FACTORS THAT HAMPER THE ACQUISITION OF MATHEMATICS KNOWLEDGE BY FEMALES IN GHANAIAN TERTIARY INSTITUTIONS

BY

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Thesis

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I declare that the above dissertation/thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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29 June 2021

Date

FACTORS THAT HAMPER THE ACQUISITION OF MATHEMATICS KNOWLEDGE BY FEMALES IN GHANAIAN TERTIARY INSTITUTIONS

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ABSTRACT (English)

This dissertation explores the plausible factors of young women's inability to pursue Mathematics beyond high school. The study uses Bandura's Social Learning Theory as the main theoretical focus. The study posits that there is a significant gender gap in Mathematics participation; the gap favours males. The gap matter-of-factly widens as females progress academically. The factors identified as contributing to upward immobility in Mathematics education among female students include games that children are introduced to, the teaching strategies of teachers and teachers' Mathematics phobia. Incentives in the form of scholarships for females who pursue Mathematics education is identified as a factor which motivates females and contributes greatly to their continuous participation and performance in Mathematics education.

Descriptive survey design together with the quantitative research method is foundational to this study. The population for the study comprised all university students in Ghana. Simple random sampling was used to select two hundred and forty-one (241) undergraduate, one hundred and nineteen (119) first degree holders, ten (10) graduate students, twenty-eight (28) master's degree holders and two (2) PhD students from eight universities. The data was collected from both primary (questionnaire) and secondary enrolment data from the University of Cape Coast (UCC).

This study seeks to add to the general body of knowledge and research work around Mathematics development with particular reference to female participation. It seeks to address Mathematics phobia among female students.

It is expected that this research could enable parents, teachers, and the nation to understand some of the factors which impede the passionate embrace of females in Mathematics education in Ghana.

The study recommends processes and incentives to facilitate and enhance the participation of females. It also recommends a framework for the professional development among teachers by agencies other than their employers.

Keywords
Mathematics phobia, Gender disparities, Mathematics knowledge, Mathematics development among women

TSHOBOKANYO (Setswana)

Tlhotlhomisi eno e sekaseka dintlha tse di dumelesegang tsa go tlhoka bokgoni ga makgarejana go tswelela ka Dipalo (Mathematics) morago ga dithuto tsa sekolo se segolo. Thutopatlisiso e dirisa Tiori ya go Ithuta ga Loago ya Bandura (Bandura's Social Learning Theory) jaaka ntlhakgolo e e totilweng ya tiori. Thutopatlisiso e tlhagisa gore go na le sekgala se se bonalang sa bong mo go nneng le seabe mo Dipalong; sekgala se se sekametseng mo banneng. Tota sekgala se tswelela go gola fa basadi ba gola mo go tsa dithuto. Dintlha tse di supilweng jaaka tse di tshwaelang mo go se tlhatlhogeng mo thutong ya Dipalo mo baithuting ba basadi di akaretsa metshameko e e itseseweng bana, ditogamaano tsa go ruta tsa barutabana le poifo ya Dipalo ya barutabana. Dithotloetso tse di mo sebopegong sa dibasari tsa basadi ba ba tsweletsang dithuto tsa Dipalo di supiwa jaaka ntlha e e rotloetsang basadi mme e tshwaela thata mo seabeng le tiragatso ya bona e e tswelelang mo thutong ya Dipalo.

Motheo wa thutopatlisiso eno ke thadiso ya patlisiso e e tlhalosang gammogo le mokgwapatlisiso o o lebelelang dipalopalo. Setlhophasegolo sa thutopatlisiso se ne se na le baithuti botlhe ba yunibesithi kwa Ghana. Go dirisitswe tsela e e bonolo ya go tlhopha sampole kwa ntle ga thulaganyo go tlhopha baithuti ba le 241 ba dithuto tsa pele ga kalogo, ba le 119 ba ba nang le dikerii ya ntlha, baithuti ba ba alogileng ba le 10, baithuti ba le 28 ba ba nang le dikerii ya *master* le baithuti ba le babedi ba *PhD* go tswa kwa diyunibesithing tse robedi. *Data* e kokoantswe go tswa mo *dateng* ya ikwadiso ya ntlha (lekwalopotsolotso) le ya bobedi go tswa kwa Yunibesithi ya Cape Coast (UCC).

Thutopatlisiso eno e batla go oketsa mo kokoanyong ya kakaretso ya kitso le tiro ya patlisiso malebana le tlhabololo ya Dipalo go lebeletswe seabe sa basadi. E batla go samagana le poifo ya Dipalo mo baithuting ba basadi.

Go solofetswe gore thutopatlisiso eno e ka kgontsha batsadi, barutabana, le setšhaba go tlhaloganya dingwe tsa dintlha tse di kgoreletsang go amogelwa ga basadi mo thutong ya Dipalo kwa Ghana. Thutopatlisiso e atlenegisa ditirego le dithotloetso tsa go bebofatsa le go tokafatsa seabe sa basadi. Gape e atlenegisa letlhomeso la tlhabololo ya seporofešenale ya barutabana ke ditheo tse dingwe kwa ntle ga bathapi ba bona.

Mafoko a botlhokwa
Poifo ya Dipalo, Go tlhoka tekatekano ya bong, kitso ya Dipalo, tlhabololo ya Dipalo mo basading

OKUCASHUNIWE (isiZulu)

Lo mqulu ubheka izici ezinengqondo zokungakwazi kwabesifazane abasebasha ukulandela isifundo seZibalo emva kokuphothula isikole samabanga aphezulu. Ucwaningo lusebenzisa Umbono kaBandura ophakamisa ukuthi isimilo somphakathi sifundwa ngokubuka nokulingisa ukuziphatha kwabanye njengombono oyinhloko okugxilwe kuwo. Ucwaningo luveza ukuthi kukhona igebe elikhulu lobulili ekubandakanyeni esifundweni seZibalo; igebe livuna abesilisa. Igebe ngokweqiniso liyakhula njengoba abesifazane bethuthuka ezifundweni. Izici ezikhonjwe njengezinegalelo ekunyukeni phezulu ekufundisweni kwesifundo seZibalo phakathi kwabafundi besifazane zibandakanya imidlalo izingane ezethulwa kuyo, amasu okufundisa othisha kanye nokwesaba kothisha isifundo seZibalo. Izikhuthazo ngendlela yemifundaze yabesifazane abalandela imfundo yesifundo seZibalo zikhonjwa njengesici esishukumisa abesifazane futhi esinikela kakhulu ekubambeni kwabo iqhaza eliqhubekayo nokusebenza emfundweni yesifundo seZibalo.

Ucwaningo oluchazayo lokwakheka kanye nendlela yocwaningo yokuqoqa nokuhlaziya imininingwane yezinombolo luyisisekelo salesi sifundo. Inani labantu esifundweni lalinabafundi bonke basemfundweni ephakeme yaseGhana. Isampula elula engahleliwe yasetshenziselwa

ukukhetha abafundi ababenza iziqu zokuqala abangamakhulu amabili namashumi amane nanye (241), abaphothule iziqu zokuqala abayikhulu neshumi nesishiyagalolunye (119), abafundi abaphothule iziqu abayishumi (10), abaphothule iziqu ze*Master's* abangamashumi amabili nesishiyagalombili (28) kanye nababili (2) abafundi abenza iziqu ze-*PhD* abavela ezimfundweni eziphakeme eziyisishiyagalombili. Imininingwane iqoqwe emininingwaneni yomibili eyinhloko (imibuzo) neyesibili yokubhaliswa evela eMfundweni Ephakeme yaseCape Coast (UCC).

Lolu cwaningo luhlose ukwengeza emkhakheni wolwazi jikelele nomsebenzi wokucwaninga ngokuphendukela ekuthuthukiseni isifundo seZibalo ikakhulukazi ngokubhekisisa ekubambeni iqhaza kwabesifazane. Ifuna ukubhekana nokwesatshwa kwesifundo seZibalo phakathi kwabafundi besifazane.

Kulindeleke ukuthi lolu cwaningo luzokwenza abazali, othisha, kanye nesizwe ukuqonda ezinye zezici eziphazamisa ukwamukelwa ngothando kwabesifazane emfundweni yesifundo seZibalo eGhana. Ucwaningo luphakamisa izinqubo nezikhuthazo zokwenza lula nokuthuthukisa ukubamba iqhaza kwabesifazane. Luphinde luphakamise uhlaka lokuthuthukiswa kobungcweti phakathi kothisha yizinhlaka ezingaphandle kwabaqashi babo.

Amagama asemqoka

Ukwesatshwa kwesifundo seZibalo, Ukwehluka kobulili, Ulwazi lwesifundo seZibalo, Ukuthuthukiswa kwesifundo seZibalo phakathi kwabesifazane

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God bless you all.

DEDICATION

I dedicate this work to a very beautiful soul, Dr Truelove Smangele Mkhwanazi. Dr., I was definitely going to graduate in a Ph.D but it may not have been UNISA but for your dedication, commitment and support. I truly am grateful. God bless your beautiful soul.

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ACRONYMS

AAUW	American Association of University Women
ABC	American Board for Certification
AIT	Accra Institute of Technology
ATEA	Australian Teacher Education Association
BMBF	Bundesministerium für Bildung und Forschung
CEER	Centre for Environmental Education & Research
CEO	Chief Executive Officer
CGPA	Cumulative Grade Point Average
CRILE	Center for Information & Research on Civic Learning and Engagement
CTBS	Canadian Test of Basic Skills
DIFD	Department for International Development
ECIS	European Conference on Information Systems
ECLS-K	Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K)
ERIC	European Research Infrastructure Consortium
FEMSA	Female Education in Mathematics and Science in Africa
FIU	Florida International University
GAD	Generalized Anxiety Disorder
GAUSS	Geophysical Airborne Unmanned Survey System
GED	General Education Degree
GES	Global Engagement Summit
HND	High National Diploma
ICT	Information Communication and Technology
IEA	Institute for Educational Advancement
IOSR	International Organization of Scientific Research
ISSN	International Standard Serial Number
KNUST	Kwame Nkrumah University of Science and Technology
M,Phil.	Master of Philosophy (M.Phil.)
M.A.	Master of Arts (M.A.)
M.Sc.	Master of Science (M.Sc.)
MAN	Mathematical Association of Nigeria

MASC	Mathematics Anxiety Rating Scale for Children
NBER	National Bureau of Economic Research
NSF	National Science Foundation
OECD	Organization for Economic Co-operation and Development
OFSTED	Office for Standards in Education
PABO	Pedagogische Academie Basisonderwijs
Ph.Ds	Doctor of Philosophies (Ph.D.s)
PIRLS	Progress in International Reading Literacy
PISA	Programme for International Student Assessment
SCT	Social Cognitive Theory
SES	Socio Economic Status
SHS	Senior High school
SMT	Societe Mathematique de Tunisie
STEM	Science, Technology, Engineering and Mathematics
STM	Science Technology and Mathematics
STME	Science Technology Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
TLM	Teaching Learning Material
UCC	University of Cape Coast
UEW	University of Education
UG	University of Ghana
UNESCO	United Nations Educational Scientific and Cultural Organization
UPSA	University of Professional Studies
USA	United State of America
WASL	Washington State Board of Education
WASSCE	West African Senior Secondary Certificate Examination

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1INTRODUCTION

The aim of this study is to assess the factors that contribute to the decline in the numbers of women in Mathematics as they progress academically in Ghana. The acquisition of adequate mathematical skills and the use of the skills are prerequisites to effective functioning in everyday activities. It also influences adequate and successful participation in many careers particularly those in who are in the fields of Science, Technology, Engineering and Mathematics (STEM) (Van Mier, Schleepen & Van den Berg, 2019).

