their involvement increases.

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2.3.3 Students' self-confidence, mathematics interest and anxiety

Some questions included to seek information about whether mathematics is easy or difficult. Most of males had a higher level of confidence. They claimed that math is very easy for them, they rated themselves above average at mathematics. Hidi and Renninger (2006) proposed a four-phase model of interest development and made a distinction between individual and situational interest. Interest is defined as a psychological state that can also develop into a tendency to reengage content. Situational interest is the initial psychological state of focused attention and affect in response to some environmental stimuli. Individual interest refers to the relatively stable tendency to reengage content over time. The first phase of the model is "triggered situational interest" which may evolve into the second phase, recognized as "maintained situational interest". The third phase, an "emerging individual interest" may then develop, which if sustained, can progress into a "well-developed individual" interest.

Interest can greatly impact students' learning (Hidi & Renninger, 2006). Interest has been shown to be positively related to achievement on related tasks (Evans, Schweingruber, & Stevenson, 2002). Individual interest can positively affect persistence and effort and academic motivation (Hidi & Renninger, 2006). Interest also predicts many choices, both educational and vocational (Su, Rounds, & Armstrong, 2009). Interest is also domain specific (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). A small number of studies have been conducted with a specific focus on mathematics interest. High interest in mathematics was shown to correlate with mathematics achievement in Taiwan, Japan, and the United States (Evans et al., 2002). Interest in mathematics has been shown to decline across the developmental period (Frenzel, Goetz, Pekrun, & Watt, 2004).

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Amy et al. (2012) conducted a study on gender differences in mathematics anxiety (MA) and its relation to mathematics performance. They observed that there are no gender differences in mathematics performance but the levels of Mathematics Anxiety (MA) and Test Anxiety (TA) were higher for girls than for boys. They revealed that girls and boys showed a positive correlation between MA and TA and a negative correlation between MA and mathematics performance.

According to an empirical study conducted in the United States of America by Fryer and Levitt (2010), there was no statistical difference in the gender gap in mathematics at the entry level in school, but girls lost focus more as compared to boys in the first six years of schooling.

Preliminarily analysis of the PISA (2001) data suggests that what matters to gender differences in learning outcomes appears to be the learning environment that is established through education efforts and social context (OECD, 2001). The school environment is an equally important influence in the gender difference in mathematics. Changes in mathematical attitudes are correlated with developmental changes in gender identity (Gallagher & Kaufman, 2006). During this stage, girls begin to firmly establish their feminine identity and so become susceptible to social and environmental pressures that undermine their confidence and performance in male dominated subjects like mathematics. The problem is that by the time some students seek a post-secondary education, they are convinced that they cannot do mathematics (James, 2007).

Internationally, researchers have undertaken studies in various contexts to examine factors that influence gendered achievement in mathematics. Many of such studies have focused on factors related to differences in the performance of boys and girls in

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mathematics (Abiam & Odok, 2006; Mahlomaholo & Sematle, 2005; Opolot-Okurot, 2005; Zhu, 2007). Feminist researchers have tried to make meaning of the experiences of girls and boys in the mathematics classrooms, and to interpret male-female power relations.

Mutemeri and Mygweni (2005) argued that the idea that mathematics is for boys may result in low motivation in girls and could widen the gender gap in mathematics achievement in favour of boys. Asante (2010) citing Collins, Kenway and McLeod (2010) argued that schools establish symbolic oppositions between male and female students through gendering of knowledge and defining of certain subjects as masculine. In contrast, female students are conditioned in the society to believe that mathematics is a male subject, and it is acceptable for them to drop it. Studies done in Botswana by Finn (1980), Duncan (1989), and Marope (1992) cited in Kaino (2008) indicated that cultural expectations of society could result in differences in performance between girls and boys in mathematics. In Nigeria, it has been argued that nurture entrenches male dominance over the female gender (Bassey, Joshua & Asim, 2007).

Eccles and Wigfield (2002) put forth an expectancy-value theory that emphasizes an individual's expectancies for academic success and their perceived value for academic tasks. The value component of this theory is also referred to as interest and several studies have addressed how the expectancy-value theory could explain gender differences in mathematics achievement, course enrollment, and career selection (Eccles, 1986; Recent studies have found gender differences in mathematics interest, with boys showing higher interest in mathematics than girls (OECD, 2004). One study found such gender differences in mathematics enjoyment as early as grade 4 (Frenzel

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et al., 2007). By adolescence, boys have higher interest levels in mathematics (Frenzel et al., 2007). One study conducted with high school students found that interest and belief about ability predicted math participation, more strongly for girls than for boys (Watt, Eccles, & Durik, 2006). Watt et al. (2006) found no statistically significant gender differences in mathematical achievement; however, boys rated their math abilities and their expectancies of success in math significantly higher than girls. Frenzel et al. (2007) conducted a longitudinal study with German students in grades 5 through 9 and found that boys had higher individual interest in mathematics than girls throughout the entire period of the study.

While few studies have focused specifically on mathematics interest, even fewer studies have addressed the relation between implicit theories of abilities and math interest. A study conducted in Germany found that boys were more interested in their physics education than girls at the end of eighth grade (Broome, 2001). Another study conducted with female college students found that women with a fixed view of their math ability reported less enjoyment of math-related subjects, less likelihood of pursuing a math major, and less likelihood of pursuing a math career (Burkley et al., 2010).

Previous studies indicated that gender predicts mathematics achievement with boys performing better than girls (Gil-Flores, Padilla-Carmona, & Suárez-Ortega, 2011; Else-Quest, Hyde, & Linn, 2010; Eshun, 2004). The above review suggests that many factors may be associated with the gender gap in mathematics achievement, including issues such as biological factors, environmental factors, attitudinal factors (students' attitudes, students' interest and self-esteem), classroom interactions, teachers' gendered attitudes, curricular materials, beliefs, social and cultural norms. These differences put together have implications for the kind of instructional procedures that

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are to be adopted for setting up an appropriate teaching and learning environment for mathematics instruction that is suitable for both genders.

2.4 The attitudes of students to the learning of mathematics

Mathematics has been regarded as a difficult subject for students by many researchers, teachers and science educators (Nakhleh, 1992) because of the abstract nature of many mathematical concepts, teaching styles applied in class, lack of teaching aids and the difficulty of the language of mathematics. All these cause students, from primary level to the university, to develop poor understanding and misunderstandings. Accordingly, they develop anxiety, disinterest and poor attitudes to learning the subject.

An attitude involves the communication of an evaluative judgment about a stimulating object, where the evaluation is the essential aspect of the attitude concept (Maio & Haddock, 2010; Olson & Kendrick, 2008). The 'attitude object' can be concrete, abstract, inanimate, people or groups, and it may involve any form of information that possesses evaluative implication (Bohner & Wänke, 2002). Attitudes are private and specific to individuals, organised through single or multiple experiences, and influence actions to be completed by the person either intrinsically or extrinsically (Rajecki, 1990). According to Kim and Song (2009), an opinion is a verbal expression of an attitude. Yet, research has still identified an 'attitude towards mathematics and science', as an attitudinal construct. However, Koballa and Glynn (2007) define attitudes as a general expression of either positive or negative feelings towards something and this distinguishes it from other terms like value, belief or opinion.

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Koballa and Glynn (2007) discussed how an attitude has been defined in a variety of ways with the unfortunate use of being interchanged with words like interest, value, motivation and opinion. This situation, they believe, is unnecessary because of the rather specific definitions in the literature relating to attitudes towards mathematics and science. However, it has been noticed by Maio and Haddock (2010) that it is difficult to effectively measure an attitude because of the variety and the uniqueness of the definition of an attitude. An individual's attitude can only be inferred from his or her response to particular or specific stimuli. This has led to a range of methods being used in measuring attitudes along with a range of terminologies relating to attitudes. Certainly, the research looking into students' attitudes to mathematics and science (Ramsden, 1998) has referred to such terms as 'motivation' and 'interest' have been used. Therefore, due to this common usage, the terms 'motivation' and 'interest' are defined and explored in this study.

It is commonly assumed that students' attitudes in mathematics and science influence their learning outcomes, their course selections, and their future career choice (Koballa, 1988; Laforgia, 1988). Thus, "changing attitudes should lead to changing behaviour" (Nieswandt, 2005, p.41). Prokop, Tuncer and Chudá (2007) highlighted the importance of understanding students' attitudes in order to positively affect their achievement and interest within a particular discipline.

Students' attitudes to mathematics and science and how students' view the contents of science are extremely influential for having the potential to significantly affect their disposition towards attainment and their retention within mathematics and science both in and out of school (Bricheno, Johnston & Sears, 2001; Osborne, et al., 2003; Lakshmi, 2004; Jones & Barmby, 2007; The Royal Society, 2008).

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2.4.1. Students' motivation to learn mathematics and science

Motivation within an educational context, has been defined as any means that commences and sustains learning behaviour, a pre-requisite and co-requisite for meaningful learning to occur (Palmer, 2009). Motivation has the potential to be influential to the student's learning process in mathematics and science. Within the definition, two distinct areas have been highlighted within motivation (Lin, 2007), these are extrinsic motivation, which focuses on the achievements from doing the activity and intrinsic motivation which focuses on the innate satisfaction derived from doing the activity. According to Entwistle and Peterson (2004), students' motivation to learn can be classified as either intrinsic (for example, wanting to know for its own sake) or extrinsic (for example, wanting to learn what is on an examination syllabus). There is also a third class, called 'a motivational' learning, which covers the situation where students do things (like attending lectures) without any conscious belief that this will help them learn anything (Vallerand & Bissonnette, 2002). Resnick (2007) found that students will engage more easily with problems that are embedded in challenging real-world contexts that have apparent relevance to their lives. If the problems are interesting, meaningful, challenging, and engaging they tend to be intrinsically motivating for students.

According to Barkoukis, Tsorbatzoudis, Grouios and Sideridis (2008), intrinsic motivation includes "the intrinsic motivation to know, to accomplish and to experience stimulation" (p.40). Intrinsic motivation to 'know' refers to the engagement in an activity to improve cognition and is representative of intrinsic motivation in education because it links to conventional educational settings (Barkoukis et al., 2008).

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Intrinsic motivation to 'accomplish' refers to engagement in an activity for the satisfaction when trying to achieve (Barkoukis et al., 2008). On the other hand, intrinsic motivation to experience 'stimulation' refers to someone engaging in an activity in order to experience stimulating sensations such as aesthetic appeal (Vallerand et al., 1992).

Researchers (Deci & Ryan, 2000; Barkoukis et al., 2008) also discuss 'a motivation' as third aspect of motivation as defined in the self-determination theory. This third component to motivation (Deci & Ryan, 2000) refers to the absence of how to behave. A motivation is when the individual does not observe the effects between their actions and the outcomes (Deci & Ryan, 2000; Barkoukis et al., 2008). This type of motivation has strong links to "learned helplessness, where individual withdraw effort because of perceptions of incompetence and loss of control" (Barkoukis et al., 2008, p.40).

A motivation in an individual may mean they discontinue participation within education or any academic activity (Vallerand et al., 1992). The three concepts of motivation intrinsic, extrinsic and a motivation) are placed on a 'self-determination continuum' running from a motivation, where there are low levels of self-determination, to extrinsic motivation with medium levels of self-determination, through to intrinsic motivation where the individual's behaviour relates to high level of self-determination (Deci & Ryan, 2000; Barkoukis et al., 2008).

According to the OECD (2000), extrinsic motivation occurs when there is an external factor or reward, influencing the act unlike intrinsic motivation where the action is completed without any obvious external factors and/or rewards. Hidi and Harackiewicz (2000) have discussed how it is important to deal with all aspects of an

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individual's motivation especially for those who are un-motivated within academia because this has the potential to optimise academic motivation.

Extrinsic motivation (Deci & Ryan, 2000; Barkoukis et al., 2008) as defined in the self-determination theory tradition includes: external regulation, introjections and identification. 'External regulation' is the most representative form of extrinsic motivation and involves the person undergoing an activity to gain a reward or avoid punishment (Barkoukis et al., 2008). 'Introjection' involves an individual self-involved with the activity where the individual is beginning to understand the reason to their actions (Deci & Ryan, 2000; Barkoukis et al., 2008). Finally, 'identification', this is the completed form of internalised extrinsic motivation because the individual values their behaviour and so, engagement is taken as being decided upon by the individual (Deci & Ryan, 2000; Barkoukis et al., 2008).