Mathematics phobia and anxiety became prominent after the conduct of a global comprehensive research which portrayed emotional difficulties as impediment in Mathematics delivery across all levels and ages in education (Villamizar Acevedo, Araujo Arenas & Trujillo Calderón, 2020). The findings resulted from the study which was conducted by Dreger and Aikenwho among the numerous university students who demonstrated uneasiness when asked to solve problems related to numeracy. The feeling was named by the authors as "Anxiety to Numbers". This was not described as a type of generalised anxiety; rather it was described as a sort of specific anxiety associated with the rules of calculus and other operations related to numeracy (Villamizar et al., 2020). After the identification of the problem, the term Mathematics Anxiety and Phobia became accepted and many more definitions emerged describing it (Pérez –Tyteca, Monje & Castro, 2013; Reali, Maldonado & Jimenez, 2015).

Mathematics phobia is currently considered as the intense undesirable emotional retort (branded by nervousness, tension, concern, doubt, fear, impatience, irritability, mental blockage and confusion). This is a hindrance to performance in mathematical problems in both daily life and or in school (Villamizar Acevedo, Araujo Arenas, Trujillo Calderón, 2020).

Many factors could cause Mathematics phobia and anxiety. These include unpleasant instructional strategies and assessment. Instances where Mathematics is assigned as punishment could aggravate the situation (Rozgonjuk, Kraav, Mikkor, Orav-Puurand, Täht, 2020). Unpleasant as it may sounds, it is still widely in used in many levels and schools. This attitude could contribute significantly in influencing the spread of Mathematics phobia and anxiety (Rozgonjuk, Kraav, Mikkor, Orav-Puurand, Täht, 2020).

Mathematics phobia , however may be traced in early stages of life, reduction in the phobia may exist at all levels of the education ladder (Rozgonjuk, Kraav, Mikkor, Orav-Puurand, Täht, 2020). Appropriate instructional strategies, and teachers' passion and commitment in the Mathematics classroom management contribute significantly to Mathematics anxiety and phobic among students (Rozgonjuk, Kraav, Mikkor, Orav-Puurand, Täht, 2020). It is important that pre-service teachers are given the needed help to reduce if not overcome their own Mathematics phobia and anxiety. This could help a great deal in reducing to the barest minimum students' Mathematics phobia and anxiety (Rozgonjuk, Kraav, Mikkor, Orav-Puurand, Täht, 2020). Creating an interactive classroom, where the teacher is seen as a facilitator of learning, guiding learners to discover knowledge etc. could also reduce Mathematics phobia and anxiety (Cooper, Downing, & Brownell, 2018).

During the last decades of the Twenty-First Century, the number of women in post-secondary education relatively increased compared to that of men. However, men outnumber women at undergraduate and graduate levels in several Western countries (U.S. Department of Education, 2000). More males than females enroll in mathematically intensive areas, including computer science and/or engineering. The self-inflicted gender isolation in choosing courses is evident at high school level (Jelenec, 2008). Mathematics in the interim has been classified as a "critical filter" in the career arcade. It is an essential prerequisite for entry into high-status or top-paying professions (Mireku, Okpoti, Addo, Mereku & Oteng, 2015). As a result, gender disproportion in Mathematics intensive fields has raised apprehension (Steele, 2003 cited in Mireku et.al, 2015).

There is available literature on gender disparity in Mathematics performance which favour males as the better performers. A critical look at the arrangements in Mathematics problem solving

among genders correlate to reasoning capabilities and psychological physiognomies that are facilitated by education and experience. A number of multifaceted variables such as psychological, biological together with environmental factors are said to be contributing factors of gender disparities in solving problems in Mathematics in some precise areas (Mireku et.al., 2015). Of the 6% to 13% graduate of high school who had what was needed to enter tertiary institutions from 2000 to 2008 in Ghana, girls were almost always half the number of the boys in each year. This qualification was based on a pass in Mathematics which is a requirement to a tertiary institution in Ghana (Mireku et. al., 2015).

To determine if Mathematics phobia and anxiety have differential impact on the Mathematics performance of girls and boys, a study was conducted and reported by Van Mier, Schleepen and Van den Berg (2019). The study calculated the females score being approximately 0.3 standard deviation (SD) higher on mathematic phobia and anxiety scales than the male from grade 6 through to college, with levels of Mathematics phobia and anxiety peaking at Grades 9 to 10. Significant gender disparities relative to Mathematics phobia and anxiety were found among students in junior and senior high schools, with the male reporting lower levels of Mathematics phobia and anxiety than girls (Hill, Mammarella, Devine, Caviola, Passolumghi & Szucs, 2016; Van Mier et al., 2019).

One of the very few existing studies addressing gender disparities in relation to the Mathematics phobia and its effect on Mathematics performance in the later part of elementary and early secondary school established the existence of a correlation which was significant among girls (Schleepen & Van Mier, 2016; Van Mier et al., 2019). A significant correlation was found by Hill et al. (2016) in girls but not in boys.

In Ghana, female students' attitude towards the study of Mathematics has been a great concern for parents, educators, relevant stakeholders and policy makers over the years. As early as Junior High School, students in the Tolon District already have perceived Mathematics as being "boring, difficult and irrelevant subject" (Salifu, 2017). Most of the female students in the district regard Mathematics as a male-domain and a subject for high achievers. Allotey (2012) observed that female students viewed Mathematics as an "abstract black box" which contains strictly held

concepts, routine imaginative and very complex formulae for memorization. Such perception contributes significantly to a dwindling of interest among female students in the study of Mathematics .

In all of these, a specific look at factors contributing to the fallout of the few who take up Mathematics from High School through to Ph.D has not been given attention. Hence, this study seeks to assess the factors that contribute to the decline in the numbers of women in Mathematics as they progress academically in Ghana.

1.2BACKGROUND TO THE RESEARCH

The researcher teaches Mathematics at Accra College of Education. She was the chair of the Mathematics and ICT Department from 2014 to 2016. The researcher's journey to this position from childhood is a simple story that depicts young girls as barely buoyant in pursuing careers in science-related courses, especially Mathematics . As a result, there are very few role models for the younger girls. This area consequently continues to be the realm for boys. The researcher's desire and passion for Mathematics development among women informed her choice of this topic to investigate factors which impede Mathematics development among women from the Ghanaian perspective.

A good number of researchers seeking the association among Mathematics learning and gender differences have conducted a series of research in various countries over the past three decades. In recent years, research efforts show no significant gender differences in achievement as both the female and male begin getting acquainted with Mathematics (Ajai & Imoko, 2015). However, with time, differences favouring male students emerge (Campbell, 1995; Mullis, Martin & Stemler, 2002; Badura, Grijalva, Newman, Yan & Jeon, 2018).

Mathematics has been seen and remains a preserve for male students over the years. Findings from recent studies suggest a minimal gender disparity in mathematical achievement through to high school level (Ato Kwamina & Offoe, 2015). Atto Kwamina and Offoe (2015) reported on a widespread review of literature which saw the male not outperforming the female in numeracy and

computational abilities. Males do not demonstrate understanding of mathematical concepts at the basic school level more than females. However, males outperform females in advanced Mathematics problem-solving beginning from high school through college. They also reported of the diminishing gender disparities in performance in Mathematics except at the higher level specifically college. Courses they found males outperforming females at the advance level included analytical geometry and calculus.

Ato Kwamina and Offoe (2015) reported the gender disparities in Mathematics achievement that favoured the male students both in interest, achievement and in selection, and engagement in higher Mathematics options. Extensive review of literature review on gender disparities in Mathematics recommend a reduction in the quantum of females studying Mathematics through college level. Among the talented students in junior high schools, the male overtook the female in quantitative SAT; this examination was clearly higher for their level (Ato Kwamina & Offoe, 2015). The emergence of a general pattern was clearly visible: female and male performances in Mathematics are nearly the same except when in advanced test material (Ato Kwamina & Offoe, 2015).

Inconclusive results have been produced by scholars on the dispute of gender difference in Science, Technology and Mathematics Education (STME). A meta-analysis during the era 1974 – 1987 on gender disparity in Mathematics resulted in two inferences: the average gender difference is relatively insignificant statistically and the decline in the differences came with time (Ato Kwamina & Offoe, 2015). Hyde, Lindberg, Linn, Ellis and Williams (2008) reported a meta-analytic finding undertaken in the 1990s. The findings indicated a triviality in the gender disparities in Mathematics performance among the general population, $d = -0.05$, as the outcome size, d, remains the mean on behalf of male minus that of the mean for the female, divided by the pooled within gender standard deviation.

Women are consistently underrepresented in engineering and its related fields. In Israel, 28% of the senior academic staff were women. They remained marginalized in physical sciences (11%), Mathematics and computer sciences (10%), engineering (14%), but dominate in paramedical occupations (63%) and education (52%). In Japan and the Republic of Korea, females

representation was just 5% and 10% in engineering. Females make up just 19% of engineers in North America and Europe. That is Germany, Canada and the United States of America. They constitute 22% in Finland. But there are however some positive spots nonetheless: 50% of graduates of engineering are females in Cyprus, in Denmark there are 38% of them. In the Russian Federation for example, there are 36%. Engineering in many cases, is preferred by many to other sciences and that include agriculture. New Zealand for instance is equitably typical. The female hopped from the minimal representation of 39% to 70% of graduating in agricultural from 2000 to 2012. They maintained the dominance in the health sciences(80–78%) but conceded in the science (43–39%) and engineering (33–27%) (UNESCO Science Report, 2017)

It is not surprising, therefore, that there is a global epidemic in many institutions called Mathematics phobia which is also very prominent in Ghana. It is described as the extreme fear of Mathematics which creates a wide gender gap in Science and Mathematics with females casing at the back of the males. The most significant factor contributing towards the small number of women at the small partaking rates in advance courses is the relatively low performance in examinations.

Gender discrimination and inequalities in education have been evident in greater part of the globe. Ghana is not exempt. Ghana' educational system is characterised by gender differences and this is visible at every level (Boateng & Gaulee, 2019).

The effort to close gender disparities in education could be dated back to 1957 when Ghana gained political freedom. The Ghana government played a key role in the measurable characteristic of achieving almost balanced boys and girls from basic through high school. Civil societies have also tried copious interventions to narrow gender disparities in both the qualitative and the quantitative sides of education. Though significant progress has been made in the enrolment of the male and female in modern times at the Northern Region of Ghana between 2010 and 2012 academic years, there was a visible imbalance in educational prospects for females and males improved from primary to Junior High level in 2012. There is a very noticeable gender gap which will make it very challenging for the government of Ghana to achieve this objective of impartiality in enrolment and attendance by 2015 (Alhassan & Odame, 2015).