Song and Black (1991) indicated that students may need help in recognizing that school-based mathematical and scientific knowledge is useful in real-world contexts. White (2008) argued that the issue of long-term and short-term goals is relevant to the learning of science. The student who goes to lectures with a short-term goal of passing examinations often has a specific approach to learning. Mathematical and scientific laws and potentially meaningful facts are learned as propositions unrelated to experience. Too often examinations reward the recall of such facts. On the contrary, the students who have a stronger sense of achievement, or who want to learn about mathematics and science, may attend the lectures with a long-term goal of a deeper understanding and appreciation of mathematics or science. They may approach it involving advanced learning strategies of reflection and inter-linking of knowledge.

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Ames and Ames (2004) pointed out that students' motivations for learning from lectures have important consequences for what they are attending to, how they are processing information, and how they are reacting to the lectures. Hadar (1986), as cited in Trumper (1995), proposed the existence of four motivational traits that are attributable to students' needs. She introduced the notion of motivational pattern and implied that learners differ with respect to their preference for and responsiveness to different instructional features. She was also able to identify empirically the four major motivational patterns in her student sample, and accordingly she divided students into four types: the achievers, the curious, the conscientious, and the sociable. Hofstein and Kempa (1985) followed this line of research and found that students of different motivational patterns have their preferred modes of learning as well. Kempa and Diaz (2010) found that a high proportion of the total student population could be clearly assigned to one of the four motivational patterns. Kempa and Diaz (2010) went on to suggest that students with the conscientious or achiever types of motivational pattern would exhibit a strong preference for formal modes of teaching. Numerous studies sought to probe motivational features of learning (Ward & Bodner, 1993; Nakhleh & Mitchell, 1993). They give an insight into the vital importance of considering motivational features in a learning situation.

There is no doubt that motivation to learn is an important factor controlling the success of learning and teachers face problems when their students do not all have the motivation to seek to understand. However, the difficulty of a topic, as perceived by students, will be a major factor in their ability and willingness to learn it (Johnstone & Kellett, 1980). It is important to note that motivation is not a stable concept within any individual. Indeed, the level of motivation depends on the environment along with other extrinsic and intrinsic factors (Barkoukis et al., 2008) and it is domain-specific

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(Linnenbrink & Pintrich, 2002). This means that a student's motivation can fluctuate, in turn this can make it difficult to measure either by observation or direct questioning; this presents limitations to the researcher and the research obtained (Hardré, Davis & Sullivan, 2008).

2.5 Empirical review

Kyei, Apam, and Nokoe (2011) conducted a research on gender differences in performance in senior high school mathematics examination in mixed high schools in the Upper East region of Ghana. The results of the study indicated that there is gender difference in the outcome of mathematics examinations in Upper East mixed senior high schools. The investigation showed that there is a gender difference with males performing better than females. Asante (2012) indicated clear-cut sex differences in attitude towards mathematics between boys and girls in high schools in Ghana. Thus, the gap found in his study is in line with gender differences in cognitive abilities reported by some authors.

In a study coordinated by the Female Education in Mathematics and Science in Africa (FEMSA, 2009) project, issues on resources and facilities for teaching and learning of mathematics and science subjects were highlighted. The objective of the FEMSA study was geared towards support materials available for the teaching and learning of mathematics and science, the project set out to find from the heads of primary and secondary schools selected for the study, the number of each kind of facility or resource that one would normally expect to find in a school, which include: financial allocation to SMT subjects, teachers (disaggregated by gender), classrooms, offices, library, laboratories, workshops, bookstores, staff room, percentage of students with textbooks (disaggregated by gender), furniture, overhead, film and slide projectors; calculators, television sets, display board and duplicating machines.

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The study found great variations in the resources and facilities available for the teaching and learning of all subjects, but in particular, the SMT subjects. Although all schools in the study were government schools, sitting for the same national examinations within a country; and depended on their governments for the bulk of their finances, some of these schools were so impoverished, they did not have the basic necessities, such as sufficient classrooms, offices, desks, textbooks, functional toilets, not to mention facilities like laboratories, libraries, workshops, chemicals, science equipment or apparatus. The negative impact created by this inadequacy or total lack of resources/facilities on participation and performance in SMT subjects, particularly by girls; and recommendations given to alleviate these problems are the focus of this booklet. Based on the findings, some recommendations were made. Firstly, the four countries should improve the equitable of distribution of educational facilities throughout and across the countries; they should design subject and examination syllabuses that take into account the resources and facilities available in each of the countries, so that no one school is unduly disadvantaged by struggling to follow set syllabuses that call for use of materials and resources that are unavailable in their school. Finally, examination papers should be set to give all students an equal chance and in which performance is not dependent on the availability or not of the required facilities in their schools (FEMSA, 2009).

The FEMSA study recognised the indispensability of teachers, particularly female teachers. It came out that despite the indispensability of teachers in Science, Mathematics and Technology Education they could be rendered ineffective by any one or a combination of the following factors:

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1. Large classes that overburden and overload the teacher;
2. Poor training, poor qualifications or inadequate in-service programmes;
3. Lack of visual aids, textbooks, chemicals or needed teaching material.

The study also found out that there is a great shortage of mathematics and science teachers at the secondary school level, and the few there are, have to be shared by a large number of students which puts a heavy workload on the teachers. At the same time, the study revealed that most mathematics and science teachers are male. The study further revealed that most teachers at both primary and secondary schools are inadequately trained and almost never participate in any in-service training. Most lack creativity and initiative and will not improvise where there are no ready-made visual aids. Most are ignorant of girls' unique problems. Some lack competence in the use of equipment available in their schools and so such equipment remains unused. In any case, use of equipment in both mathematics and science lessons is viewed by both male and female students as a male domain, so girls as well as boys and even teachers, usually expect the boys to work with the equipment while the girls watch. Many teachers complain that science syllabuses, mainly at the secondary level, are inordinately long and that there is not sufficient time to cover the syllabus adequately. This is often the pretext for skipping practical work, even where equipment is available, on the basis that practical work takes up too much class time. The unwillingness to engage in practical work is bolstered by examinations which test learned knowledge and not practical skills, or as in the case of Tanzania where there are no practical examinations at the end of Form 4 (FEMSA, 2009).

The importance of researching students' attitudes towards science has been highlighted by the Organisation for Economic Co-operation and Development (OECD, 2010) who believe that a student's 'scientific literacy' should include certain

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attitudes, beliefs which by possessing and utilising effectively, it is believed this will benefit the individual, the society and worldwide. Previous studies have looked at students' attitudes within the broader context of their attitudes to science (Barmby, Kind & Jones, 2008; Bennett & Hogarth, 2009; Cerini, Jenkins & Nelson, 2005; Murray & Reiss, 2003; Osborne & Collins, 2001. The House of Commons (2002a) found that 71 percent of students who stopped studying science still valued it as interesting and more importantly 79 percent saw it as interesting. This could possibly be suggesting the link between practical work and enjoyment in school science but not the link to student retention post compulsion. These findings support the claim made by Abrahams (2009) that practical work may generate enjoyment for individual science lessons, but is rather ineffective at prolonging this motivation to study science post compulsion or influence a personal interest in it even though it is often thought to be the case.

Research has suggested the need to understand why students think the way they do to better understand and hopefully benefit student uptake as well as enhancing student engagement and enjoyment in science (Barmby et al., 2008). Chen and Howard (2010), Kim and Song (2009) studied the potential links between positive student attitude and its influence on continued participation and attainment. It could be understood that positive attitudes towards science may mean students are more inclined to participate and/or be more motivated to achieve.

Some science educators (Thompson & Soyibo, 2002) reported in studies that practical work was important means for enhancing attitudes, stimulating interest and enjoyment, and motivating students to learn science. Hofstein and Lunetta (2004) argued that hands-on activities have the potential to enhance positive attitudes and cognitive growth. Baker (1998) found that students having a negative attitude towards

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science may have more to do with the student not finding themselves suiting the image of science (Cleaves, 2005; Jenkins & Nelson, 2005) or lacking cognition in science (Malone & Cavanagh, 1997). There has been research (Koballa & Glynn, 2007) suggesting that students' affective factors consist of two theoretical areas: their attitudes towards science and their interest in science topics, where interest here means a direct causal factor influencing students' learning behaviour.

It is important to understand that there is no single set of recommendations as to how to incorporate a constructivist approach to learning into the classroom. Each of the major theorists has specific recommendations and they do not always agree with each other. The common thread that runs throughout a constructivist approach is that the development of meaning is more important that the acquisition of a large set of knowledge or skills that are easily forgotten (Black & McClintock, 2005). Two of the most important concepts for applying these theories relate to matching learning experiences to a student's level of readiness and providing for social interaction during the learning process.

2.6 Summary of literature review

This chapter reviews the relevant/related literature to the study. Essentially, the review encompasses the theoretical framework that focused on gender and mathematics achievement. There is a range of theories which account for gender differences and mathematics achievement. The current study is rooted in the equality or equity, deficit feminist, expectancy-value theory of achievement, and the implicit theories. The Expectancy Value Theory, for instance, explains that differences in performance in mathematics according to gender are important at the highest grade levels than at the least levels. The theory therefore suggests that examining male and female performance at different ability levels gives a clear picture of the relationship

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between the gender of the student and academic achievement than is achieved by merely considering group averages.

The literature review also embodied the gender differences in mathematics achievement. The review points out that mathematics has been regarded as a difficult subject for students by many researchers, teachers and science educators because of the abstract nature of many mathematical concepts, teaching styles applied in class, lack of teaching aids and the difficulty of the language of mathematics. All these cause students, from primary level to the university, to develop poor attitudes, interest and anxiety, in learning the subject.

It emerged from the review that mathematics has been viewed as a subject favouring male students worldwide. Despite research evidences for male's superiority in mathematics achievement, some research findings do not support the difference between these two genders in mathematics achievement. In this regard, the current review points to mixed opinions on gender differences in mathematics achievement.

It unfolds from the review that a good number of variables influence gender differences in mathematics achievement. These variables could be categorized into biological, environmental, attitudinal (students' attitudes, students' interest and self-esteem), socio-cultural norms and beliefs. It came to light from the review that the home factors which account for gender differences in mathematics achievement include, but not limited to educational level of students' parents, home educational resources, socioeconomic status of the family, home language versus language of test, and providing quality homework assistance by parents.

The review indicates that the school variables which influence gender differences in mathematics achievement include the organizational climate of the school, curriculum

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planning, curricular materials, teaching learning setup, schools climate and culture, school connectedness or engagement, classroom interactions, and teachers' gendered attitudes. On the other hand, the review brings to fore the attitudinal variables that determine gender differences in students' mathematics achievement. These variables include attitude towards mathematics, self-concept, confidence, mathematics anxiety, motivation and interest in mathematics.

The above review suggests that many factors, particularly students' attitudes may be associated with the gender gap in mathematics achievement. These differences put together have implications for the kind of instructional procedures that are to be adopted for setting up an appropriate teaching and learning environment for mathematics instruction that is suitable for both genders.

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CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the research methodology. Specifically, it describes the research design, the population, the sample and sampling procedure, instrumentation, validity and reliability of the instruments, data collection procedure, data analysis, and ethical considerations.

3.1 Research design

This study, which is descriptive in nature, used the quantitative paradigm. Specifically, the study adopted the cross-sectional survey design. A survey can examine current attitudes, beliefs, opinions, or practices. Attitudes, beliefs, and opinions are ways in which individuals think about issues, whereas practices are their actual behaviours (Creswell, 2012). This design has the advantage of measuring current attitudes or practices. It also provides information in a short amount of time, such as the time required for administering the survey and collecting the information needed (Creswell, 2012). Cross sectional survey design fits well with this study because the researcher obtained data from a section of college of education students on their opinions on gender and mathematics achievement as at the time of the research.

3.2 Population of the study

In research parlance, population is defined as the larger group upon which a researcher wishes to generalize: it includes members of a defined class of people, events or objects (Creswell (2009). Creswell (2009) further indicated that population

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is the sum aggregate or totality of the phenomena of interest to the researcher. The target population of this study comprised eight hundred and ninety (890) teacher trainees of the Bimbilla College of Education. The accessible population was 309 comprising 190 male and 119 female level 200 students of the college. The level 300 students were excluded from this study because they were on teaching practice/internship. The level 100 students were also excluded from the study because they did not have much exposure to college mathematics. This means that they were not taught many college mathematics concepts because they did not cover many topics in the college of education mathematics curriculum or syllabus.

3.3 Sample, sampling techniques and procedures

The sample size for this study was thirty (30) representing 9.7%, that is approximately 10% of the target population. The choice of 9.7% of the target population is based on Dornyei's (2007) assertion that between 1% and 10% of a study population gives an adequate sampling fraction.

Sampling is the procedure a researcher uses to select people, places, or things to study (Flick, 2014). The quality of a sample determines the quality of the research findings in large measure. Sampling and selection of a site is to a large extent influenced by the strategy of enquiry used by the researcher (Creswell, 2009). The 30 students were sampled via stratified and simple random sampling techniques using the lottery approach.

In this study, the students were first stratified into categories or strata: by gender or sex group (male and female). In selecting the students, pieces of paper equaled to the total number of students who constituted the study units (sampling frame) in level 200 by gender category were designed by the researcher. In selecting the sample of female

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level 200 students, for instance, the researcher designed 119 pieces of paper. Eleven (11) pieces of paper had the inscription “Yes” whilst the other remaining 108 pieces of paper were captioned “No”. The pieces of paper were folded, and put in a box. The box was turned over and over again to ensure that the pieces of paper were well mixed to guarantee that each female student had an equal opportunity of being selected. The female students were assembled and each picked a piece of paper from the box at random. A female student who picked a piece of paper bearing ‘Yes’ response was enrolled as a participant for this study. This yielded a sample size of 19 (10%) female students. This sampling process or procedure was repeated for the 190 level 200 male students. In all, 19 male students were also selected.

The random selection ensured that each student had an equal chance of being selected, and this is required for generalisation of the results to the target population as noted by Creswell (2009). This sampling technique ensured representativeness of the sample, and it also eliminated selection bias. The researcher also employed this technique because it is a more refined form of random sampling which introduces stratification or grouping of the population/variable according to its different traits or attributes in order to ensure that the sample takes care of all the different attributes of the population. As affirmed by Seidu (2007), the process avoids skewing the representation disproportionate number of member randomly selected to constitute the sample.

3.4 Data collection instruments

Two techniques were used in gathering data for this study. These were administration of questionnaire and test. In this regard, two (2) instruments were used to gather the necessary data from the students and mathematics tutors.

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3.4.1 The questionnaire design

The questionnaire, which had close-ended items, consisted of personal data, mathematics test scores of the students indicating gender differences or parity in mathematics achievement, factors influencing gender differences in mathematics achievement and students' attitudes to mathematics learning.

Some of the questions for this survey contained five-point Likert-type items: strongly agree (SA) = 4, agree (A) = 3, Neutral (N) = 2, Disagree (D) = 1 and strongly disagree (SD) = 0). The items were built to reflect on the key themes raised in the research questions. It consisted of sections: A, B, C, and D. Section 'A', which had 1 closed-ended questions, was on gender of the students. Section 'B' had 11 close-ended questions on gender and mathematics achievement. . Section 'C' contained 9 closed-ended items on the factors responsible for gender differences in mathematics achievement. The last section, part 'D', had 17 items on the attitudes of students towards mathematics. In all, the questionnaire had 41 items. The questionnaire request straightforward, concise, brief and short answers. The respondents used 25-30 minutes to answer the question.

Questionnaire is widely used as a very useful instrument for collecting survey information, providing structured outline and it is being able to be administered without the presence of the researcher if respondents can read and write. Again, it is often being comparatively straightforward to analyse (Cohen, Manion, & Morrison, 2007).

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3.4.2 Mathematics test items

There were five (5) written test items for the students. The items were based on concepts or topics in the college mathematics syllabus which they had been taught. They spent 30 minutes in answering the questions.

3.5 Validity and reliability of instruments

Validity refers to the extent to which the research instrument serves the use for which it is intended (Seidu, 2007). Face validity was done by giving the instruments to colleague M.Ed mathematics students in the Department of Mathematics Education of the University of Education, Winneba (UEW) for scrutiny. Indeed, their comments were considered for review of the questions. The content validity of the instruments was granted by the research supervisor who scrutinized the items for their suitability before pre-test. All the necessary corrections in the items were made and declared valid by the supervisor. Construct validity was also ensured by employing accepted definitions and constructions of concepts and terms; operationalizing the research and its measures.

Joppe (2000) defines reliability as the extent to which results are consistent over time and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. To ensure reliability of the research instruments, they were pre-tested on 20 students and 2 mathematics tutors of St. Vincent College of Education, Yendi. The results of the pilot test were subjected to Cronbach's alpha reliability analysis using version 21 of Statistical Product and Service Solutions (SPSS). This yielded a reliability coefficient (r) of 0.73 which is deemed as an acceptable measure of reliability because this is above the 0.70 the

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threshold value of acceptability as a measure of reliability as noted by Dörnyei and Taguchi (2010). According to Fraenkel and Wallen (2000), reliability co-efficient of .70 is seen to be highly reliable for research purpose. This value is also in line with that of Tavakol, Mohagheghi, and Dennick (2008), that the acceptable values of alpha, ranges from 0.70 to 0.95. This result implies that the instrument was reliable; hence it was used for the actual study. The pilot study also offered the researcher an opportunity for identifying some of the problems that could have been encountered in the main study. This informed the necessary corrections to the questions before the main study is done.

3.6 Data collection procedure

In conducting a study, Creswell (2005) advises researchers to seek and obtain permission from the authorities in charge of the site of the study because it involves a prolonged and extensive data collection. In line with this, an introductory letter was obtained from the Head of Department of Mathematics Education from the University of Education, Winneba. This letter provided the details of the study, including data collection, and issues of confidentiality and anonymity.

This letter was used to obtain permission from the Principal of Bimbilla College of Education. An approval letter was then given to the researcher to open the gate for data collection. After permission was granted, the researcher first met the sampled participants to inform them of the impending administration of the questionnaire test. The questionnaires and the test items were personally administered to the students. They agreed to complete them and submit them the same day. Respondents adhered to the agreed time and presented the completed questionnaire at the end of the day. This was done to ensure high coverage, completion, and return rate. The completion and return rate was 100%.

3.7 Data analysis

Yin (2003) stated that before interpretation takes place, data should be analysed statistically and presented. Responses from respondents on the questionnaire were tallied in order to get the number of respondents who answered each set of items. The collected data were keyed or fed into the SPSS version 21 software and they were analyzed. Frequency counts, percentage distributions, mean and standard deviations of responses were generated according to each research question raised, and this was presented in tables. The researcher also used the SPSS to run independent samples t-test to find significant gender differences in mathematics achievement. This was done at a significance level of $p \leq .05$. The interpretation of the t-test results made it possible to make appropriate inferences.

3.8 Ethical considerations

Resnik (2009) defines ethics in research as the discipline that study standards of conduct, such as philosophy, theology, law, psychology or sociology. In other words, it is a method, procedure or perspective for deciding how to act and for analyzing complex problems and issues. Protection of participants and their responses were assured by obtaining their informed consent, protecting privacy and ensuring confidentiality. In doing this, description of the study, the purpose and the possible benefits were mentioned to participants. The researcher permitted participants to freely withdraw or leave at any time if they deemed it fit.

a. No harm to participants

In Babbie's opinion (2004), the ethical norms of voluntary participation and no harm to participants have, become formalized in the concept of informed consent. Accordingly, participants base their voluntary participation in research studies on the

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full understanding of the possible risks involved. Harm can either be physical or emotional (Trochim, 2006). Throughout this study, the researcher made an effort to ensure that participants were not harmed psychologically or emotionally.

b. Anonymity

Research participants' well-being and interests need to be protected. Participants' identities in the study should be masked or blinded as far as possible (Trochim, 2006). The people who read the research and the researcher should not be able to identify a given response with a given respondent (Babbie, 2004). The names of the respondents who participated in this study were not revealed anywhere instead, code names were used.

c. Confidentiality

Confidentiality indicates the handling of information in a confidential manner (Strydom, 2002). This implies that the researcher must jealously guard all the information disclosed by the participant so that only the researcher has access to it. The test scores and completed questionnaire of the participants were kept out of view and were not accessible to other students and mathematics tutors. They were kept by the principal investigator and used for this research only.

d. Plagiarism

As a way of preventing plagiarism, all ideas, writings, drawings and other documents or intellectual property of other people were referenced indicating the authors, title of publications, year and publishers.

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CHAPTER FOUR

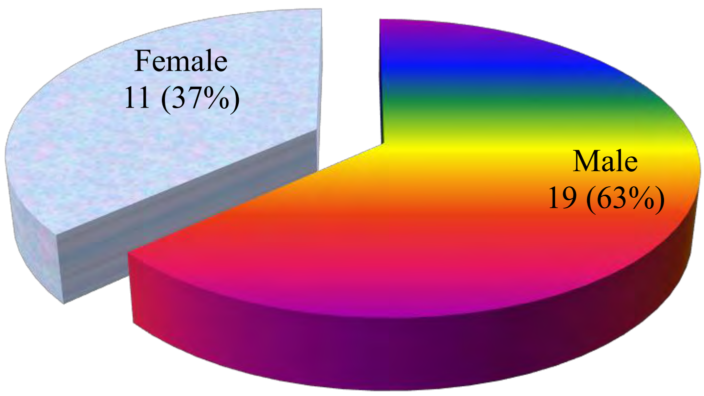
RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results of the data analysis and addresses each of the three research questions posed followed by a discussion of each research question. The study examined gender differences in mathematics achievement among students of Bimbilla College of Education. Data have been organized, presented and discussed under the following themes: demographic data of the students, mathematics achievements of the students, the factors responsible for gender differences in mathematics achievements among the students, and students' attitudes towards the learning of mathematics.

4.1 Demographic characteristics of the respondents

The study identified gender as demographic characteristic or indicator in the study of mathematics. This helped give information about the participants of the study. The data are presented in Figures 4.1. (n = 30)



Source: Field data (2018)

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Figure 4.1: Gender distribution of the students.

In Figure 4.1, out of 30 students, 19 respondents representing 63% of them were males while 11respondents representing 37% of them were females.

4.2. Mathematics achievements of students in Bimbilla College of Education

The data presented and discussed under this theme bears on research question 1 which states that *"How different is the mathematics achievements of female students with that of their male counterparts in Bimbilla College of Education?"* This question sought to find out the academic performance of students in mathematics. To find answer to this research question, 5 written mathematics test items were given to the students to solve. Responses to the questions numbered 1 to 5 were analysed. The quantitative data are presented as frequency counts and percentages in Table 1.

Table 4.1: Distribution of students' scores in a written mathematics test

Score	Frequency	Percentage
0-49	0	0
50-59	0	0
60-69	17	57
70-79	9	30
80-100	4	13
Total	**30**	**100**

It is evident from the results that 17 (57%) college students who scored 60-69%, 9 (30%) students scored between 70% and 79%, whereas 4 (13%) students scored 80-89%.

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Table 4.2: Gender and mathematics achievement

(n = 30)

Variable	Variable category	F	%
Entry qualification	A1	0	0
	B2 / B3	0	0
	C4 /C5/C6	30	100
	D7	0	0
Response on whether student perform well in college mathematics	Yes	21	70
	No	0	0
	I am not sure	9	30
Level of academic performance in class in college mathematics	0%-49%	0	0
	50-59%	4	13
	60%-69%	17	57
	70%-79%	7	23
	80%-100%	2	7
Response on whether male and female students perform equally in mathematics	Yes	6	20
	No	19	63
	I am not sure	5	17
Response on whether females perform better than males in mathematics	Yes	3	10
	No	23	77
	I am not sure	4	13
Response on whether females easily understand mathematical concepts than males	Yes	2	6
	No	23	77
	I am not sure	5	17
Response on whether a lot of females excel in mathematics than males	Yes	1	3
	No	26	87
	I am not sure	3	10
Response on whether females are able to follow mathematical principles better than males	Yes	2	6
	No	22	73
	I am not sure	6	21
Response on whether females are able to make better analysis than males in mathematics.	Yes	1	3
	No	22	73
	I am not sure	7	23

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Response on whether mathematics is seen as masculine than feminine subject	Yes	24	80
	No	6	20
	I am not sure	0	0
Response on whether males are able to make logical and systematic presentations than females	Yes	25	83
	No	5	17
	I am not sure	0	0
Response on students' views on mathematical concepts	Very difficult	5	17
	Somehow difficult	14	47
	I don't know	0	0
	Easy	6	20
	Very easy	5	17

Key: F = Frequency; **%** = Percentage

Table 4.3 presents data on gender and mathematics achievement of students of Bimbilla College of Education. It becomes clear that all the sampled students (30 or 100%) had admissions into the Bimbilla College of Education with average but low grade points of C4, C5 and C6 in secondary mathematics during the West African Secondary School Certificate Examination (WASSCE). This means that most of them were average students in mathematics. This is likely to predict their performance in college mathematics.

The majority (21) which represents 70% of the students averred that they perform well in college mathematics. However, 9 (30%) students answered in the negative. Seventeen (57%) students rated their level of class performance in college mathematics as falling within 60% to 69% which is grades C4, C5 and C6. This is followed by 7 (23%) students whose class scores in college mathematics ranges from 70% - 79% which is grades B and B+, and 2 (7%) students whose class scores are between 80% and 100% which is grade A. Four (13%) students rated their level of class performance in college mathematics as falling within 50% to 59% which is grade D7.