In their study "Female Enrollments in STEM in Higher Education: Trend Analysis from 2003 – 2018", Appiah-Castel, Lamptey, Titiloye and Pels (2020) identified progression in the female enrolment trend in STEM courses in Kwame Nkrumah University of Science and Technology (K.N.U.S.T.) in Ghana. However, the total percentage of female in science and engineering in K.N.U.S.T. remains lower as compared to the male. With all the societal recognition given STEM as a filter to job opportunities and a strengthening field for the female, there exists a huge shortage of female participation in STEM education. Appiah-Castel et.al (2020) recommended a change of policy in enrollment and its approaches in order to retain female interest in Science, Technology, Engineering and Mathematics in higher education.

In his quest to find the extent to which enrolment of women in Mathematics programmes reflects in an increase in female enrolment into Ghanaian universities, Fletcher (2009) made some important discovery. The study aimed at unearthing the available job opportunities for females in Mathematics and what the female undergraduate perception of Mathematics is as factors which influence women decision into the study of Mathematics . Fletcher's study revealed that females who take up Mathematics end up as Mathematics teachers in the end with only a few considering Engineering and Technology. Their self-confidence together with their high ability in Mathematics notwithstanding, fathers were the next influential factor found. Fathers encourage their daughters into the study of Mathematics . The least influential factor was role models.

In her investigation into gender disparity and participation in STEM-related fields in higher education in Ghana, Acheampong (2014) discovered that out of the over twenty-four million people in Ghana, women constitute fifty-one percent (41%) of the populace (Ghana Statistical Service, 2012). This statistics notwithstanding, females constitute the minority in higher education specifically in STEM.

In their study, "From Studentship to Academia: The Academic Female STEM Trajectory in Ghana", Boateng and Gaulee (2019) discovered that their respondents all through their education and career had to rely on one support system or the other in order to succeed. The silver-lining of this support was however smothered by gender inequity which was underpinned by deep-seated

patriarchy, a feature of Ghanaian culture. It beliefs in the relegation of the girl child to the boy child. Irrespective of the female achievement, she is perceived and handled as a second fiddle to men. The female, whilst in school, benefits from cooperation, collaboration and support from the male counterparts. This kind of cooperation, collaboration and support decreased rapidly as the female advanced to the STEM workspace; at this point their male class mates become perpetrators of gender inequality. This patriarchal realisms in Ghana, Boateng and Gaulee (2019) advised need urgent attention from all relevant stakeholders in Ghana so that it could nip gender disproportions and discriminations in the bud.

In his conclusion on the study "Mathematics Anxiety Among Ghanaian Students', Bruce (2016) discovered the existence of Mathematics phobia and anxiety exists among students at Junior High School (JHS) and Senior High School (SHS) levels. The rate of Mathematics phobia and anxiety amongst students is contained in the range that called for a reduction in phobia and anxiety. Churcher, Asiedu-Owuba and Adjabui (2015) in their studies, "Assessment of Students' Performance in Mathematics at the Second Cycle Schools", also identified a substantial correlation between students' performance in Mathematics and predictors of their performance. Insufficient textbooks and performance of facilitators remain the major factors that contribute to students' performance for all the three levels.

Tetteh, Wilmot and Ashong (2018) observed in their study "The Pattern of Mathematical Achievement of Secondary School Students in Ghana" a higher achievement of the male than the female in Mathematics at the secondary school level. Wilmot (2008) also established the disparity in Mathematics attainment among girls and boys gets clearly visible or manifest at the sixth grade.

Asante (2010) in his study, "Sex Differences in Mathematics Performance Among Senior High Students in Ghana", established that the lack of confidence on the part of girls, had a devastating underlying provenance patterns perceiving or making Mathematics a male domain as compared to boys. Salifu (2017) described this as an affirmation of the assertion that male students exhibit positive attitudes towards Mathematics than female students. Low representation of women in Mathematics , science and technology programmes and professions in Ghana has been blamed on the negative attitudes and perceptions of women towards those disciplines (Asante, 2010). The

identified factors known to be the causes of these disparities in attitude towards Mathematics among females and males are the school environment, the beliefs and attitudes of the Mathematics teacher and the pedagogical approaches employed by the teacher, together with parental educational status and attitudes (Asante, 2010).

Gavor (2014), in his analysis of the Results of the 2012 and 2013 West African Senior Secondary Certificate Examination (WASSCE) revealed that, out of the 59,400 candidates who sat for the Elective Mathematics examinations, only 27.4% of females obtained the pass grades of A1 to E8 as compared to 70.5 % of their male counterparts. There were, however, limited differences in the pass rates of males and females with regard to Core Mathematics . The pass rates for males and females were 35.6% and 35.5% respectively of the total number of candidates who sat for the Core Mathematics examinations. Whereas the pass rates for males and females in Core Mathematics were 40.0% and 31.7% respectively, in 2013, the pass rate for Elective Mathematics for males and females were 54.3% and 23.1% respectively (WAEC, 2013). The performance of girls in the analysis is worrying and calls for stakeholder involvement in ensuring equal participation and performance in Mathematics among boys and girls.

Even though Anamuah-Mensah, Mereku, and Asabere-Ameyaw (2004) report on the "Trends in International Mathematics and Science Study" (TIMSS-2003) did not establish any significant difference in the performance of boys and girls in Mathematics , differences were observed between boys and girls in their attitude to the subject and aspirations for higher education. Frempong and Ayia (2006) attributed non-performance and participation in Mathematics to their low interest and confidence in learning Mathematics and low academic expectation.

In his study, "Female Students' Participation in Mathematics Education at the University Level in Ghana", Yarkwah (2020) considered female enrolment into Mathematics in the sampled universities. This included the University of Cape Coast and University of Education, Winneba from 2007 to 2017. The study discovered that the female participation in Mathematics Education was relatively higher from 2007/2008 – 2010/2011 academic years. The curve became unstable from 2010/2011 academic year to 2016/2017 academic years. There were significant reductions in enrolment of female into the Mathematics programme in the two major teacher training

universities in Ghana. Taking the last five years of the study into consideration the study discovered that female enrolment onto the Mathematics Education programme from 2011/2012 to 20162017 academic years were lower compared to enrolment of female onto the Mathematics Education programme from 2007/2008 to 2010/2011 academic years. The study concluded based on the data that the numerous interventions, campaigns, policies notwithstanding, recent times have seen a decline in female participation in Mathematics education in Ghana.

In concluding their study; "From Studentship to Academia: The Academic Female STEM Trajectory in Ghana", Boateng and Gualee (2019) saw a gender gap characterising Ghana's educational system at the gamut of all educational levels. They identified ample literature on gender disparities concerning Ghana's education, but there remains a few that touch on the experiences of females in the STEM fields, which are deemed to be male-dominated disciplinary domains (Boateng & Gualee, 2019).

Women's participation in Mathematics has serious effects on forthcoming career and commercial prospects. This is because the world is increasingly becoming dependent on technologically obsessed competencies. Mathematics is professed as the critical filter that creates access for women into equitable, higher paying jobs such as Engineering (Sells cited in Mireku et.al., 2015). Women have progressively made strides in pursuing mathematically oriented college degrees over recent decades. However, the number of men keeps increasing than the women at a ratio of two to one in quantitative university concentrations (Mann & Diprete, 2013). Participation by women is still below 20% in the Engineering fields.

The reduction in the number of women in Science, Technology, Mathematics and Engineering (STEM) occupations notwithstanding, there has been a concentrated determination to escalate the female number in STEM (Hill, Corbett & St. Rose, 2010). Only 26% of mathematical and computer scientists and 11% of engineers were women in the United State of America in 2007. (National Science Foundation, Division of Science Resources Statistics, 2009). Although the number of Science and Engineering Bachelor's and Graduate degrees earned by females have improved, some degrees remain bizarrely male. Although there has been improvement in broadening participation in STEM, the National Center for Science and Engineering Statistics

(NCES) (2015) data shows that the recognized minority group which include women is being underrepresented in STEM and are lagging behind their majority counterparts in the STEM degree accomplishment and workforce exemplification (James & Singer, 2016). Though women earned 50.5% of the bachelor's degrees and 41.1% of doctoral degrees in engineering and science in 2012, the number of undergraduate and graduate degrees awarded to women in Computer Science, Mathematics and Statistics deteriorated between 2002 and 2012, and physics undergraduate degree accomplishment also declined (Cahalan & Perna, 2015).

Nguyen and Wodon (2013) purposely highlighted the gender disparity in educational participation between boys and girls from primary school to senior high school in Ghana. They stated that with respect to the age cohort of 21 to 24 years, 84.1% of girls commenced primary school compared with 90.7% of boys. Their primary school completion rate was 86.5% and 92.7% for girls and boys, respectively. In the transition from Junior High to Senior High School, the completion rates widen, favouring boys at 65.1% and 51.2% for girls. Between enrolment and completion, access is a constantly negotiated gendered process that is enacted on a daily basis (Dunne, Akyeampong, & Humphreys, 2007 cited in Boateng & Gaulee, 2019) among the schools and teachers, families and communities, as well as educational administrators (Humphreys, Moses, Kaibo & Dunne, 2015). This resultant school dropout in Ghana had an obvious gender dimension.

Even in the face of current progress in female enrolment as a result of affirmative action and awareness creation campaigns, there still exist gender gaps which are quite conspicuous in certain societies across the globe. The impediments together with struggles to gender parity in education exist, particularly in downgraded communities where conventional mindsets are principal (Masanja, 2004 cited in Masaja, 2016). This underrepresentation of girls and women in (STEM) is a worldwide phenomenon which is a continual concern for social scientists and policymakers (Stoet & Geary, 2018).

1.3 RATIONALE OF THE STUDY

The researcher poses an initial question: Why study the gender difference in Mathematics ?

Mathematical abilities are well-thought-out to be indispensable and gateway to success in STEM fields (Wu et.al, 2018). This is crucial and indicates that one cannot successfully enter into STEM without Mathematics knowledge. The dispute of proficiency in Mathematics has progressively become imperative and has been pursued at the highest policy level in recent years. Mathematical proficiency remained recognised as one of the major competencies required for personal accomplishment and social inclusion (European Commission, 2011).

The significance of mathematical knowledge as recorded by Schrøter Joensen and Skyt Nielsen (2010) offer evidence that Mathematics skills encompass a fundamental outcome of job-market outcomes. It is evident that mathematical proficiency gives upper proceeds than the other skills, according to Paglin and Rufolo (1990 cited in Doris et. al. (2013). The Organization for Economic Co-operation and Development (OECD) (2010) states that despite the emphasis on the importance of mathematical proficiency, most of the countries do not have policies that support children to attain high levels of mathematical achievement. As a result, the improvement in mathematical skills acquisition has been a key hub of instructive policy for numerous governments.

The study demonstrates the existence of gender-disparity in Mathematics Education and why it still exists in our schools irrespective of the numerous research conducted on Gender and Mathematics Education. The teaching and learning of Mathematics has been problematic because the research conducted in the area is either scanty and needs further research or is limited to specific geographical locations.

This study argues that investment in Mathematics development among women could produce broad fiscal reimbursement in Africa if only we would take cognizance of Aggrey's timeless adage that "If you educate a man, you educate an individual; but if you educate a woman, you educate a nation." Ghanaian women are vital to sustainable development and socioeconomic advancement.