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Six (20%) students affirmed, whereas 19 (63%) disclaimed that male and female students perform equally in mathematics. Five (17%) students were irresolute with the statement. Also, 2 (6%) students answered in the affirmative that females easily understand mathematical concepts than males. Twenty-three (77%) students gave a negative response, while 5 (17%) were not sure. Only 1 (3%) student affirmed that more females than males excel in mathematics. The majority (26) which represents 87% of the students held opposing views, whereas 3 (10%) not sure.

Two (7%) students answered in the positive, 22 (73%) stated no while 7 (21%) were irresolute with the statement that females are able to follow mathematical principles better than their male counterparts. The majority (24) which represents 80% of the students averred that mathematics is seen as masculine than feminine subject. However, 6 (20%) students held divergent views.

A large number of the students (25) which represents 83% of the students affirmed that males are able to make logical and systematic presentations than females. Conversely, 5 (17%) students held opposing views. Five (17%) students stated that mathematical concepts are very difficult, 14 (47%) mentioned somehow difficult, 6 (20%) indicated easy, while 5 (17%) mentioned very easy.

It could be deduced from the results that the majority of students who enroll into Ghanaian Colleges of Education are average achievers in mathematics. It also came to light from the results that there are gender differences in mathematics achievement. The findings indicate that males outperform females in mathematics as affirmed by 63% of the students. This means that mathematics is perceived as a masculine subject as noted by 80% students. Generally, mathematics is perceived as difficult as stated by 64% of the college students. This finding corroborates the views of Muthukrishna

(2010) and Fennema (2000) who found that boys perform better than girls in mathematics. The finding is also consistent with the assertion of Ogunkunle (2007) who found a significant difference in favour of males. It also agrees with earlier studies of Asante (2010) and Fennema (2000) who found significant gender differences in mathematics achievement. This finding, however, is at variance with the views of Hydea and Mertzb (2009) who stated that girls have reached parity with boys in mathematics.

4.3. The factors which accounts for gender differences in mathematics achievements among students of Bimbilla College of Education

One of the core issues that was explored by the researcher was the factors which account for gender differences in mathematics achievement. The data presented and analysed under this theme seek to answer research question 3 which states, *"What factors contribute to the gender differences in mathematics achievement among students in the college?"* The data for this research question were obtained from responses to items 15 to 24 in the questionnaire. The data are depicted in Table 4.4.

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Table 4.3: The factors that account for gender differences in mathematics achievement at Bimbilla College of Education

(n = 30)

Factor	Agree		Neutral		Disagree	
	F	%	F	%	F	%
Inadequate curricular materials.	23	77	2	7	5	17
Poor teaching learning setup.	15	50	2	7	12	40
Teachers' gendered attitudes.	18	60	3	10	9	30
Poor attitudes of teachers towards maths instruction	16	53	3	10	11	37
Weak/poor methodology for maths instruction	16	53	3	10	11	37
Methods and teaching learning resources used to teach mathematics favour female students	10	33	0	0	20	67
Weak/poor foundation in mathematics	24	80	2	7	4	13
Negative self-concept towards maths learning	21	70	2	7	7	23
Low confidence in mathematics.	19	63	3	10	8	27
Low motivation and interest in mathematics.	18	60	2	7	10	33

Source: Field data (2018).

Key: F = Frequency; % = Percentage; n = sample

Twenty-three (77%) students agreed, while 5 (17%) disagreed with the statement that inadequate mathematics curricular materials in the college is a factor which accounts for gender differences in mathematics achievement. Only 2 (7%) students were irresolute with the statement. Fifteen (50%) students linked gender differences in mathematics achievement among college students to poor teaching learning setup. However, 12 (40%) students held opposing views and 2 (7%) were indecisive.

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The majority (18) which represents 60% of the students attributed gender differences in mathematics achievement among college students to teachers' gendered attitudes. Three (10%) students disagreed with the statement, while 9 (30%) were undecided. Also, 16 (53%) students cited poor attitudes of teachers towards mathematics instruction as a factor which accounts for gender differences in mathematics achievement. However, 3(10%) students disagreed and 11 (30%) were irresolute with the statement.

Similarly, 16 (53%) students mentioned weak or poor methodology for mathematics instruction as a factor which accounts for gender differences in mathematics achievement. However, 3(10%) students held opposing views and 11 (30%) were neutral. Ten (33%) students agreed, while 20 (67%) disagreed with the statement that methods and teaching learning resources used to teach mathematics favour female students.

As many as 24 (80%) students cited weak or poor foundation of students in mathematics as a factor which accounts for gender differences in mathematics achievement. However, 4 (13%) students disagreed and 2 (7%) were irresolute with the statement. Twenty-one (70%) students attributed gender differences in mathematics achievement to negative self-concept towards mathematics learning. However, 7 (23%) students disagreed with the statement and 2 (7%) were undecided.

Nineteen (63%) students cited low confidence in mathematics as a factor which accounts for gender differences in mathematics achievement. Eight (27%) students disagreed with the statement and 3 (10%) were undecided. Similarly, 18 (60%) students attributed gender differences in mathematics achievement among the

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students to low motivation and interest in mathematics. However, 10 (33%) students held divergent views and 2 (7%) were undecided.

It emerged from the findings of this study that weak or poor foundation in mathematics (80%) is the major factor which accounts for gender differences in mathematics achievement. This is followed by inadequate curriculum materials (77%), negative concept towards mathematics learning (70%), low confidence in mathematics (63%), low motivation and interest in mathematics (60%), and teachers' gendered attitudes (60%). This finding points to the fact that a plethora of factors account for gender differences in mathematics achievement. These factors primarily include but not limited to negative perceptions and attitudes of learners towards mathematics. This finding substantiates the views of Hammouri (2004) and Kiamanesh (2004) who found that students' performance in mathematics are due to factors such as poor attitude towards mathematics.

4.4. Attitudes of the students of Bimbilla College towards mathematics

To answer research question 3 which is *"What are the attitudes of students to the study of mathematics in the college?"* The data for this research question were obtained from responses to items 25 to 42 in the questionnaire. The data are depicted in Table 4.5.

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Table 4.4: The attitudes of students of Bimbilla College of Education students towards mathematics

(n = 30)

Statement	N F(%)	R F(%)	S F(%)	MoT F(%)	A F(%)
Mathematics is interesting.	0(0)	0(0)	21(70)	6(20)	3(10)
I like mathematics.	0(0)	0(0)	24(80)	3(10)	3(10)
Mathematics is fun.	8(27)	7(23)	10(33)	3(10)	2(7)
Mathematics is easy for me.	6(20)	7(23)	12(40)	3(10)	2(7)
Mathematics is boring.	3(10)	2(7)	7(23)	10(33)	8(27)
Mathematics is hard for me.	3(10)	3(10)	5(17)	12(40)	7(23)
Maths is something which I enjoy.	8(27)	7(23)	10(33)	3(10)	2(7)
Maths is so interesting to me & I enjoy it.	6(20)	7(23)	12(40)	3(10)	2(7)
My mind goes blank & I'm unable to think when working maths.	3(10)	4(13)	15(50)	6(20)	2(7)
I never liked maths and it's my most dreaded subject.	4(13)	3(10)	3(10)	9(30)	11(37)
I feel a sense of insecurity when attempting mathematics questions.	4(13)	3(10)	3(10)	9(30)	11(37)
Maths makes me feel uncomfortable, restless, irritable and impatient.	4(13)	3(10)	3(10)	9(30)	11(37)
I feel ease in mathematics and I like it very much.	8(27)	7(23)	10(33)	3(10)	2(7)
I am happier in mathematics class in any other class.	7(23)	6(20)	12(40)	3(10)	2(7)
I feel a definite positive reaction to mathematics lessons.	9(30)	7(23)	9(30)	3(10)	2(7)

Source: Field data (2018).

Key: F = Frequency; % = Percentage; n = sample; N = Never; R = Rarely; S= Sometimes; MoT = Most of time; A = Always

Note: *The figures in parentheses are in percentages.*

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Table 4.5 presents data on the attitudes of students of Bimbilla College of Education towards mathematics. The data (responses) were further collapsed into three categories: not at all, sometimes and always for easy discussion. Mathematics is most of the time an interesting subject to 9 (30%) students, but it is sometimes interesting to 21 (70%) of them. The majority (24) which represents 80% of the students occasionally liked mathematics, while 6 (20%) always liked it.

Mathematics is fun to 5 (17%) students all the time. In contrast, 15 (37%) students held opposing views, and 10 (33) of them sometimes see it as fun. Mathematics is always easy for 5 (17%) students, and sometimes easy for 12 (40%) of them. Conversely, 13 (43%) students answered in the negative. Mathematics is most of the time boring to 18 (60%) students, and it is sometimes boring to a few (7 or 23%) students. However, 6 (60%) gave opposing views.

Mathematics is most of the time hard for 19 (63%) students, and sometimes hard for 5 (17%) of them. Nonetheless, it is never hard for 6 (20%) students. Mathematics is something which only a few students (5 or 17%) enjoy, 10 (33%) of them sometimes enjoy it, but 15 (50%) never enjoy it. Mathematics is most of the time interesting to a few students only (5 or 17%), and it is sometimes interesting to 12 (40%) students, but never interesting to 13 (43%) students.

Eight (27%) students stated that their minds always go blank and they are unable to think when working mathematics. Fifteen (50%) of them sometimes experience it, but 7 (23%) never experience it. The majority (20) which represents 67% of the students never liked mathematics because it is a dreaded subject to them. Three (10%) students agreed to some extent, while 7 (23) held incongruent views. Similarly, 20 (67%)

students felt a sense of insecurity when attempting mathematics questions. Three (10%) students agreed to some extent, whereas 7 (23) expresses divergent views.

Again, 20 (67%) students revealed that mathematics makes them uncomfortable, restless, irritable and impatient. Three (10%) students agreed to some extent, but 7 (23) never felt so. Only a few students (5) which represents 17% of them always felt at ease in mathematics and liked it very much. Conversely, 15 (50%) students did not but 10 (33%) sometimes felt at ease.

Only a small number (5) which represents 17% of the students most of the time felt happier in mathematics class than in any other class. However, 13 (43%) students did not but 12 (33%) occasionally felt happy. A few students (5 or 17%) most of the time felt a definitive positive reaction towards mathematics lessons. However, 16 (53%) students did not but 9 (30%) sometimes felt positive about it.

It could be concluded from the results of this study that most students of Bimbilla College of Education have poor attitudes towards college mathematics. This is because they perceived it as a dreaded subject as affirmed by 67% of the students, and they feel insecure when attempting mathematics questions. It is also because mathematics makes them uncomfortable, restless, irritable and impatient.

Other reasons given by the students for their negative attitudes towards mathematics were: it is a hard or difficult subject (63%), it is boring (60%), and a feeling of negative reaction towards mathematics lessons (53%). Consequently, they have negative reaction towards mathematics lessons and never enjoy the subject (50%). Further to that, they never felt at ease and happier in mathematics classes (50%). The finding of this study signifies that poor or negative perceptions and attitudes of learners to mathematics is a recipe to poor achievement in mathematics. This

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observation is in tandem with the assertion of The Royal Society (2008), Jones and Barmby (2007), Lakshmi (2004), Osborne, et al. (2003), Bricheno, Johnston and Sears (2001) which indicate that students' attitudes to mathematics and science significantly affect their disposition towards attainment and their retention within mathematics and science both in and out of school.

Other studies by Opolot-Okurut (2005) found that for all the attitudinal variables (anxiety, confidence and motivation), males had higher mean scores than females. This finding further supports the views of Gallagher and Kaufman (2006) which indicate that the mathematics achievement and interest of boys are better than the girls. This also corroborates with the views of Watt (2007) who indicated that girls have less confidence in mathematics ability than boys.

4.5. Testing of hypothesis

Null Hypothesis (Ho): *There will be no significant gender differences in mathematics test scores of male and female students in Bimbilla College of Education.*

Table 4.5: Independent sample test (t-test) result of gender differences in mathematics achievement

Gender	Sample (N)	Mean	Std. Dev	t	df	Sig (2-tailed)
Male	19	2.36	.505	-3.234	28	.003
Female	11	1.84	.375			
Total	30	2.03	.490			

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*Test variables - Dependent variable (*mathematics achievement*) & independent variable (*gender*).

** df (28) - degrees of freedom

*** t-test is significant at the .05 level (2-tailed).

The result in Table 4.6 shows that there is a significant gender difference in college mathematics achievement between male and female students ($p \leq .05$). The t-test output indicates that the observed difference in the means is significant; $t(28) = -3.234$, $p = .003$. This result statistically shows a negative but significant gender difference in mathematics achievement among male and female college students. Hence, the **Ho** is rejected. This current study revealed gender differences in mathematics achievement. The finding reveals that male students outperform female students in mathematics. This finding is in tandem with earlier findings by Muthukrishna (2010), Asante (2010), Ogunkunle (2007) and Fennema (2000) who also found significant gender differences in mathematics achievement.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0. Overview

This study examined gender differences in mathematics achievement among students of Bimbilla College of Education. To arrive at this objective, 30 teacher trainees were sampled via stratified and random sampling techniques for the study. The design adopted for this study was descriptive cross-sectional survey. Basically, the main instruments used were questionnaire (Cronbach's alpha = 0.73), and mathematics test items. Data collected were analyzed using frequency and percentage and these were presented in tables. Inferential statistics was computed using t-tests at a significance level of $p \leq .05$. This chapter highlights the summary of the study, conclusions and recommendations drawn from the study. Suggestions for further studies are also put forward.

5.1 Summary of findings

Among the findings of this study were the following:

The first research question sought to find out differences in mathematics achievements of female and male students in Bimbilla College of Education. The data showed that the male students outperformed their female counterparts in mathematics as indicated by the mean performance of 2.36 and 1.84 respectively. This signifies a significant gender differences in mathematics achievement ($p \leq .05$).

The second research question looked at the factors contributing to the gender differences in mathematics achievement among students in the college. The study

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found that weak or poor foundation in mathematics primarily accounts for gender differences in mathematics achievement.

The data again indicated that negative perceptions and attitudes of learners towards mathematics as well as a host of factors account for gender differences in mathematics achievement.

The third research question sought to determine the attitudes of students to the study of mathematics in the college. The findings of this study reveal that most of the students had poor attitudes towards the learning of college mathematics.

5.2 Conclusions

Based on the study the following conclusions have been made:

There is a disparity in performance between male and female students. It is evident from this study that students' achievement in college mathematics is dependent on gender. The finding of this research confirms the global evidence in the context of Bimbilla College of Education female students' achievements are less than boys in mathematics. The study on sex differences in achievement in mathematics raises many questions. These questions which need deep thinking and research to understand the patterns. It would be informative to find whether gender differences exist in mathematics achievement by grade levels (primary grade, junior grade, high school, college, university). Another pertinent question is whether males in mixed-sex schools outperform their female counterparts in college mathematics. Again, it would be informative to explore whether males in single-sex schools will achieve higher scores in college mathematics than their female counterparts and/or vice versa.

One of the objectives of the study was to find out the attitudes of students toward learning college mathematics. The study indicated that students in the study area had

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unfavourable attitudes towards mathematics. The males' superiority in achievement in college mathematics over their female counterparts is linked to differences in students' attitudes towards mathematics.

5.3. Recommendations

In the light of the findings of this study, the following recommendations are put forward:

It emerged from this study that male students outperformed their female counterparts in mathematics. This signifies a significant gender differences in mathematics achievement. Therefore, mathematics teachers in the Bimbilla College of Education should give female students equal opportunities in the classroom so that their confidence in the subject will be high.

It is also recommended that management of the college should ensure that mathematics teachers with the requisite qualifications are assigned to handle the subject. These will help foster a more positive attitude of students towards mathematics.

Weak or poor foundation in mathematics and a number of factors were suggested for the difference in performance in mathematics between male and the female students. Now that this research unfolds what factors are causing the low performance of females in college mathematics, how could it be minimized or eliminated if possible? It is recommended that mathematics tutors in the college should use appropriate media or technology and teaching approaches that make mathematics learning grounded in learner centred pedagogies. This would encourage active learning of the subject with application to life outside of the classroom. This could offer opportunities for students to construct and discover knowledge.

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It also came to light from the findings of this study that negative perceptions and attitudes of learners towards mathematics account for gender differences in mathematics achievement. In this regard, mathematics teachers in the college should incorporate new methods of teaching mathematics such as the use of audio visuals in presenting mathematics lessons to facilitate students understanding and sustain their interest in the subject.

5.4. Suggestions for further research

With reference to this research and its limitations, the following recommendations are proposed:

The study covered only one College of Education in Ghana. In order to have a broader view on gender differences in students' mathematics achievement, the researcher recommend that further studies be conducted in other Colleges of Education in Ghana to widen the scope of the research population. Further studies should concentrate on students' attitude towards learning of college mathematics.

No major study conducted about cultural influences on female mathematics achievement verifying any solid understanding of why females do not score better than males. It would be an important study to understand how culture in Ghana plays a role in the achievement of females in mathematics.

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REFERENCES

Abdu-Raheem, B. O. (2012). The influence of gender on secondary school students' academic performance in South-West, Nigeria. *Journal of Social Sciences, 31*(1), 93-98.

Abiam, P. O., & Odok, J. K. (2006). Factors in students' achievement in different branches of secondary school mathematics. *Journal of Education and Technology, 1*(1), 161 – 168.

Adams, J., & Hayes, J. (2001). *Understanding and managing personal change.* U.S.A: Martin Robinson Publications

Adeleke, M. S. (2007). Determinants of vocational interests and academic career choice performance among business education teacher trainees of Colleges of Education in Oyo State, Nigeria Olumo. *Journal of Education, 2*(2), 197- 207.

Adeyemi, B. S. (2014). Effect of gender on secondary school students' achievement in map work. *European Journal of Educational Studies, 6*(1), 21-31.

Ajai, J. T., & Imoko, I. I. (2015). Gender differences in mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science (IJRES), 1*(1), 45- 50.

Ajai, J. T., & Imoko, I. I. (2015). Gender differences in mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science (IJRES), 1*(1), 45- 50.

Ajai, J., & Imoko, I. (2015). Gender differences in mathematics achievement and retention scores: A case of problem-based learning method . *International Journal of Research in Education and Science (IJRES), 1*(1), 45- 50.

Alex, J. K., & Mammen, K. J. (2012). A survey of South African grade 10 learners' geometric thinking levels in terms of the van Hiele theory. *Anthropologist, 14*(2), 123-129.

Allik, J., Must, O., & Lynn, R. (1999). Sex differences in general intelligence among

Asante, K. O. (2010). *Sex differences in mathematics performance among senior high students in Ghana.* Retrieved on March 2, 2018 from http://www.faqs.org/periodicals/201012/2187713381.html#ixzz1I5YvD0t3.

American Association of University Women (1992). *How schools shortchange girls: The AAUW report.* Washington, DC: Author.

Antonijevic, R. (2005). *Differences in teaching and learning mathematics and student's mathematics achievement in TIMSS 2003.* Belgrade: Institute for educational research.

University of Education, Winneba http://ir.uew.edu.gh

Aremu, A. O., & Sokan, B. O. (2002). Multi casual evaluation of academic performance of Nigerian learners: Issues and implications for national development. An unpublished paper.

Asante, K. O. (2010). Sex differences in mathematics performance among senior high students in Ghana. Retrieved on January, 2018 from http://www.faqs.org/periodicals/201012/2187713381.html#ixzz1I5YvD0t3

Asante, K. O. (2012). Secondary students' attitudes towards mathematics. *Journal of Ife Psychologia*, *20*(1), 121-133.

Asim, A. E. (2007). Examination ethics and school based assessments in science, technology and mathematics: A proceedings *of epiSTEME 3* critical concern for universal basic education. *Proceedings of the 9th National Conference of National Association of Evaluators and Researchers*, Nigeria, Ago-Iuoye.

Asim, A. E., Kalu, I. M., Idaka, I. E., & Bassey, S. W. (2007). Competency in STM assessment: The case of primary school teachers in Cross River State, Nigeria. *Proceedings of International Conference to Review Research in Science, Technology and Mathematics Education* (epiSTEME-2), Feb. 12-15, Mumbai, India.

Atovigba, M. V., Vershima, A. M., O'Kwu E. I., & Ijenkeli, E. (2012). Gender trends in Nigerian secondary school students' performance in algebra. *Research Journal of Mathematics and Statistics*, *4*(2), 42-44.

Awofala, A. O. A. (2011). Effect of concept mapping strategy on students' achievement in junior secondary school mathematics. *International Journal of Mathematics Trends and Technology, 2*(2), 11-16.

Babbie, E. (2004). Laud Humphreys and research ethics. *International Journal of Sociology and Social Policy, 24*(3), 12-19.

Bal, A. P. (2014). Predictor variables for primary school students related to van Hiele geometric thinking. *Journal of Theory and Practice in Education, 10*(1), 259-278.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman and Company.

Bassey, S. W., Joshua, M. T., & Asim, A. E. (2007). Gender differences and mathematics achievement of rural senior secondary students in Cross River State, Nigeria. Retrieved on February 2, 2018 from http://web.gnowledge.org/episteme3/pro_pdfs/09-bassvjoshua-asim.pdf.

Barkoukis, V., Tsorbatzoudis, H., Grouios, G., & Sideridis, G. (2008). The assessment of intrinsic and extrinsic motivation and amotivation: Validity and reliability of the Greek version of the academic motivation scale. *Assessment in Education: Principles, Policy and Practice*, *15*(1), 39-55.

University of Education, Winneba http://ir.uew.edu.gh

Barmby, P., Kind, P. M., & Jones, K. (2008). Examining changing attitudes in secondary school science. *International Journal of Science Education, 30*(8), 1075–1093.

Beaton, A. E., Mullis, I. V. S., Martin, M. O., Gonzalez, E. J., Kelly, D. L., & Smith, T. A. (1996). *Mathematics achievement in the middle school years: IEA's Trend in International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

Bennett, J., & Hogarth, S. (2009). Would you want to talk to a scientist at a party? High school students' attitudes to school science and to science. *International Journal of Science Education, 31*(14), 1975-1998.

Biesanz, J. C., Deeb-Sossa, N., Papadakis, A. A., Bollen, K. A., & Curran, P. J. (2004). The role of coding time in estimating and interpreting growth curve models. *Psychological Methods, 9,* 30–52.

Blum, R. W. M., & Libbey, H. P. (2004). Excutive summary. *Journal of School Health, 74*(7), *274-283.*

Bricheno, P., Johnston, J., & Sears, J. (2001). Children's attitudes to science: beyond the men in white coats. In J. Sears & P. Sorensen (Eds.), *Issues in science teaching* (pp. 143-153). London: Routledge.

Broome, P. (2001). The gender-related influence of implicit self-theories of one's intelligence with regard to academic performance in introductory physics classes. *Psychologische Beitrage*, *43*(1), 100–128.

Burkley, M., Parker, J., Stermer, S. P., & Burkley, E. (2010). Trait beliefs that make women vulnerable to math disengagement. *Personality and Individual Differences*, *48*(2), 234–238.

Butty, J. A. M. (2001). Teacher instruction, student attitudes and mathematics performance among 10 and 12 grade black and Hispanic students. *Journal of Negro Education*, *70*(2), 19 -37.

Byrne, B., & Shavelson, R. J. (1987). Adolescent self-concept: Testing the assumption of equivalent structurfe across gender. *American Educational Research Journal*, *24*(3), 365-368.

Carr, M., & Jessup, D. L. (1997). Gender differences in first grade mathematics strategy use: Social and metacognitive influences. *Journal of Educational Psychology, 89,* 318- 328.

Casey, M. B., Nuttal, R. L., & Pezaris, E. (2001). Spatial-mechanical reasoning skills versus mathematics: Self-confidence as mediators of gender diffecross-national gender-based items. *Journal of Research in Mathematics Education, 32*(1) 28-57.

Cassels, J. R. T. & Johnstone, A. H., (1980). *Understanding of non-technical words in science.* London: The Chemical Society.

Cerini, B., Murray, I., & Reiss, M. (2003). *Student review of the science curriculum. Major findings.* London: Planet Science/Institute of Education University of London/Science Museum.

Chen, C. H., & Howard, B. (2010). Effect of live simulation on middle school students' attitudes and learning towards science. *Educational Technology and Society*, *13* (1), 133-139.

Cleaves, A. (2005). The formation of science choices in secondary school. *International Journal of Science Education, 27*(4), 471- 486.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). Oxon: Routledge.

Collins, L. M., & Lanza, S. T. (2010). *Latent class and latent transition analysis: With applications in the social, behavioral, and health sciences*. New York: Wiley.

Colom, R., & Lynn, R. (2004). Testing the development theory of sex differences in intelligence on 12-18 years old. *Personality and Individual Differences*, *36,* 75-82.

Cox, A. E., & Whaley, D. E. (2004). The influence of task value, expectancies for success, and identity on athletes' achievement behaviors. *Journal of Applied Sport Psychology, 16,* 103–117.

David, M. E., Ball, S. J., & Reay, D. (2003). Gender issues in parental involvement in student choices of higher education. *Gender and Education, 15(1),* 21-37.