It is important for women to join the STEM workforce because their contribution in the field of science can maximise innovation and increase creativity and competitiveness (Hill et al., 2010). Scientists today are doing a lot of work which involves cutting-edge technology, medical miracles and discoveries, tackling global warming, building bridges and machinery etc. The inadequate

participation of women in these important activities may lead to the exclusion of a true diversity of perspectives in addressing the needs of women in productive activities.

This research sought to explore why there are few females in Mathematics as compared to males, the reduction in the number of women as they climb the social and academic ladder and implications thereof for curriculum development as well as the provision of required support for redress to any phobia. With the new flippant phrases of "being scientific and technological", all stakeholders need to chart a new course of development for Ghana, whether they are families, schools, communities and governments, in the process of their skills acquisition, modernism and brain power. The best way to assist the Ghanaian women is through gender-sensitive policy development and implementation. This research believes such an approach would help to add knowledge and elevate the women in mathematical skills' acquisition in Ghana.

1.4 STATEMENT OF THE PROBLEM

There is a huge gap in percentage in the enrolment into the Arts-and Humanities and Science, Engineering, Technology and Mathematics in Ghana (Atuahene & Owusu-Ansah, 2013). Even though the Ministry of Education, Science and Sports [MOESS] (2010) worked out a sixty: forty enrolment policy in Science and Technology, and Arts and Humanities programmes respectively for upward enrolment trends over the last few decades, the goals of the policy is far from being realised. By this, the probability that the greater percentage of the few women opportune to be enrolled into tertiary institutions in Ghana are likely to join the traditional disciplines is high. This leaves the STEM for few females and mostly males (Acheampong, 2014). Male enrolment into the STEM fields in Ghana is significantly higher than the female as a result of factors including gender stereotyping, societal beliefs and practices, patriarchy in decision making and perceived gender roles (Acheampong, 2014).

Numerous advocates of international organisations, including the United Nations, campaigned for gender equality in all aspect of life. Yarkwah (2020) made a declaration on gender inequalities in Mathematics. Griffith said that this gap begins from infancy. It however deteriorates as one progresses on the academic ladder. Even though there is equity in education in most of the

developed countries, the girl child enrollment into mathematical studies is relatively low (El Yacoubi, 2015). Females attained two-thirds of all degrees awarded at the undergraduate level, this represents almost 67%. A few of these degrees, however, are attained in Science and Technology.

Yarkwah (2020) revealed that of the total number of women that enrolled and completed terminal degrees, only 1% could attain Ph.D degrees in the area of the STEM fields. The story could not get better after ten years. Women are able to earn 42% of the doctorate degrees in Life, Physical, Computer, Psychology and Engineering, Earth and Social Sciences, women, however, earn only 25% of the Ph.D degrees in Computer Science and Mathematics in 2015 (National Science Foundation, 2016).

Women therefore constitute a small percentage in enrolment into Mathematics intensive fields. In their study, "Gender Differences in Participation in Elective Mathematics of Senior Secondary School Students in Ghana", Kwame, McCarthy, McCarthy and Gyan (2015) revealed the low participation of female students since 1995 in elective Mathematics in High schools. The gender difference in elective Mathematics participation increased from 10% in 1995 to 20.9% in 1999 this further increased to 27.2% in the year 2000. In the year 2000, 50.5% of the male as against 27.2% of female students in Senior Secondary School year three studied elective Mathematics (Kwame et al., 2015). Elective Mathematics is the main requirement into higher Mathematics studies in college.

This small percentage of the women continues to decrease as the women climb the social and academic ladder. With the abundance of literature on gender differences in Ghana's education, little is done on the female experience in the STEM fields (Campion & Shrum, 2004; Boateng, 2017) an area of global interest where the male have dominated. Kitetu (2004) also contends that the African perception of gender in classroom practices is mainly based on studies and findings premeditated in North America and Western Europe. However, transferring the findings from the Western world, constructed on Western traditional concepts, create problems such as lack of conducive classrooms and pupils learning under trees, lack of teaching learning resources, to mention just a few in the African context (Mireku et.al. 2015). Reporting from South Africa,

Mahlomaholo and Mathamela (2004) state the explicit variation among girls and boys at all levels of observed analysis.

Ato Kwamina and Offoe (2015) reported on the existence of a no substantial gender and accomplishment difference in algebra and its processes, number and numeration and statistics in Nigerian schools. The study however established the existence of a weak but significant relationship in Geometry and Trigonometry. Ato Kwamena and Offoe (2015), in the their study, "Gender Differences and Mathematics Achievement of Senior High School Students: A Case of Ghana National College", found no gender-bias in performance assessment tests. Their study contradicted the popular assertion that the male perform better in Mathematics than the female specifically in their early secondary school, in the case of Ghana. Their study could not discover any significant gender disparity in Mathematics performance among the male and female students in their experimental group.

Even when the female performed equally well in Mathematics as the male, studies conducted and reported by Yarkwah (2020) showed that the female nonetheless have demonstrable negative attitudes when it comes to participation in Mathematics as a result of the greater phobia and anxiety they have towards the study of Mathematics . This Yarkwah (2020) saw this as a contributing factor to the low participation by the female at the college level.

Studies conducted from the West campaign for innovative standpoints on learning and teaching which could lead to a change in classroom practice. Lack of political will may make it difficult for the African to adopt and implement such recommendations completely as noted by Mahlomaholo and Mathamela (2004). There is, therefore, the urgent need for the African, precisely the Ghanaian to find the factors contributing to the decline in the number of women in Mathematics education beyond high school and hence find suitable solutions. This research seek to explore the probable reasons by identifying the plausible factors that impact on female participation in Mathematics education and why young women are not able to pursuit Mathematics beyond high school from the Ghanaian perspective.

Mathematics does not only teach the steps to solve a problem; it also involves developing and using logic. Logical reasoning is something everybody uses in everyday life to make decisions and in problem-solving. Formal Mathematics may not be used every day, but logic is used every day in almost everything we do.

1.5 RESEARCH QUESTIONS

1.5.1 The main research question

Why do the few women who are mathematically-inclined in high school not able to pursue Mathematics beyond high school level?

1.5.2 Research sub-questions

- What societal factors contribute to women falling behind and not able to participate in the field of Mathematics as they progress in the academic and social fields?
- What role does the school play in the declining enrolment in Mathematics if any, of girls as they progress academically?
- What role, if any, does the home play in the declining enrolment in Mathematics of girls as they progress academically?
- What role do teachers play in the declining enrolment in Mathematics , if any, of girls as they progress academically?
- To what extent do teaching learning resources contribute to the participation and performance of the female in Mathematics education?

1.6 AIM AND OBJECTIVES

1.6.1 The research aim

The main aim of the dissertation is to assess the factors that hinder the upward mobility of women in Mathematics as they progress social and academic ladders in Ghana.

1.6.2 Objectives

The specific objectives of this study were to:

- Explore societal factors that contribute to women falling behind and not participating in the field of Mathematics as they progress in the academic and social fields.
- Determine the extent to which the school contributes to the decline in the number of girls in Mathematics Education, if any, as they progress academically.
- Examine the extent to which the home contributes to the decline in the number of girls in Mathematics Education, if any, as they progress academically.
- Assess the extent to which the teachers contribute to the decline in the number of girls in Mathematics Education, if any, as they progress academically.
- Examine the extent to which teaching learning resources contribute to participation and performance of the female in Mathematics education.

1.7 SIGNIFICANCE OF THE STUDY

1.7.1 Theoretical significance

The thought that boys are superior in the taking of Mathematics as a course than young ladies is barely new. Apparently it is common misinterpretation. It leads to a distorted discernment of arithmetic in education and beyond. Existing in all societies from inconspicuous inclinations to references in well-known culture, the sexual orientation imbalance is blatantly obvious in higher education. Even though the college gender disparities have somehow faded, males still outnumber the females and females are still underrepresented in ambitious or high- powered careers such as being CEOs and acquiring Ph.D's globally. This is worse generally in Finance, Business, Science, Technology, Engineering and Mathematics (Bertrand & Katz, 2010; Ginther & Kahn, 2009; Smith, & Verner, 2013).

Women involvement in highly prestigious occupations particularly in the area of technology and science that are seemingly tough, have remained truncated irrespective of efforts that has been made by numerous worried countries. This low-representation of the female focused mainly on the areas of technology, Mathematics , engineering and physics (Christie et.al., 2017). The reasons stated by Hassi, Hannula and Saló i Nevado as the main obstacle to learning high-level science and technology has been the lack of Mathematics knowledge (Hassi, Hannula & Saló i Nevado, 2010). This research sought to add to the general body of knowledge and research work in the area of Mathematics development and female participation.

The African perception of gender in school and learning enviroment is most often grounded on what has been studied in Western Europe and North America (Kitetu, 2004). Ertekin, Dilmac and Yazici (2009) state that societies that are aware of the importance of Mathematics , make the foundation of instruction of new cohorts or generation on intellectual skills and logic, take the front position in all fields in the future. This study sought to extend the discussion to a seeming decline in the number of girls and women in the field of Mathematics as they progress academically in Ghana. It would also contribute towards the on-going debate about Mathematics phobia and its impact among female professionals in academia.

Mireku (2015) explained Mathematics as being a critical filter to the high-status area in academia and employment. Ertekin, Dilmac and Yazici (2009) stated that societies that are aware of the importance of Mathematics and build the foundation of instruction of new cohorts or generation on intellectual skills and logic, take the front position in all fields in the future. This research seek to design a model to encourage female participation in Mathematics Education.

The unrelenting smaller number of women in the science-related courses is worth mentioning because the end results are the lack of a competent workforce in the science-related occupations. Its principal product is a salient example of professional gender segregation. Mann and Diprete (2013) questioned if Science is the ultimate frontier for professional gender equality. Although countless dynamics are contributing factors to the under-representation of women in Science, in recent times, the role of gender segregation at the high extreme of the mathematical attainment

allotment has acknowledged much consideration (National Academy of Sciences, 2007). Xie, Fang and Shauman (2015) discovered that science professionals tremendously achieve 90th percentile or above in Mathematics in high school. Pope and Sydnoe (2010) confirm the disproportionately few females scoring at this level. Consequently, though both the achievement and participation gaps are being closed with the females surpassing males in college graduations, their unrelenting deficit in Mathematics attainment has considerable consequences.

Much of the issues confronting Mathematics Education in Ghana appear to be associated with attitude of people. This in turn can be related to how most people are very passionate about Mathematics . In most cases, both children and grown-ups discover Mathematics as aimless, boring and slightly curious compared to other. The significant effect of the negative sentiments towards Mathematics needles to talk about Mathematics anxiety, is considered to impede a person's confidence in their capacities and eventually in career choice (Lai, Zhu, Chen & Li, 2015). The teacher's role is profoundly significant, not necessarily as a result of high rate demonstrated in Mathematics anxiety among potential teachers, but the fact that there is the believe that teachers who have uncertain sentiments and negative encounters towards Mathematics have an extraordinary possibility of influencing the state of mind of their students. This implies that a modern era of negative sentiments and recognitions towards the subject of Mathematics has been created (Shamoon, 2014). Bearing in mind the generally constrained research about affective variables in teaching and learning Mathematics , most of the researches conducted considers or centres on measuring Mathematics anxiety primarily using quantitative methods. As a result, there's insufficient qualitative research which takes the emotional characteristic of Mathematics Education into serious consideration (Khankeh, Ranjbar, Khorasani-Zavareh, Zargham-Boroujeni, & Johansson, 2015).