De San Román, A. G., & de La Rica Goiricelaya, S. (2012). Gender gaps in PISA test scores: The impact of social norms and the mother's transmission of role attitudes. *Retrieved on March 11, 2018 from* http://www.eu/newsletters/november-2015.html

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227-268.

DeFleur, M. L., & Westie, F. R. (1963). Attitude as a scientific concept. *Social Forces*, *42* (1), 17-31.

University of Education, Winneba http://ir.uew.edu.gh

Desimone, L. (1999). Linking parent involvement with student achievement: Do race and income matter? *The Journal of Educational Research, 93*(1), 11-30.

Ding, C. S., Song, K., & Richardson, L. I. (2007). Do mathematical gender differences continue? *Educational Study, 1, 279 – 295.*

Dweck, C. (2000). *Self-theories*: *Their role in motivation, personality, and development*. New York: Psychology Press.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. Philadelphia, PA: Psychology Press.

Eccles, J. S. (1990). Bringing young women to mathematics and science. In M. Crawford and M. Gentry (Eds), *Gender and thought: Psycholgical perspectives* (pp.38-57). New York: Springer-Verlag.

Eccles, J. S. (1986). Gender-roles and women's achievement. *Educational Researcher, 15,* 15-19.

Eccles, J. S., Wigfield, A., Harold, R. D., & Blumenfeld, P. C. (2007). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development, 34,* 380–347.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109–132.

Else-Quest, N. M, Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin, 136*(1), 103-127.

Engheta, C. M. (2004). Education goals: Results by the TIMSS-99 for participating G8 countries. In C. Papanastasiou (Ed.), *Proceedings of the IRC-2004 TIMSS* (pp. 172-186). Nicosia: Cyprus University.

Entwistle, N., & Peterson, E. R. (2004). Learning styles and approaches to studying. In C. Spielberger (Ed.), Encyclopedia of Applied Psychology, NY: Academic Press.

Evans, E. M., Schweingruber, H., & Stevenson, H. W. (2002). Gender differences in interest and knowledge acquisition: The United States, Taiwan and Japan. *Sex Roles, 47*(3), 153–167.

Eshun, B. A. (2004). Sex-differences in attitude of students towards mathematics in secondary schools. *Mathematics Connection, 4*, 1-13.

Ewumi, A. M. (2012). Gender and social-economic status as correlates of students' academic achievement in senior secondary schools. *European Scientific Journal, 8*(4), 23-36.

University of Education, Winneba http://ir.uew.edu.gh

Fenemma, E. (2000). *Gender and mathematics. What is known and what I wish was known?* Madison, Wisconsin: Wisconsin Centre for Educational Research.

Fennema, E., & Leder, C. G. (1990). *Mathematics and gender: Teachers college*: Columbia: Columbia University Press.

Fennema E (1989). The study of affect and mathematics: A proposed generic model for research. In D. B. McLeod & V. M. Adams (Eds.), *Affect and mathematical problem solving: A new*
Perspective (pp. 205-219). New York: Springer-Verlag

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

Fennema, E., & Sherman, J. (1977). The study of mathematics by high school girls and
boys: Related variables. *American Educational Research Journal, 14*(2), 159-168.

Flick, U. (2014). *An introduction to qualitative research* (5th ed.). London: Sage.

Forgasz, H. J., Leder, G. C., & Vale, C. (2000). Gender and mathematics: Changing perspectives. In K. Owens & J. A. Mousley (Eds.), *Research in mathematics education in Australasia 1996-1999*. Turramurra, NSW: Mathematics Education Research Group of Australasia Inc.

Franken, R. (1994). *Human motivation* (3rd ed.). CA: Brooks/Cole Publishing Co.

Fredricks, J. A., & Eccles, J. S. (2002). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental Psychology, 38,* 519–533.

Freiberg, H. J. (1998). Measuring school climate: Let me count the ways. *Educational Leadership*, *56*(1), 22-26.

Fryer, R. G., & Levitt, S. D. (2010). An empirical analysis of the gender gap in mathematics. *American Economic Journal of Applied Economics, 2,* 210–240.

Fullan, M. (2001). *Leading in a culture of change*. San Francesco: Jossey-Bass.

Fullarton Sue (2004). Closing the gaps between schools: Accounting for variation in mathematics achievement in Australian schools using TIMSS 95 and TIMSS 99. In C. Papanastasiou (Ed.), *Proceedings of the IRC-2004 TIMSS Vol. 1* (pp. 16-31). Cyprus: University of Nicosia Press.

Gallagher, A. M., & Kaufman, J. C. (2006). Gender differences in mathematics. *Integrative Psychological Approach, 54*(2), 245- 247.

University of Education, Winneba http://ir.uew.edu.gh

Geary, D., Saults, C., Liu, F., & Hoard, M. K. (2000). Sex differences in spatial cognition , computational fluency, and arithmetical reasoning. *Journal of Experimental Child Psychology*, *77,* 337-353.

Gherasim, L. R., Butnaru, S., & Mairean, C. (2013). Classroom environment, achievement goals and maths performance: gender differences. *Educational Studies, 39*(1), 1-12.

Gil-Flores, J., Padilla-Carmona, M. T., & Suárez-Ortega, M. (2011). Influence of gender, educational attainment and family environment on the educational aspirations of secondary school students. *Educational Review, 63*(3), 345-363.

Graham, M. (2001). Increasing participation of female students in physical science class. Saint Xavier University, Chicago, an unpublished master's thesis.

Graham, S. (1990). Communicating low ability in the classroom: Bad things good teachers sometimes do. In S. Graham & V. Folkes (Eds.), *Attribution theory: Applications to achievement, mental health, and interpersonal conflict* (pp. 17–36). Mahwah, NJ: Erlbaum.

Griffith, S. A. (2005). Assuring fairness in school-based assessment: Mapping the boundaries of teachers' involvement. Paper presented at the 31st Annual Conference of International Association for Educational Assessments, 4-9 September. Abuja.

Guiso, L., Monte, F., Sapienza P., & Zingales L. (2008). Culture, gender, and math. *Science*, *320*(5880), 1164–1165.

Halpern, D. F. (2004). A cognitive taxonomy for sex differences in cognitive abilities. *Current Directions in Psychological Science, 13,* 135–139.

Halpern, D. F., & Collaer, M. (2005). Sex differences in visuospatial abilities: More than meets the eye. In P. Shah & A. Miyake (Eds.), Sex differences in intrinsic aptitude for mathematics and science? *American Psychologist, 60,* 950–958.

Halpern, D., Aronson, J., Reimer, N., Star, J. R., & Wentzel, K. (2007). *Encouraging girls in math and science: NCER 2007-2003*. Washington DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education.

Hamachek, D. (1995). Self-concept and school achievement: Interaction dynamics and a tool for assessing the self-concept component. *Journal of Counseling & Development, 73*(4), 419-425.

Hammouri, H. A. M, (2004). Attitudeinal and motivational variables related to mathematics achievement in Jordan. *Educational Research, 46*(3), *241- 257.*

Heckman, J. J., & T. Kautz (2012). Hard evidence on soft skills. *Labour Economics*, *19*, 451-464.

University of Education, Winneba http://ir.uew.edu.gh

Heckman, J. J., & T. Kautz (2014). Fostering and measuring skills interventions that improve character and cognition. In J. J. Heckman, J. E. Humphries, & T. Kautz (Eds.), The GED myth: Education, achievement tests, and the role of character in American life, chapter 9. Chicago, IL: University of Chicago Press.

Hedges, L. V., & Nowell, A. (1995). Sex differences in mental test scores variability and numbers of high scoring individuals. *Journal of Research in Science Teaching, 269*(2), 41-45.

Hedges, L. V., & Nowell, A. (1995). Sex differences in mental test scores, variability, and numbers of high-scoring individuals. Science 269, 41–45.

Hidi, S., & Harackiewicz, J. M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research*, *70*, 151-179.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41,* 111–127.

Hofstein, A., & Kempa, R. F. (1985). Motivating Strategies in Science Education: Attempt at an Analysis, *European Journal of Science Education*, *7*(3), 221-229.

Hofstein, A., & Mamlok-Naaman, R. (2011). High-school students' attitudes toward and interest in learning chemistry. *Educación química, 22* (2), 90-102.

Hopkins, K. B., McGillicuddy-De Lisi, A. V., & De Lisi, R. (1997). Student gender and
teaching methods as sources of variability in children's computational arithmetic performance. *The Journal of Genetic Psychology, 158,* 333-345.

Howes, E. V. (2002). *Connecting girls and science: Constructivism, feminism, and education reform*. New York: Teachers College Press.

Howie, S. J. (2005). Contextual factors at the school and classroom level related to pupils' performance in mathematics in South Africa. *Educational Research and Evaluation, 11(2), 123– 140.*

Hyde J. S., & Mertz, J. E. (2009). Gender, culture, and mathematics performance. *Proceeding of the National Academy of Sciences. 106*, 8801–8807.

Hyde, J. S. (2005). The gender similarities hypothesis. *American Psychologist, 60,* 581-592.

Hyde, J. S., Fennema, E. H., & Lamon, S. J. (1990). Gender differences in mathematics performance: A meta-analysis. *Psychological Bulletin, 107,* 139–155.

University of Education, Winneba http://ir.uew.edu.gh

Hyde, J. S., Fennema, E., Ryan, M., Frost, L. A., & Hopp, C. (1990). Gender comparisons of mathematics attitudes and affect: A meta-analysis. *Psychology of Women Quarterly*, *14*(3), 299–324.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender characterize math performance. *Science, 321, 494-4*95.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Diversity: Gender similarities characterize math performance. *Science*, *321*(5888), 494–495.

Hydea, J. S., & Mertzb, J. E. (2009). *Gender, culture, and mathematics performance.* Retrieved on January17, 2018 from http: / /tctvideo. madison.com/uw/gender.

International Institute for Educational Planning [HEP], UNESCO (2004). *EFA - Gender equality in reading and mathematics achievement.* Reflecting on EFA Goal 5. HEP Newsletter, April, 8-9.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grade one through twelve. *Child Development, 73,* 509–527.

Jacobs, J. E., & Bleeker, M. M. (2004). Girls' and boys' developing interests in math and science: Do parents matter? *New Directions for Child & Adolescent Development, 2004*(106), 5-21.

Jacobs, J. E., Davis-Kean, P., Bleeker, M., Eccles, J. S., & Malnchuk, O. (2005). I can, but I don't want to: The impact of parents, interests, and activities on gender differences in math. In A. M. Gallangher & J. C. Kaufman (Eds.), *Gender differences in mathematics*. Cambridge: Cambridge University Press.

James, M. C., & Scharmann, L. C. (2007). Using analogies to improve the teaching performance of preservice teachers. *Journal of Research in Science Teaching, 44*(4), 565-585.

Jenkins, E. W., & Nelson, N. W. (2005). Important but not for me: Students' attitudes towards secondary school science in England. *Research in Science & Technological Education*, *23*, 41-57.

Johnstone, A. H., & Selepeng, D. (2001). A language problem re-visited. *Chemistry Education: Research and Practice in Europe* (CERAPIE), *2*(1), 19-29.

Joppe, G. (2000). Testing reliability and validity of research instruments. *Journal of American Academy of Business Cambridge*, *4*(2), 49-54.

Kahle, J. B., & Lakes, M. K. (2003). The myth of equality in science classrooms

Kane, J., & Mertz, J. (2012). Debunking myths about gender and mathematics performance. *Notices of the American Mathematical Society*, *59*(1), 10–22.

Kellett, N. C., (1978). Studies on the perception of organic chemical structures. University of Glasgow. An unpublished Ph.D. thesis.

Khwaileh, F. M., & Zaza, H. I. (2011). Gender differences in academic performance among undergraduates at the University of Jordan: Are they real or stereotyping?. *College Student Journal*, *45*(3), 633- 648.

Kim, M., & Song, J. (2009). The effects of dichotomous attitudes toward science on interest and conceptual understanding in physics. *International Journal of Science Education*, *31*(17), 2385-2406.

Kind, P., Jones, K., & Barmby, P. (2007). Developing attitudes towards science measures. *International Journal of Science Education*, *29* (7), 871-893.

Kind, V., & Taber, K. (2005). *Science: Teaching school subjects 11-19.* London: Routledge.

Kiamanesh, A. R. (2004). Factor affecting Iranian students' achievement in mathematics. In C. Papanastasiou (Ed.), *Proceedings of the IRC-2004 TIMSS Vol. 1* (pp. 157-169). Cyprus: University of Nicosia Press.

Kiamanesh, A. R. (2006). Gender differences in mathematics achievement among Iranian eight graders in two consecutive international studies (TIMSS 99 & TIMSS 2003). *Retrieved on March 3, 2018 from* http://www.iea.nl/irc2006_timss.html.

Kimball, M. M. (1989). A new perspective on women's math achievement. *Psychological Bulletin, 105,* 198-214.

Kimura, D. (2002). Sex differences in the brain. *Scientific American Special Edition, 12,* 32- 37.

Kiptum, J. K., Rono, P. K., Too, J. K., Bii, B. K., & Too, J. (2013). Effects of students gender on mathematics performance in primary schools in Keiyo South District, Kenya. *International Journal of Scientific and Technology Research, 2*(6), 117 – 123.

Koballa Jr, T. R., & Glynn, S. M. (2007). Attitudinal and motivational constructs in science learning. In S. K. Abell, & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 75-102). London: Lawrence Erlbaum Associates.

Koller, O., Baumert, J., & Schnabel, K. (2001). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal* for *Research in Mathematics Education*, *32*(5), 448-470.

Koutsoulis, K. M., & Campbell, J. R. (2001). Family processes affect students' motivation, and science and math achievement in Cypriot high schools. *Structural Equation Modeling, 8*(1), 108-127.

University of Education, Winneba http://ir.uew.edu.gh

Kyei, L., Apam, B., & Nokoe, S. K. (2011). Some gender differences in performance in senior high mathematics examinations in mixed high schools. *American Journal of Social and Management Sciences*, *2*(4), 348- 355**.**

Lakin, J. M. (2013). Sex differences in reasoning abilities: Surprising evidence that male-female ratios in the tails of the quantitative reasoning distribution have increased. *Intelligence, 41,* 263–274.

Lakshmi, G. B. (2004). *Attitude towards science.* New Delhi: Discovery Publishing House.

Lee, A. M., Fredenburg, K., Belcher, D., & Cleveland, N. (1999). Gender differences in children's conceptions of competence and motivation in physical education. *Sport Education and Society, 4,* 161–174.

Lindberg, S. M. (2010). New trends in gender and mathematics performance: A meta-analysis. *Psychol. Bulletin, 136,* 1123–1135.

Linenbrink, E. A., & Pintrich, P. R. (2002). Motivation as enabler of academic success. *School Psychology Review, 31*(3), 313-327.

Luo, D., Thompson, L. A., & Detterman, D. K. (2003). The causal factor underlying the correlation between psychometric g and scholastic performance. *Intelligence, 31*(1), 67-83.

Lubienski, S., Robinson, J., Crane, C., Ganley, C. (2013). Girls' and boys' mathematics achievem*ent,* affect,and experiences: Findings from ECLS-K. *Journal for Research in Mathematics Education, 44,* 634-645.

Mahlomaholo, S., & Sematle, M. (2005). Gender differences and black students' attitudes towards mathematics in selected high schools in South Africa. Retrieved on March 2, 2018 from http://www.icme-organisers.dk/tsg26/2SechabaMZ.doc.

Maio, G. R., & Haddock, G. (2010). *The psychology of attitudes and attitude change.* London: SAGE Publications.

Malone, J. A., & Cavanagh, R. F. (1997). The influence of students' cognitive preferences on the selection of science and mathematics subjects. *International Journal of Science Education*, *19*(4), 481-490.

Mamlok-Naaman, R., Ben-Zvi, R., Hofstein, A., Menis, J., & Erduran, S. (2005). Learning science through a historical approach: Does it affect the attitudes of nonscience-oriented students towards science? *International Journal of Science and Mathematics Education*, *3*(3), 485-507.

Marjoribanks, K. (2002). *Family and school capital: Towards a context theory of students' school outcomes.* Dordecht: Kluwer Academic Publishers.
Mathematics and Science Study (TIMSS). Chestnut Hill, MA: Boston College.

University of Education, Winneba http://ir.uew.edu.gh

Marsh, H. W., Hau, K., & Grayson, D. (2005). Goodness of fit in structural equation models.

Marsh, H. W., Hau, K., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling, 11*(3), 320-341.

Marzano, R. J. (2003). *What works in schools: Translating research into action? mathematics Association of Ghana*, *5,* 29-38.

Millar, R., & Abrahams, I. (2009). Practical work: making it more effective. *School Science Review, 91*(334), 59-64.

Morris, V. C. (1959). Male, female, and the higher learning: The educational significance of differences between the sexes. *Journal of Higher Education*, 30, 67-72.

Muganyizi Kaino, L. (2008). Technology in learning: Narrowing the gender gap? *Eurasia Journal of Mathematics, Science and Technology Education, 4*(3), 263-268.

Mullis, I. V. S., Martin, M. O., Beaton, A. E., Gonzalez, E. J., Gregory, K. D., Garden, R. A., & Murphy, R. J. L. (2000). Sex differences in objective test performance. *British Journal of Educational Psychology*, *52*, 213–219

Mullis, I. V. S., Martin, M. O., Gonzalez, E. J., & Chrostowski, S. J. (2004). *TIMSS 2003 international mathematics report: Findings from IEA's trend in international mathematics and science study at the fourth and eighth grades.* Chestnut Hill, MA: Boston College.

Mullis, I.V.S., Drucker, K.T., Preuschoff, C., Arora, A., & Stanco, G.M. (2012). Methods and procedures: Assessment framework and instrument development. In Martin, M. O. & L. V. S. Mullis (Eds.), *Methods and procedures in TIMSS and PIRLS 2011* (pp. 1-22).Chestnut Hill, MA: Boston College.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

National Science Foundation (2009). *TABLE C-4 bachelor's degrees by sex and field in 1997-2006:* Women, minorities, and persons, with disabilities in science and engineering. Retrieved on May 1, 2018 from http://www.nsf.gov/statistics/wmpd/tables.cfm

Nakhleh, M. (1992). Why some students don't learn chemistry: Chemical misconceptions. *Journal of Chemical Education*, *69*(3), 191-196.

University of Education, Winneba http://ir.uew.edu.gh

Nieswandt, M. (2005). Attitudes toward science: A review of the field. In Alsop, S. (Ed.), *Beyond cartesian dualism: encountering affect in the teaching and learning of science: Volume 29 of Science and technology education library* (pp. 41-52). The Netherlands: Springer.

Nielsen, H. B. (2003). One of the boys? World organization of the scout movement.

Nowack, K. W., & Hanson, A. L. (1985). Academic achievement of freshmen as a function of residence hall housing. *NASPA Journal*, *1,* 22-28.

O'Connor-Petruso, S. , Schiering, M., Hayes, B., & Serrano, B. (2004). Pedagogical and parental influences in mathematics achievement by gender among selected European countries from the TIMSS-R Study, in *Proceedings of the IRC-2004 TIMSS Vol. II* (ed.) C. Papanastasiou, (Cyprus University, Nicosia, 2004) 69-84.

O'Connor-Petruso, S., & Miranda, K. (2004). Gender inequalities among the top scoring nations in mathematics achievement. Singapore, Republic of Korea, and Chinese Taipei,

OECD (2001). *Knowledge and skills for life: first results from OECD Programme for International Student Assessment (PISA) 2000.* Paris: OECD.

OECD (2004). *Learning for tomorrow's world: First results from PISA 2003.* Paris, France: Author.

OECD (2007). *PISA 2006 science compelenciesfor tomorrow's world* (Vol. 2). New York: Program for International Student Assessment, OECD.

OECD (2014). *PISA 2012 results in focus: What 15-year-olds know and what they can do with what they know*. Paris: OECD.

OECD (2015). *The ABC of gender equality in education: Aptitude, behavior, confidence*. Paris: OECD.

Oakes, J. (1990). Opportunities, achievement, and choice: Women and minority students in science and mathematics. *Review of Research in Education, 16,* 153-222.

Ogunkunle, L. A. (2007). Effects of gender on mathematics achievement of students in constructivist and non-constructivists groups in secondary school. *ABACUS, Journal of Mathematical Association of Nigeria, 32*(1), 41-50.

Okeke, E. C. (2003): Gender and sexuality education: Bridging the gap in human resource development. *Journal of Curriculum Organization of Nigeria, 10*(1), 117-120.

Oluwatayo, J. A. (2011). Gender differences and performance of secondary school students in mathematics. *European Journal of Educational Studies, 3*(1), 173-179.

University of Education, Winneba http://ir.uew.edu.gh

Olson, M. A., & Kendrick, R. V. (2008). Origins of attitudes. In W. D. Crano & R. Prislin (Eds.), *Attitudes and attitude change* (pp. 111-130). Hove: Taylor and Francis group.

Osborne, J. A., Simon, S. B., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Opolot-Okurot, C. (2005). Students' attitudes toward mathematics in Uganda secondary schools. *African Journal of Research in Mathematics, Science and Technology Education*, *9*(2), 167-174.

Otu-Danquah, M. (2002). Gender differences in academic achievements in English, Science and Mathematics of senior secondary school students in the Cape Coast municipality, Ghana: Implications for counselling. University of Cape Coast. An unpublished MPhil thesis.

Palmer, D. H. (2009). Student interest generated during an inquiry skills lesson. *Journal of Research in Science Teaching*, *46*(2), 147-165.

Papanastasiou, C. (2002). School, teaching and family influence on student attitudes toward science: Based on TIMSS data Cyprus. *Studies in Educational Evaluation, 28,* 71-86.

Penner, A. M., & Parer M. (2008) Gender differences in mathematics achievement: Exploring the early grades and the extremes. *Social Science Research, 37*(1), 239-253.

Perie, M., Moran, R., & Lutkus, A. D. (2005). *NAEP 2004 trends in academic progress three decades of student performance in reading and Mathematics.* Washington D. C.: National Center for Education Statistics.

Programme for International Student Assessment (PISA) (NCES 2001-07). Washington, DC:

Prokop, P., Tuncer, G., & Chudá, J. (2007). Slovakian students' attitudes toward biology. *Eurasia Journal of Mathematics, Science and Technology Education, 3*(4), 287-295.

Rajecki, D. W. (1990). *Attitudes.* Sunderland, Massachusetts: Sinauer Associates Sunderland, Inc.

Reilly, D., Neumann, D. L., & Andrews, G. (2016). Sex and sex-role differences in specific cognitive abilities. *Intelligence, 54*, 147-158.

Resnik, D. B. (2009). What is ethics in research and why is it important? Retrieved on May 2, 2018 from http://www.niehs.nih.gov/research/resources/bioethics/whatis.cfm.

University of Education, Winneba http://ir.uew.edu.gh

Sharmistha, R. (2008). *A comparative study of factors affecting academic achievement of school going adolescent boys and girls*. Paper presentation, Department of Human Development and Family Studies Faculty of Family and Community Sciences, Maharaja Sayajirao University of Baroda Vadodara, Gujarat, India.

Sinnes, A. T. (2006). *Approaches to gender equity in science education. Two initiatives in sub-Saharan African seen through a lens derived from feminist critique of science.* Oslo: Unipub.

Song, J. & Black, P., (1991). The effects of task contexts on pupils' performance in science process skills. *International Journal of Science Education*, *13,* 49-53.

Stavy, R. (1988). Children's conception of gas. *International Journal of Science Education, 20,* 553–560.

Strydom, H. (2002). Ethical aspects of research in the social sciences and human service professions. In A.S. de Vos (Ed.), Research at grass roots for the social sciences and human service professions (2nd ed.). Pretoria: Van Schaik Publishers.

Su, R., Rounds, J., & Armstrong, P. I. (2009). Men and things, women and people: A meta-analysis of sex differences in interests. *Psychological Bulletin*, *135*(6), 859–884.

Solomon, Y. (2009). *Mathematical literacy: Developing identities of inclusion*. London: Routledge.

Solomon, M. A., Lee, A. M., Belcher, D., Harrison, L. Jr., & Wells, L. (2003). Beliefs about gender appropriateness, ability, and competence in physical activity. *Journal of Teaching in Physical Education, 22,* 261–279.

Spelke, E. S. (2005). Sex differences in intrinsic aptitude for mathematics and science? *American Psychologist, 60,* 950-958.

Sprigler, D. M., & Alsup, J. K. (2003). An analysis of gender and the mathematical reasoning ability sub-skill of analysis-synthesis. *Education, 123*(4), 13-15.

Sui-Chu, E. H., & Willms, J. D. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education, 69*(2), 126-141.

The Royal Society (2008). *A 'state of the nation' report on the participation and attainment of 14–19 year olds in science and mathematics in the UK, 1996–2007.* London: The Royal Society.

Thompson, J., & Soyibo, K. (2002). Effects of lecture, teacher demonstrations, discussion and practical work on 10th graders' attitudes to chemistry and understanding of electrolysis. *Research in Science and Technological Education*, *20*(1), 25-37.