Subsequently, this research will offer Mathematics facilitators and students the opportunity to share their untold stories and experiences from the beginning of their Mathematics journey. Students have the opportunity to share what they have been through and the effects it had on their studies, how they survived all the odds and made it to the level they are. Mentorship awareness could be created through the journey. Following Sheppard and Charles (2014), I argue that when

an individual shared their experiences with others, awareness about the relationship to the subject is made.

1.7.2 Practical significance

It is anticipated that the conceptual framework developed in this research provided an improved model for evaluating socio-cultural effects that Mathematics phobia has on the females in particular and the society as a whole. According to Fayowole (2015), Mathematics empowers students with an interestingly powerful set of tools to aid them in altering the world, these tools incorporate issue fathoming aptitudes, coherent thinking, and critical thinking skills. Mathematics is imperative in our daily lives in numerous forms of work, within the economy, in public decision making, the medical, the environment and in science and innovation. This research seek to address some of the myths associated with the gender gap in Science, Technology, Engineering and Mathematics (STEM) fields especially Mathematics education and performance.

Parents would be informed of the role the doll, computer games, toys, and other objects they buy for their kids play in the development of the spatial skills of the kids. The research may inform Mathematics teachers about the contribution of the teacher's strategies, classroom settings and teaching learning materials to the decline of Mathematics knowledge among girls. Future researchers and academics may rely on the findings that this research provides, and the recommendation(s) thereafter for further research or implementation of policies.

Globally and in Ghana in particular, several employments request technology and Mathematics , and comprehensive knowledge in Mathematics is needful to merit a prestigious position within the work force. Apart from being the fundamentals and basis for technological and science fields, mathematical knowledge is progressively imperative in business, humanities and social sciences.

1.8 DEFINITION OF CONCEPTS

Mathematics

The expression 'Mathematics' originates from the Greek term 'mathema'. It means the learning and or the study of science. It remains an interdisciplinary language, a tool considered as a rudiment in formal educational system (Roy, 2011). Yadav (2017) referred to Mathematics as the queen of science. Mathematics remains essential as far as knowledge acquisition in many other disciplines are concerned. Mathematics is the science of order, relation and structure. It evolves from fundamental practices of measuring, describing and counting the shapes and objects (John & Berggren, 2019). Mathematics is the language of all material science and pivot of all engineering programs. Mathematics is life, it is a critical filter of college selection and job placement.

General phobia

Phobia is a type of anxiety disorder, defined as the persistent fear of something or a situation. The individual tries every means possible to avoid it. The amount of fear is disproportional to the actual danger posed. If the object in question or situation cannot be entirely avoided, then the affected person would have to endure it with striking distress and considerable obstruction in collective or occupational activities (Bourne, 2011). Generalised Anxiety Disorder (GAD) is apprehension disorder distinguished by unjustifiable, uncontainable often-unreasonable fret; it is tentative probability about events or activities. This extreme fret often interferes with everyday performance. Persons with GAD naturally predict tragedy. These persons usually exhibit a multiplicity of substantial symptoms, including fatigue, fidgeting, headaches, nausea, numbness in hands and feet, tension in the muscle, and muscle aches. (Wikipedia, n.d). For the purpose of this study, phobia is defined as an extremely strong dislike or fear of something. This fear could be exaggerated, inexplicable and illogical.

Mathematics phobia

Mathematics phobia is referred to as aversion in Mathematics among individuals who deal with learning in psychological dimension (Olaniyan & Salman, 2015). Mathematics phobia, therefore, could be defined as unrelenting, unwarranted or irrational fear of Mathematics. Mathematics phobic persons are very uncomfortable with the mention of Mathematics. Phobia, as defined by Wikipedia, is a type of nervousness condition, typically relentless fright of an object in this case Mathematics or a situation. The affected person will do everything possible to avoid the said condition or situation. It is typically disproportional to the actual danger it poses. If the object or

situation is entirely non-avoidable, the affected person will endure it with marked distress and momentous interference in social and occupational activities (Wikipedia, n.d). Mathematics phobia, therefore, is the persistent fear of Mathematics. Mathematics phobia, exhibited by many people especially those in school, is the persistent, illogical, intense and sometimes unusual fear of not succeeding in Mathematics. It is the belief that one is unable to handle the issues associated with the learning of Mathematics. Many people incorrectly assume that Mathematics phobia is inherited from one's parents.

Mathematics anxiety

Mathematics anxiety has been defined as "the helplessness, panic, paralysis, and mental ineptitude arising among people whenever they are required to solve problems in mathematics". Many are alleged to be affected by a large proportion of the population (Marshall, Mann & Wilson, 2016). Anxiety is a wide-ranging term for many disorders that cause apprehension, panic, nervousness, and upset. These disorders affect behaviour, which is evidenced in actual and physical symptoms. Serene anxiety is indistinct and disturbing, while rigorous anxiety can be exceedingly devastating; it has a sober impact on daily life. Mathematics anxiety is apprehension about a person's ability to cope with Mathematics (MNT Editorial Team, 2017). Mathematics anxiety is a feeling of discomfort. It is a fear or worry which may be accompanied with physical symptoms such as rapid heartbeat and trembling when Mathematics is mentioned or one comes in contact with Mathematics.

Mathematical skills

The definitions of Mathematics differ extensively and diverse schools of thought, predominantly in philosophy, recommended a radically different and divisive account (Hill, Mammarella, Devine, Caviola, Passolumghi & Szucs, 2016). Mathematical skills in the context of this research are competencies in the inferential study of numbers, geometry and nonconcrete concepts or structures. It can be described as the selection and application of arithmetic operations to calculate solutions to mathematical problems.

1.9 CONCLUSION

Mathematics has held its leading position on the school curriculum due to the indispensable role it plays, thus it remains the central intellectual discipline of any technological society. Mathematics has been classified as a "critical filter" in the job market. However, a good number of researches in the quest for a relationship between gender and Mathematics learning have been conducted in various countries. From the abundance of literature, men outnumber women at undergraduate and graduate levels in several Western countries. There are literature reports on gender disparity in Mathematics performance which favour males as the better performers. And a critical look at the patterns in mathematical problem solving between genders is found to be correlated to cognitive abilities and psychological characteristics that are mediated by experience and education. Women's involvement in Mathematics has an adverse effects on future career and socioeconomic opportunities. Efforts to bridge gender differences in education in Ghana could be traced back to 1957 when the country gained independence. The government of Ghana played a key role in the achieving almost a balance between boys and girls from Basic through to High School. Recent affirmative action and sensitization campaigns have contributed to female enrolment, however, gender gaps still exit and are quite conspicuous in some communities.

Kitetu (2004) argued that the African perception of gender in classroom practices is mainly based on studies from the Western Europe and North America. Meanwhile transferring these conclusions which is grounded on Western cultural concepts, poses a problem in the African context. Mahlomaholo and Mathamela (2004) also report from South Africa the clear distinction between males and females at all levels of analysis. While Western studies promoter new standpoints in instructional practices which may result in change in classroom practice, lack of political will may make it difficult for the African to adopt and implement such recommendations completely. There is therefore, the urgent need for the African to find the courses and effects of this gender gap in Mathematics problem-solving and hence find a suitable solution.

The problem of this study is the disproportionate constitution of women in enrollment into Mathematics intensive field as they climb the social and academic ladder. The school, home, society and other societal factors contribute to the fall out of women as they climb the social and academic ladder. Hassi et.al. (2010) however explained the key impediment to the learning of

advance Technology and Science to be deficiency in Mathematics skills and this research sought to investigating societal factors that contribute to women falling out and not participating in the field of Mathematics in the Ghanaian context. Kitetu also argued that the African has not researched into gender and Mathematics learning. The Africa cannot adopt findings from studies curried out in the western context because of sociocultural differences. There is therefore the need to research into gender and Mathematics learning from the African perspective. It is anticipated that the conceptual framework developed in this research provided an improved model for evaluating socio-cultural effects that Mathematics phobia has on the females in particular and the society as a whole.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews scholarly work done in relation to Mathematics phobia. It explores debates and issues on Mathematics phobia and anxiety. The chapter also cross-examines various scholarly views on the relationship between Mathematics phobia and anxiety and other forms of anxiety. Mathematics skills, Mathematics and the teacher, Mathematics and the teaching learning resources will be interrogated in this study. The chapter also outlines Mathematics and gender, together with Mathematics and other factors.

Mathematics, apart from being an important subject with broad applicability to everyday life, is also considered as a filter to prestigious positions and employment (Sells cited in Mireku et. al., 2015). Fajemidagba, Salman and Ayinla (2012) describe Mathematics as a core science subject and tool for the development of any science-based discipline. Meanwhile it is often considered as a difficult subject in schools. This notion stays in the mind of students resulting in destitute performing hence the development of Mathematics phobia.

2.2 MATHEMATICS PHOBIA AND ANXIETY

Olaniyan and Salman (2015) define Mathematics phobia as weakness demonstrated by students in Mathematics that deal with the psychological aspect of learning. Suárez-Pellicioni, Núñez-Peña & Colomé, (2016) define phobia as learned passionate answers which causes recurrent intense and severe anxiety. Mathematics phobia could be defined as a feeling of anxiety that obstructs one from tackling mathematical problems efficiently (Nwoke & Ugwuegbulam 2016). Okigbo (2010) indicates that phobia is a scholarly illness with the virus yet to be fully diagnosed for effective cure in class with the warning sign of this phobia which are typically conveyed on the faces of Mathematics students in class. Dowker, Cheriton and Horton (2019) observed the construct in

relation to persona characteristics, undesirable attitudes towards Mathematics , Mathematics avoidance, poor Mathematics background, poor teaching behaviour, achievement levels, lack of confidence and negative experiences in school. Olaniyan and Salman (2015) point out that Mathematics phobia is regarded as the Mathematics weakness in students which deals with the psychological dimension of learning.

Mathematics anxiety is common among some grownups O'Leary et.al. (2017), including teachers and is influenced by the beliefs of people (Luttenberger et.al., 2018). Both have been described by O'Leary et.al (2017) as an irrational fear, and a rational phobia deep rooted in the actual knowledge and involvement with disappointment, inadequacy plus failure (O'Leary et.al., 2017). According to Cherkas accompanying demonstrative elements comprise 'anger', 'tension' guiltiness plus 'anxiety, hatred, apprehension, disorientation, panic, seizure, horror, absurdity, thwarting, and a distress thought of being seen as stupid' (Lovitt, 2011).

Mathematics phobia could impact and influence learners' mathematical achievement substantially through distressing memory which was described as the creation of uneasiness and helplessness in concentrating (Tobias, 1978 as cited in Ural, 2015). Cockcroft posits that individuals cultivate surviving and managing approaches for day to day life cycle which reflects even in studies and when this fails, the individuals avoid Mathematics whenever probable (Petronzi, 2016).

The first scholars who recognised Mathematics anxiety are Dreger and Aiken (1975) cited in (Dowker et. al. 2016). They identified the occurrence they named "number anxiety," autonomous of generalised apprehension, causing performance of students to be relatively lower in Mathematics than their counterparts who have the same capabilities. The Wechsler-Bellevue scales were used in the measurement (Dreger & Aiken, 1957: 345). Dreger and Aiken (1957:347) discovered that there was not a precise description of number apprehension. The "little factor analysis" was applied to an accessible apparent apprehension scale (ibid: 345). A declaration was made about the suffering of a participant of some amount of fear if responses from them in a survey is an experience of two or more of the following:

- fear any time they have to do calculation;

- “freezing up” any time they encounter a Mathematics situation or problem; and
- Entertaining the belief that one is deficient in Mathematics and not as good in it as in other subjects (ibid: 346).

Current scholars define Mathematics phobia as having different levels of symptoms. Sokolowski & Ansari (2017) defined Mathematics phobia and anxiety as a situation of distress that occurs in response to the state involving mathematical responsibilities that are alleged as threatening to self-esteem. It can be connected to further intense such reactions as paralysis and fright. Sokolowski & Ansari (2017) simply define Mathematics phobia by way of an illogical fear for Mathematics . Luttenberger et.al (2018) define the situation by testifying that Mathematics phobia engrosses emotional state of uneasiness which hamper the operation of figures and the assessment of mathematical difficulties in both academic situations and real life. A significant discrepancy among individuals with Mathematics phobia and those who merely “don’t like Mathematics ” is that the Mathematics -phobic individual is very likely to dodge courses, responsibilities and careers involving Mathematics or computation (Hughes, 2016). This results in gender segregation both in Mathematics participation, career selection and in academia taking into consideration the fact that Mathematics remains a precarious filter in job selection and attainment of high and prestigious positions both in the corporate world and in academia.

Certainly, the salience of familial manipulations in young children, Crosnoe, Purtell, Davis-Kean, Ansari & Benner (2016) explain how the disparities in family setting are. This explicitly implies that parental education not forgetting race, affect gender disparities. Gender gaps do not subsist or exist in a space, they are rather networked by other alliances of disparity such as class and race. Early research proves gender disparities in academic attainment differ significantly across race and SES at high school and post-secondary levels (Fortin, Oreopoulos & Phipps, 2015). A considerable or large body of studies verify the significance of class and race for near the beginning of academic attainment (Thomson, 2018). Consequently, more than the study of early gender attainment gaps and variation across these other axes of inequality should be taken into account. Jones (2009) also discovered that factors including race, socioeconomic status and gender contribute significantly to Mathematics anxiety among African American students. A sound mind they say is a sound body, poverty could deny an individual of a sound mind.

This “gender gap” is most visible where male students outscore female students by more than about 3-to-1 at extremely high levels of Mathematics ability and scientific reasoning (Wai et al., 2010). A lot has been said, written, and researched about the less or small number of women found in top positions in Science, Technology, Engineering, and Mathematics (ibid). While some researchers such as Gupta (2011) believe in the intrinsic differences between the sexes’ abilities when it comes to Mathematics achievement, organisations such as the American Association of University Women (AAUW), National Science Foundation (NSF), and National Alliance for Partnerships in Equity, consider many social and cultural factors. These are self-assessment, stereotypes and socialisation as underlying causes for this gender gap. However, in reality, there are real differences in girls enrolling in mathematics compared to boys in Mathematics achievement (Wai et al., 2010).

There exist biological disparities among male and female make up. Morgenroth & Ryan (2018). argue that investigations on hormones and biological variations state that both men and women encounter the world in a different way. This is purely founded on hormones (ibid). The researchers did not refute the impact and influence of culture, but purposefully stated that men and women appear and encounter the world in a different way. They explained the upbringing not to be the cause but experiences with a diverse feeling of touch including hearing with different auditory reaction and the puzzling out of problems with diverse cells in the brains.

Studies on brain lateralisation generally point to the fact that the female brain is structured to functions that are extra symmetrically permitting the incorporation of both the right and left brain works extra eagerly than that of the man. Current researches propose evidence, which is to be established that the female and male brains are likely to be organised and arranged differently as far as the two cerebral hemispheres which specialises more or less well interrelated in the male than the female. The ability of the two to shift in between using the two hemispheres is diverse. Numerous suggestions indicate the existence of disparities in the arrange of the brain, example, a thicker corpus callosum linking both right and left brain hemispheres in female (He, Duan, Karsch, & Miles, 2010).

Notwithstanding the Biological dissimilarities, roughly an era of compromise has existed to the point that there are not any gender disparities in the broad intellect (Blazar & Kraft, 2017)). Conclusions from the no gender disparities in intellect have, as a result, been reproduced many times on dissimilar consistency illustrations by varying trial series (Christov-Moore et.al. 2014). Gender disparities in Mathematics abilities ever provoked composite bio-psychological philosophies of inherent intellectual disparities amid men and women vanished as time goes on (Gasant, 2011). Nevertheless, the men are frequently detected at standard advanced achievement on several assessments of four-dimensional (special) capacity, and targeting mathematical logic. Conversely, women are regularly identified to have advanced averages with regards to assessments of retention, vocal skill, and movement synchronisation contained by the individual space (Heald, Van Hedger & Nusbaum, 2017). The scope of sex disparity in achievement or participation differs from country to country.

What is the rationale for Mathematics phobia and anxiety? Mathematics fretfulness has a contrary relationship with outcome in Mathematics and achievement, according to (Friel, 2014). However, it is a believed that a degree of cognitive anxiety such as worrying or apprehension may possibly stimulate the learner to endeavour and try harder. Performance is affected when this worry or apprehension becomes very strong (Friel, 2014, Harari, Vukovic, & Bailey, 2013). The assumption that non-performance in Mathematics is as a result of lack of Mathematics knowledge ought to be challenged. There could be other factors which need to be unearthed. Mathematics anxiety should be given due attention and techniques. Further, strategies for overcoming the anxiety should be considered in the Mathematics curriculum.

Harari et. al., (2013), emphasised on mathematical anxiety as being a global problem in the classrooms which threatens both performance and participation. A major consequence of Mathematics anxiety is its avoidance (Wei, 2010). Mathematics ' anxious students take fewer elective Mathematics classes and most often stay away from college majors and professional paths which depend entirely on either a skill in quantitative or Mathematics abilities (Wei, 2010). The evasion of Mathematics leads to a limitation in job selection, grinding down our country's reserve pedestal in Science and Technology (ibid). Recently in America, graduates enter a globally competitive job market where fierce competition and ability in the application of technology and

Mathematics remains crucial to success. While US accomplishment has raised transversely our nation, the US still lags behind our global competitors. As a nation it is important we work hard at Mathematics development for grades kindergarten through 12 (Klein, 2018).

The Mathematics requirement is a necessity for every high school in the Washington State. Soon, the State of Washington will be escalating that prerequisite. Starting with the 2013 graduating class, all the high school students need a pass in Algebra II in order to graduate. This will enable them to pass all segments of the WASL (Washington State Board of Education, 2008). Standardised tests such as WASL are attaining the procedures for learner success, teacher merit and the failure of the school. The scores may have far-reaching effects on budgets, closing down schools and on the teacher's pay if and only if proposals are accepted. This pressure is a lot for students and teachers to be subjected to. Students under pressure have their stress levels raised and have an increasing feeling of anxiety. This may have a pessimistic effect on scores in the Mathematics test (Friel, 2014). Mathematics anxiety is negatively correlated with Mathematics achievement, and if this issue is not properly dealt with or managed, it could have an awful effect in many areas of our educational system.

2.3 POTENTIAL ORIGINS OF MATHEMATICS ANXIETY AND PHOBIA

Mathematics phobia and anxiety have several origins (Sokolowski and Ansari, 2017).What influence has the home, society and the school on Mathematics phobia and anxiety?

2.3.1 The home

Parents who suffer from Mathematics anxiety and phobia could unintentionally transfer the anxiety and phobia to their kids. The sentiments uttered by an individual will, without a doubt, shape the other within parent-child connections in the standpoint of doing Mathematics (Xu et.al., 2018). For instance, children who are admonished for the inaccuracies they commit are likely to develop a phobia of taking risks and exploring new potential. This could result in the child hating Mathematics . Disappointment and dejection from parents are chiefly frightening, as a result of the importance positioned on the lofty progressive view of parents by their children (Cichy et. al.

2013) Although parents who give Mathematics a low status apply strain or force on children contributing to the improvement of Mathematics anxiety (Petronzi, 2016). Dowker, Sarkar & Looi (2016) also identified how parents contribute indirectly to Mathematics anxiety by providing excuses which motivate their children to discontinue when perturbed or disturbed as a result of troubles with a mathematical chore.

Responses such as, '*Don't worry, I have never been able to understand fractions*' or '*Never mind, Mathematics was always complex for me at school too*', from parents, can contribute significantly to the development of Mathematics phobia. High achievers are not susceptible to pressures from parents. The parents' over-bearing attitude, pressure for success and concern about the difficulty of Mathematics for their children may contribute to Mathematics anxiety even with the high achievers (Whyte et.al. 2012).

2.3.2 Society

Social factors, including mathematical myths, are likely to induce and reinforce Mathematics anxiety and phobia among students. An example is a parable which says boys perform better than girls in Mathematics. The myth that few people have a 'Mathematics mind' undermine positive self-efficacy beliefs among students most importantly girls. One could encounter a situation and easily conclude that it is 'cool' to hate Mathematics . People readily state with some amount of pride, '*I am no good at Mathematics ',* as nevertheless displaying a brooch of honour or elevating membership to the I Hate Mathematics 'Facebook' group. Mathematics, as a discipline is unique, and it is important for us to note that the embarrassment in Mathematics class is not often from failure. A study linking above 1000 undergraduate students in the United States asserts the analysis that Mathematics failure is socially acceptable and the unembarrassed participants related the absence of Mathematics skills to their efficiency in language skills (Acharya, 2016).

Societal factors of Mathematics phobia and anxiety, such as gender issues, cultural influences and societal beliefs are as relevant as the determinants of affective cognition in addressing Mathematics phobia and anxiety. The belief that the female is not as good at Mathematics as the male are prevalent in our culture (Brewster & Miller, 2020). Theis is well-communicated and implanted

into the female's self-beliefs and description. This results in a perpetual notion that the female is not as proficient at Mathematics as the male (Brewster & Miller, 2020). Numerous studies have rated the female's Mathematics ability lower than the males (Brewster & Miller, 2020; Devine, Forscher, Austin & Cox, 2012; Hembree, 1990; Wigfield & Meece, 1988). A situation like this may result in an increased rate of Mathematics phobia and anxiety amid females. Consequently, negative self-consciousness of the female about their Mathematics ability may subliminally pass on this message to their learners. It could as well generate situations which may lead to wasted opportunities for the learner in the learning of Mathematics due to perceived fear for Mathematics (Brewster & Miller, 2020). This societal influence could have extended and disturbing effect on the female, as she is engrossed in this cultural paradigm of the negative communication. She may not even think of taking a course which is STEM related. Those in teaching and are qualified to teach higher levels are often teaching at the primary and junior levels (Maloney, Rameriz, Gunderson, Levine & Beilock, 2015).