University of Education, Winneba http://ir.uew.edu.gh

Thomson, S., & De Bortolli, L. (2008). *Exploring scientific literacy: How Australia measures up (The PISA 2006 suf1ey of students' scientific, reading and mathematical literacy skills).* Melbourne: ACER.

Thomson, S., Creswell, J., & De Bortoli, L. (2004). *Facing the future: A focus on mathematical literacy among Australian 15-year-old students in PISA 2003.* Melbourne: ACER.

Tonah. S. (2009). *Contemporary social problems in Ghana.* Legon, Accra: University of Ghana Press.

Trochim, W. (2006). *The research methods knowledge base* (3rd ed.). Cincinnati, OH: Atomic Dog Publishing.

Trumper, R. (1995). Students' motivational traits in science: A cross-age study. *British Educational Research Journal*, *21*(4), 505-515.

Tully, D., & Jacobs, B. (2010). Effects of single-gender mathematics classrooms on self-perception of mathematical ability and post secondary engineering paths: An Australian case study. *European Journal of Engineering Education*, *35*(4), 455–467.

Umoh, E. D. (2003). Female gender and public sector leadership in Nigeria. *African Journal of Social and Policy Studies, 2*(1), 119-126.

UNESCO (2003). Gender and education for all: the leap for equality: Global monitoring report 2003/2004. Retrieved on January 2, 2018 from http://www.unesco/oc.unesco.org/education/eta-report/2003-pdf/chapter3.pdf.

Uttal, D. H., Miller, D. I., & Newcombe, N. S. (2013). Exploring and enhancing spatial thinking links to achievement in science, technology, engineering, and mathematics? *Current Directions in Psychological Science, 22*(5), 367-373.

Vale, C. (2009). *Trends and factors concerning gender and mathematics in Australasia.* Retrieved on January19, 2018 from http://tsg.icmell.org/document/get/169.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E.

Voyer, D., Voyer, S., & Bryden, M. P. (1995). Magnitudes of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin, 117*(2), 250-270.

Ward, R., & Bodner, G. (1993). How lecture can undermine the motivation of our students. *Journal of Chemical Education*, *70*(3), 198-199

Watt, H. M. G. (2006). The role of motivation in gendered educational and occupational trajectories related to maths. *Educational Research and Evaluation, 12(4),* 305-322.

University of Education, Winneba http://ir.uew.edu.gh

Weerakkody, W. A. S., & Ediriweera, A. N. (2008). Influence of gender on academic performance: A comparative study between management and commerce undergraduates in the University of Kelaniya, Sri Lanka. *Journal of International Cooperation in Education*, *15*(3), 135-148.

Weiss, K., & Krappmann, L. (1993). *Parental support and children's social integration.* Paper presented at the biennial meeting of the Society for Research in Child Development, New Orleans, LA.

Weiss, E. M., Kemmlera, G., Deisenhammerb, E. A., Fleischhackera, W.W., & Delazer, M. (2003). Sex differences in cognitive functions. *Personality and Individual Differences,* 35, 863–875.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25,* 116–119.

Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R., & Davis-Kean, P. (2006).Development of achievement motivation. In W. Damon & N. Eisenberg
(Eds.). *Handbook of child psychology* (pp. 933–1002). New York: Wiley.

Wilhite, S. C. (1990). Self-efficacy, locus of control, self-assessment of memory ability, and study activities as predictors of college course achievement. *Journal of Educational Psychology, 82,* 696-700.

White, R. T., & Gunstone, R. F. (2008). The conceptual change approach and the teaching of science. In S. Vosniadou (Ed.), *International handbook of research on conceptual change* (pp. 619-628). New York: Routledge

Xiang, P., Chen, A., & Bruene, A. (2005). Interactive impact of intrinsic motivators and extrinsic rewards on behavior and motivation outcomes. *Journal of Teaching in Physical Education, 24,* 179–197.

Xiang, P., McBride, R., & Bruene, A. (2004). Fourth graders' motivation in an elementary physical education running program. *Elementary School Journal,104,* 253–266.

Xiang, P., McBride, R., & Bruene, A. (2006). Fourth graders' motivational changes in an elementary physical education running program. *Research Quarterly for Exercise and Sport, 77,* 195–207.

Xiang, P., McBride, R., Guan, J., & Solomon, M. A. (2003). Children's motivation in elementary physical education: An expectancy-value model of achievement choice. *Research Quarterly for Sport and Exercise, 74,* 25–35.

Yin, R. K. (2003). *Case study research design and methods: Applied social research methods series* (3rd ed.). London: Sage.

University of Education, Winneba http://ir.uew.edu.gh

Zaman, A. (2011). *Relation between mathematical thinking and achievement in mathematics among secondary school students of North West Frontier Province, Pakistan.* Faculty of social sciences, Department of Education. Islamabad: International Islamic University Press.

Zhu, Z. (2007). Gender differences in mathematical problem solving patterns: A review of literature. *International Education Journal, 8*(2), 187-203.

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APPENDIX A

STUDENT'S QUESTIONNAIRE

Introduction

I am a student of the University of Education; Winneba. I am carrying out a study to examine gender differences in mathematics achievement among students of Bimbilla College of Education. The information that you provide in this questionnaire is anonymous and will only be accessed by one researcher. You will not be identified anywhere in this research study and you are not required to provide your name in the questionnaire. All information provided here shall be kept confidential and shall be used for research purpose only. **Thank you.**

Instruction: *Please tick* [√] *as applicable* ***per item****.*

SECTION A: PERSONAL DATA

1. Sex: Female [ ] Male [ ]

SECTION B: GENDER AND MATHEMATICS ACHIEVEMENT

Instruction: *Please tick* [√] *as applicable* ***per item****.*

2. What is the entry qualification into the college of the majority (50%) of the students' in mathematics?

   A1 [ ] B2 / B3 [ ] C4 /C5/C6 [ ] D7 [ ]

3. Do you perform well in your college mathematics Yes [ ] No [ ] I am not sure [ ]

4. How would you rate your level of academic performance in mathematics in your class in the college?

   0%-49% [ ] 50-59% [ ] 60%-69% [ ] 70%-79% [ ] 80%-100% [ ]

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5. Generally, males and females perform equally in mathematics.

Yes [ ] No [ ] I am not sure [ ]

6. Females perform better than males in mathematics.

Yes [ ] No [ ] I am not sure [ ]

7. Females easily understand mathematical concepts than males

Yes [ ] No [ ] I am not sure [ ]

8. A lot of females excel in mathematics than males. Yes [ ] No [ ] I am not sure [ ]

9. Females are able to follow mathematical principles better than males.

Yes [ ] No [ ] I am not sure [ ]

10. Females are able to make better analysis than males in mathematics.

Yes [ ] No [ ] I am not sure [ ]

11. Mathematics is seen as masculine than feminine subject or career.

Yes [ ] No [ ] I am not sure [ ]

12. Males are able to make logical and systematic presentations than females

Yes [ ] No [ ] I am not sure [ ]

13. What do you think of mathematical concepts?

Very difficult [ ] Somehow difficult [ ] I don't know [ ] Easy [ ] Very easy [ ]

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SECTION C: FACTORS RESPONSIBLE FOR GENDER DIFFERENCES IN MATHEMATICS ACHIEVEMENT

1	2	3	4	5
SD	**D**	**N**	**A**	**SA**

SD= Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree

14. Inadequate curricular materials. SD [ ] D [ ] N [ ] A [ ] SA [ ]

15. Poor teaching learning setup. SD [ ] D [ ] N [ ] A [ ] SA [ ]

16. Teachers' gendered attitudes. SD [ ] D [ ] N [ ] A [ ] SA [ ]

17. Poor attitudes of teachers towards mathematics instruction. SD [ ] D [ ] N [ ] A [ ] SA [ ]

18. Weak/poor methodology for mathematics instruction SD [ ] D [ ] N[ ] A [ ] SA [ ]

19. Methods and teaching learning resources use to teach mathematics favour female students than the male students. SD [ ] D [ ] N [ ] A [ ] SA [ ]

20. Weak/poor foundation in mathematics SD [ ] D [ ] N [ ] A [ ] SA [ ]

Negative self-concept towards mathematics learning. SD [ ] D [ ] N [ ] A [ ] SA [ ]

21. Low confidence in mathematics. SD [ ] D [ ] N [ ] A [ ] SA [ ]

22. Low mathematics anxiety. SD [ ] D [ ] N [ ] A [ ] SA [ ]

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23. Low motivation and interest in mathematics. SD [ ] D [ ] N [ ] A [ ] SA [ ]

SECTION D: ATTITUDES OF STUDENTS TOWARDS MATHEMATICS

Please answer the questions below honestly; there are no right or wrong answers.

Instruction: Using the following1-5scale, please indicate by *ticking* [√] the degree to which you agree or disagree with the following statements:

1	2	3	4	5
N	**R**	**S**	**MoT**	**A**

N = Never; R = Rarely; S= Sometimes; MoT = Most of time; A = Always

24. Mathematics is interesting. N [ ] R [ ] S [ ] MoT [ ] A [ ]

25. I like mathematics. N [ ] R [ ] S [ ] MoT [ ] A [ ]

26. Mathematics is fun. N [ ] R [ ] S [ ] MoT [ ] A [ ]

27. Mathematics is easy for me. N [ ] R [ ] S [ ] MoT [ ] A [ ]

28. Mathematics is boring. N [ ] R [ ] S [ ] MoT [ ] A [ ]

29. Mathematics is hard for me. N [ ] R [ ] S [ ] MoT [ ] A [ ]

30. Mathematics is something which I enjoy N [ ] R [ ] S [ ] MoT [ ] A [ ]

31. Do you enjoy a great deal N [ ] R [ ] S [ ] MoT [ ] A [ ]

32. I am always under a terrible *strain* in mathematics class N [ ] R [ ] S [ ] MoT [ ] A [ ]

33. I do not like mathematics because it scares me when learning it. N [ ] R [ ] S [ ] MoT [ ] A [ ]

34. Mathematics is very interesting to me and I enjoy it N [ ] R [ ] S [ ] MoT [ ] A [ ]

35. My mind goes blank and I am unable to think when working mathematics N [ ] R [ ] S [ ] MoT [ ] A [ ]

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36. I never liked mathematics and it is my
most dreaded subject N [ ] R [ ] S [ ] MoT [ ] A [ ]

37. I feel a sense of insecurity when
attempting mathematics questions N [ ] R [ ] S [ ] MoT [ ] A [ ]

38. Mathematics makes me feel uncomfortable
restless, irritable and impatient N [ ] R [ ] S [ ] MoT [ ] A [ ]

39. I feel ease in mathematics and I like
it very much N [ ] R [ ] S [ ] MoT [ ] A [ ]

40. I am happier in mathematics class than
in any other class N [ ] R [ ] S [ ] MoT [ ] A [ ]

41. I feel a definite positive reaction to
Mathematics lessons N [ ] R [ ] S [ ] MoT [ ] A [ ]

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APPENDIX B

TEST ITEMS FOR THE STUDENTS

DURATION: 1HR 30 MINUTE

Answer All Questions

1. The operation $\triangle$ is defined on the set of non-zero rational numbers by a $\triangle$ b $= \frac{a+b}{ab}$, ab≠0

   Determine whether the operation $\triangle$ is:

   (a) Commutative

   (b) Find the inverse of -5

2. In a class of 100 students, 40 offer Biology, and 10 offer Chemistry and Biology. 10 offer Physics and Chemistry, and 30 offer Physics and Biology. Each student offers at least one of the three subjects. The number of students who offer Biology is equal to those who offer Physics only and the sum of the number of students who offer Biology and those who offer Chemistry is equal to the number of students who offer Physics. (a) Illustrate the information on a Venn diagram.(b)Find the number of students who offer (i) All three subjects (ii) Chemistry only (iii) Physics

3. a) A man invested a certain amount of money in a bank at a simple interest rate of 5% per annum. At the end of the year, his total amount in the bank was Gh₵840,000.00. How much did he invest in the bank?

   b) A woman received a commission of 12 ½% on sales made in a month. Her commission was Gh₵35.00. Find her total sales of the month.

4. a) If 10 men can weed a piece of land using 9 days, how long will 15 men weed the same piece of land if they work at the same rate.

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b) Simplify 3.222.... as a mixed fraction

5. a) using a ruler and a pair of compasses only:

i. Construct $\Delta ABC \; such \; that \; |AB| = 8cm, angle \; BAC = 60^0 \; and \; angle \; ABC = 75^0$.

ii. Locate the point O, inside ΔABC equidistance from A, B and C.

iii. Construct a circle with centre O, which passes through A.

b) Measure and write down the values of

i. |OA|

ii. angle ACB

iii. angle AOC