Cultural effects also contributes substantial to Mathematics phobia and anxiety the society. Foley, Herts, Borgonovi, Guerriero, Levine and Beiloc, (2017) affirm this using data from the Pisa 2012 database. Lee (2009) also discovered that although they have minimal Mathematics self-efficacy and Mathematics self-concept, students from Asian countries performed well in the 2003 PISA considering the Mathematics results of forty-one countries. The support on high value allocated to academic attainment in the Asian culture, may be a contributing factor to this conclusion (Brewster & Miller, 2020). This finding explains the complication of the effect of culture on Mathematics phobia, anxiety and attainment. It further substantiated the social dimensions of Mathematics phobia and anxiety.

To add to cultural influences and societal beliefs, gender also plays a critical role in social determinant of Mathematics phobia and anxiety. Studies have been conducted examining the differences between phobia and or anxiety, and gender, particularly trait anxiety. The trait anxiety is a steady personality propensity aimed at managing worries, phobia and anxiety in different situations (Dowkeretal, 2016). Studies show that the female has a higher trait anxiety which results in a more Mathematics anxiety than the male. This influences their vulnerability to mathematic phobia and anxiety greatly (Brewster & Miller, 2020; Chapman et al., 2007; Costa et al., 2001).

2.3.3 The school

Usually, young children especially, when starting school may have informal competence in numeracy. The foundation they receive from the very first day in school or classroom could promote and flourish Mathematics anxiety. Research by Jaggernauth et.al. (2010) suggests that the combination of parental and societal factors contribute significantly to Mathematics anxiety. This means Mathematics anxiety and phobia could emanate from teaching and the teachers themselves. Mathematics phobic teachers are likely to produce Mathematics anxious students. Mathematics lessons delivered by Mathematics phobic teachers are branded by an over-reliance on conventional instructional strategies including flashcards, worksheets and drills, passing on similar work for every learner without any gender consideration. They often instruct from the textbook; upholding and are so adamant to only one exact way of solving a problem. They also concentrate on essential skills rather than theories or concepts and entire class coaching (Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher, 2020). In spite of New Zealand's complete and systematic efforts to adjust primary Mathematics programmes, an extension of appendage of non-performance in Mathematics and conservative routine of learning Mathematics has been the practice within the schools as argued by Neill, Fisher and Dingle (2010).

Traditional instructions and culture of the classroom are likely to contribute to Mathematics anxiety and phobia. Classroom culture is the attitude, practices and customs that direct classroom interactions. A good Mathematics classroom is well organised, structured and gender sensitive. Rigid classrooms make no or little opportunity for debate or discussion. The needs of the girl child is not taken into consideration. Accurate classrooms centre on searching for the one right answer contributing some degree of support to echo on reasoning, emphasised timed tests and presume rapid answers (Trerise, 2011). Considering classrooms of this nature, both the overt and covert teacher is likely to have behaviours implicated in fostering students' Mathematics anxiety (Whyte & Anthony, 2012). These behaviours are unrealistic expectations of students, gender bias, deprived or meagre explanations, resentment, irritation or terrorisation. It could as well be embarrassing on the part of students especially the girl child, to be in front of peers for the wrong answer or if a theory or concept is not implicit, and, a tactless or hard-hearted attitude (Telzer et.al., 2018).

The surfacing of the National Standards in New Zealand encouraged teachers to incorporate variety of evaluation technique and practices which sustain and assist students' learning. However, research and literature indicate that the implementation of effective assessment for learning practices is difficult. Restricted turnout to and inquiring children's accepted wisdom implies assessment which is anticipated to be grounded on transcribed work. Regrettably, paper tests in particular form regular principal source for students' anxiety (Telzer et.al., 2018). Timed assessments and activities within competitive environments are additional assessment types which might contribute in a way to Mathematics anxiety. Non-performing students in these types of evaluation often left with the feeling of embarrassment and with the belief that the individuals cannot do Mathematics creating Mathematics anxiety and phobia in the individuals.

In the classroom, the strategies used 'dropped stitch' contribute to Mathematics anxiety and phobia. These stitches which are described as a breach of a learner's prior Mathematics learning, averts more complex concept in learning (Luttenberger et. al, 2018). The situation occurs when the students neglected, fails to see learning admittance to meticulous theory or concepts due to non-payment of fees, illness, or other personal reasons (Castagnaro, 2012)

Belief schemes could be transformed as Gardner (2010) identified numerous elements which assisted in the changing of thoughts. A factor of these associate to the operational constituent of the material or notion which is supposed to be learnt alluding to the mode and way an idea was taught. This might be tactically leveraged in the parent-child association (Adrienne, 2010). Children particularly girls, trust and are comfortable with caring parents. Any adult who tries to be caring steps into the shoes of the parents. Learning becomes easier when this trust is won. A caring teacher or adult is likely to make learning more palatable or even enjoyable. It is important for teachers to strategically foster this, in matters of instruction during the child's developmental stage, when they are more receptive to change and when parents or caring adults are still influential and involved in a hands on manner (Adrienne, 2010).

2.3.4 Other social issues

Other factors contribute significantly to Mathematics phobia and anxiety. In 1992, Mattel introduced the talking Barbie doll. One of the things this doll said was, “Math is hard!” This generated a heated debate on the stereotype that girls are incompetent in Mathematics . In studies conducted at the University of Michigan, women who tested equally on the SAT scores were given a set of difficult Mathematics problems to solve. When told that gender could not affect the scores, the performance was the same for both the women and men. Another group was given the same test but was not given the same instructions. The women scores were significantly lower than men. The study revealed that the performance of women was affected upon assuming their Mathematics skills were being evaluated. The study was repeated with White males. This time, the group was told that Asian-Americans were better at Mathematics . The group that was given this instruction did worse than the group that was not given the instructions. The conclusion is that the fear of confirming negative stereotypes can hinder performance (Van Mier et.al, 2019).

In 2001, actress Rosie O’Donnell started a debate over Mathematics when she stated in Newsweek magazine: “I think there’s no need to teach [Mathematics] now. After all we have computers. We don’t really need to know why $3x = \frac{2y}{4}$". Arguments such as these show a societal trend in discrediting Mathematics . The effects of these societal trends promote Mathematics phobia. One does not work very hard at it if Mathematics is less important. Research indicates that the opposite is true. Mireku et.al. (2015) reported in their study that societies that are mindful of the prominence of Mathematics and base their teaching of new generations on the intellectual and cognitive skills will be at the forefront in all fields in the future.

Cultural stereotyping was also identified by Gudyanga, Mandizvidza and Gudyanga (2016) as a blockage to female participation in Mathematics beyond secondary school level.

2.4 SYMPTOMS OF MATHEMATICS PHOBIA

Sufferers of Mathematics phobia and anxiety experience it in countless means ranging from nervous and uneasy emotion to trouble or difficulty with breathing while making efforts to perform mathematical tasks (Luttenberger et.al, 2018). They experience physiological and psychological

symptoms. Improved heart rate, sweaty, sticky damp hands, troubled stomach plus dizziness are all instances of the physiological indications (Leary, 2015). Feeling vulnerable, troubled, humiliated, and the inability to manage are instances of psychological indications (Leary, 2015). According to Sokolowski H & Ansari D (2017), the initial thing the individuals recollect on failure in Mathematics is it's feeling of sudden loss of self. Suffering from Mathematics phobia is as a result of lack of mathematical skills. The next chapter looks at Mathematics skills and its role in the gender segregation in Mathematics participation and performance.

Physically, a student with Mathematics phobia and anxiety may experience similar symptoms to ones with general phobia and anxiety. The major difference is the rate together with the environment where it occurs. Mavilidi, Ouwehand, Riley, Chandler and Paas (2020) gave the following as some of the signs to look for:

Excessive worrying: The behaviour of the individual changes whenever given mathematic test or exercise. The individual may appear unreasonably worried. This can be severe and disturbing, resulting in difficulty in concentrating on given task.

Rapid heartbeat: The human body or system responds with a 'flight or fight' system each time we get nervous. The system then sends a haste of energy hormones into the body which activates an intensification in heart beat and flow of blood.

Sweating: Sweat is amazingly common in phobia and anxiety. The body compassionate nervous system relay red flags to the human body alerting it about the likely overheating when in the panic mode. The body responds to this by producing additional sweat to stay cool.

Dry mouth: Anxiety decreases the drift of saliva in the mouth. It then becomes unclear and sticky. This can result in difficulty in chewing and swallowing.

Restlessness: Restlessness is also a common sign of phobia and anxiety. This is mostly found among children and teens. Nevertheless, only restlessness is not sufficient to establish a condition

of Mathematics phobia and anxiety. In a study of 128 children who were diagnosed with anxiety disorder, 74% of them reported restlessness as one of the main symptoms (Mavilidi et.al., 2020).

Mathematics phobia and anxiety could manifest with certain suggestive characters by which identification of children suffering from Mathematics phobia and anxiety are made. There are psychological, behavioural and physical suggestive characters. The psychological symptoms are associated with inability to concentrate in Mathematics class or lessons resulting in the feeling of helpless, disgrace or embarrassment and worrying. The Behavioural symptoms is associated with avoiding Mathematics class, not giving Mathematics homework the needed attention until the last moment coupled with irregular study of Mathematics (Darling-Hammond et.al., 2020). The physical symptoms are associated with increasing heartbeat, sweaty or moist hands, upset stomach and appears light headiness. Mathematics phobia and anxiety begins at diverse ages for different individual, for some people it could start as early as third or fourth grade (Luttenberger et.al., 2018). The problem of Mathematics phobia and anxiety usually occur in middle school (Sokolowski and Ansari, 2017). An individual who is Mathematics phobic or anxious could have a bad attitude towards Mathematics even before endeavouring the given problem or even before the problem is explained. Mathematics phobic and anxious individuals could be nervous and uncomfortable in Mathematics class. They may have difficulty attending a Mathematics class and when they manage to, they may have greater difficulty answering a teacher's question for the fear of getting it wrong. This experience is not same in other subject class (Leary, 2015). Mathematics phobic and anxious individuals may be embarrassed, frustrated, irritated and fearful whenever they hear Mathematics (Leary, 2015). Individuals who have negative attitude about Mathematics may expressed it with body language, facial expression and other indicators. It may severely hinders the individual's working memory (Leary, 2015). Mathematics phobic and anxious individual have difficulty solving a problem with long division hence they are unable to exclusively focus on doing the calculations, especially dealing and managing negative thought towards Mathematics .

2.5 MATHEMATICS ANXIETY AND ATTITUDES TOWARDS MATHEMATICS

Attitude towards Mathematics, even the very negative one, is not comparable to Mathematics phobia and or anxiety. Attitude is based on cognitive and motivational elements while phobia and anxiety are precisely emotional element. Nonetheless, the measure of attitude correlate closer to Mathematics phobia and anxiety. Researchers in the nineties, found a mean correlation of −0.73 with enjoyment of Mathematics and −0.82 with confidence in Mathematics among school pupils. The equivalent mean correlations among college students were a little lower than among basic school children. It was however very high at −0.47 among Mathematics phobia and or anxiety together with Mathematics enjoyment. It showed −0.65 between Mathematics phobia and or anxiety tougher with confidence in Mathematics (Dowker et.al., 2016).

Mathematics phobia and anxiety are mostly correlated with self-rating in relation to Mathematics. People who rate themselves low when it comes to Mathematics are likely Mathematics phobic or anxious individuals. Lots of research conducted indicated a negative association among self-concept in Mathematics and Mathematics phobia and anxiety (Goetz et al., 2010; Hoffman, 2010; Dowker et.al, 2016).

Majority of the studies were however correlational and not longitudinal. Hence finding or establishing the direction of the causation, say could anxiety result in lack of confidence in the individual's own mathematical capability, or could lack of confidence in an individual's mathematical capability him/her more phobic and or anxious? Ahmed et al. (2012) established from their longitudinal study of 495 seventh-grade pupils, after they have completed a self-report measures of anxiety together with self-concept three times in a school year. The modelling of structural equation advocated for the influence of each characteristics over time, however the consequence of self-concept on consequent phobia and anxiety were considerably massive as compare to the influence of phobia and anxiety on consequent self-concept. In considering the details of results, a considerable caution should be taken. This is because even though the study conducted is longitudinal in nature, it was done over a comparatively short time of one school year, diverse pattern may be identified amongst children. It however indicate association amid Mathematics phobia and anxiety together with Mathematics self-concept reciprocal with each influencing the other (Dowker, 2016).

Similarly, approaches to Mathematics encompass conceptualization of Mathematics . There is the possibility the conceptualization is relevant to Mathematics phobia and anxiety. To many people, Mathematics is regarded only as arithmetic taught in school without considering other cultural practices which involve numbers as Mathematics (Dowker, 2016). Interestingly, people may have difficulty recognizing the fact that mathematical capability encompasses several constituents and not a single unitary ability, (Dowker, 2016). This facilitate the risk of their assumption that once they could not do geometry or algebra or statistics etc. they are generally bad at Mathematics. This increase the risk of Mathematics phobia and anxiety. Consequences of the phobic and anxious conditions are Mathematics avoidance. This result in students choice of programs and careers in areas of knowledge that are not Mathematics related (Schleepen and Van Mier, 2016; Van Mier, Schleepen, & Van den Berg, 2019).

2.6 THE RELATIONSHIP BETWEEN MATHEMATICS PHOBIA AND ANXIETY AND OTHER FORMS OF ANXIETY

Mathematics phobia and anxiety relate closely to performance in Mathematics. It cannot be limited to mathematical problems only. Undoubtedly, before you presume Mathematics phobia and anxiety as entities on their own right, it is important to consider the association between other forms of phobia and anxiety especially test anxiety, general anxiety and Mathematics anxiety. Recommendations from several studies indicate a close relationship between Mathematics phobia and anxiety. The other measures of anxiety mostly test anxiety measure, academic ability, and performance (Dowker, Sarkar & Looi, 2016). Studies of this nature exhibit correlations of 0.3 and 0.5 between the measure of Mathematics anxiety and test anxiety.

There is an identified correlation between Mathematics phobia and anxiety and measures of general anxiety. This could possibly serve as a background variable, which can greatly explain the correlation between Mathematics phobia and anxiety and test anxiety. For example Shishigu (2018) discovered a mean correlation of 0.35 between the MARS and a degree of general anxiety. In a study of behavioural genetic, Wang et al. (2014) established evidence indicating that genetically based variations in general anxiety contribute to genetic variation in Mathematics phobia and anxiety (Dowker et. al., 2016).

Nonetheless, Mathematics phobia and anxiety cannot be lessen to either general anxiety or test anxiety. Diverse measures of Mathematics phobia and anxiety highly correlate with one another (0.5 – 0.8) more than with general anxiety or test anxiety (Ashcraft and Ridley, 2005).

Individuals may exhibit performance anxiety not necessarily in participating in an examination and test but also during lesson delivery in school. Mathematics is more often than not assumed to evoke more grounded passionate responses, and particularly anxiety, than any other subject, this assumption however needs further investigations (Punaro and Reeve, 2012). In spite of the fact that individuals generally assume the existence of intense phobia, anxiety and other negative attitudes toward Mathematics than the other subjects, there have not been adequate studies comparing directly if there is any difference in attitudes to Mathematics and other subjects (Dowker, Sarkar & Looi, 2016).

Certainly there exist phobia and anxiety toward other subjects particularly when performance in those subjects are not as expected. Individuals with dyslexia have been found to show anxiety with literacy (Carroll et al., 2005; Carroll and Iles, 2006). It is eminent, that the learning and use of foreign language, particularly by grown-ups, is regularly repressed by anxiety (Wu and Lin, 2014). Students of Music including renowned musicians frequently illustrate music performance anxiety (Kenny, 2011).

Drawing also elicit anxiety in performance and inadequate confidence result in reduction in interest as the individual ages. This finding is parallel as compare to the that of Mathematics (Dowker, Sarkar & Looi, 2016). Many enjoy drawing during childhood as they often do it spontaneously. Most authors report of the seeming decline in drawing among many children before entering into second cycle institutions. The amazing part is when some teenagers and adults continuously say they “cannot draw,” though they have drawn severally in the past (Burkitt et al., 2010).

Punaro and Reeve (2012) in a study that specifically associated literacy, Mathematics phobia and anxiety in Australian among 9 – year - old pupils associated anxiety to their real academic capacities. In spite of the fact that, children express difficulty in both literacy and numeracy, the

stresses are without a doubt more prominent in numeracy than literacy. In addition, phobia and anxiety in Mathematics was related to real performance in Mathematics , while literacy anxiety was not related to real performance in literacy. Dowker, Sarkar & Looi (2016) proposed that in spite of the fact that Mathematics isn't the only subject that inspires and or stimulates anxiety, undoubtedly anxiety may be extremely severe and may possibly affect performance in Mathematics than other subjects

2.7 MATHEMATICS SKILLS

Mathematical skills refers to knowing mathematical concept and applying it in the proper and appropriate manner. A Mathematics skilled person is expected to have knowledge of the various problems that may arise when dealing with mathematical operation. Lack of mathematical skills is frequently acknowledged Haylock, which is often transferred to pupils from parentages. Philosophies prominent in Mathematical apprehension take account of 'the mathematical cognizance' which is desirable as alleged indicating that the right or left brain is dominant (Filippatou, 2016). Rakes (2015) said being good in the arts implies an individual can't be mathematically skilful. For an individual to be analytical and constructive, s(he) must identify and adhere to the existence of the set of wrong or right approach or manner in solving Mathematical problems with meticulous solution (Das & Das, 2013).

Mathematics , perceived as non-concrete in nature might be a contributing factor to its phobia (Mutodi & Ngirande, 2014). It is believed that the use of guidelines should be done skilfully in a manner, that will make recall easier when in need, of preceding understanding of Mathematics skills. This will help eradicate deficiency in originality in attainment of responses and solutions (Mutodi & Ngirande, 2014). Learners' understanding of Mathematics concepts can be affected through the teaching of Mathematics skills deprived of an exploratory, unrestricted tactic (Flevares & Schiff, 2014). Portraying Mathematics as combining formula and practice, will result in learners believe in involving and going by given rules to arrive at the correct answer or solutions. Such approaches by rote learning could result in Mathematics apprehension (Mutodi & Ngirande, 2014).

The rules in Mathematics if derived with students, become part of them. That way, they know how the rules came into existence reducing the abstract nature by making it more practical. Mathematics is not merely putting of procedures into practice (Bueno & Agustin, 2019). It begins with the establishment of the procedure, putting it into practice and applying it. Often teachers of Mathematics are silent on the application aspect of topics they teach. This isolates Mathematics from life.

Most women hold onto the perceived assumption that Mathematics is a subject which is difficult, has no relevance to their career ambitions and hence remains a domain for the male (Gudyanga, Mandizvidza and Gudyanga, 2016).

2.8 MATHEMATICS AND THE TEACHER

Additional concern recognised is the perception of 'being discovered' by somebody who may probably be superior and may be hypercritical. Hence instructors are perceived to be correct always while students on the other hand accept responsibility for none acquisition of skills (Darling-Hammond et.al, 2020). Stoehr, (2017) define aggression, intolerance and inconsiderateness among Mathematics instructors and teachers as contributing to Mathematics apprehension. Not every Mathematics teacher is hostile, some may be hostile and this could be attributed to the lack of both content and pedagogical skills. Like the saying "the best form of defence is to attack". Such teachers do not make the school and classroom safe for the students especially the girl-child.

In finding solution to Mathematics phobia and its related problems and enhance Mathematics self-efficacy, various researchers considered teachers' attitude about Mathematics as having great impact on strategies and methods of teaching (Blazar & Kraft, 2017; Mensah & Okyere 2019; Estrada & Batanero, 2020). Mathematics phobic and apprehensive teachers negatively impact on their learners through the transfer of their apprehensions and phobia. The ripple effect of the transfer of the phobia and anxiety is the low Mathematics attainment. Instructors seem to have the supreme inspiration in whichever way above learners' mind-set in Mathematics (Serdyukov, 2017). Other researcher's reports indicate that Mathematics anxious teachers react by shunning Mathematics entirely. In a classroom observation, Dowker, Sarkar & Looi, (2016) explained that

those with higher anxiety consider fewer or avoid, where possible, Mathematics lessons. They teach non-Mathematics content as often as they can. These researchers caution the harmful effects the anxiety in particular, of the teacher can have on learner's mathematical skills improvement, particularly at the basic school. Suárez-Pellicioni, Núñez-Peña, & Colomé, (2016) establish that the uppermost level of phobia and anxiety occurs at the basic schools where learners encounter Mathematics phobic instructor in the teaching and learning processes. One intervention recommended in a summary by researchers seek to assist Mathematics phobic and anxious teacher, particularly those teaching at the basic. This may help thwart students efforts in developing Mathematics anxiety and phobia.

Elementary school teachers are reported to have a higher Mathematics phobia and anxiety demonstrated in their day to day activities in the classroom which hinders student learning of Mathematics (Ramirez, Hooper, Kersting, Ferguson & Yeager, 2018). What is not too clear is how exactly teachers' Mathematics phobia and anxiety affect the learning of Mathematics by students especially the female student

Geist (2010), a prominent proponent of new pedagogy which takes the way of thinking of the student into consideration recognizes that parental education together with gender issues could play a key role in Mathematics phobia and anxiety condition. He however stressed the important role played by the teachers in building conducive teaching and learning environment together with the setting of achievable goals for their learners. Extraordinary risk tests which promote or place value on rote learning and memorisation are the major sources of Mathematics phobia and anxiety (Mutodi & Ngirande, 2014). Contrary to this view, Lyons (2012) recounted that phobia and anxiety are actually flimsy obstacle in knowledge acquisition. Question therefore is why do phobia and anxiety appear as having a crippling consequence on certain individuals' mathematical abilities? This unbiased clarification was given to explain why people avoid Mathematics and its-related subjects. Anxiety and phobia are generally known to have influence in a student's resolutions on classes to choose which often lead to avoidance of Mathematics (Maloney, 2012).

A study was conducted on what could possibly influence the female decision to study Mathematics at the college level in Swaziland. Yarkwah (2020) reported on how less likely teachers were in

making efforts to encourage the girl child to take up a course in science and or Mathematics . Interestingly, teachers in single sex schools where the girls put up good performances in Mathematics are less likely to encourage and bust the confidence of these young girls to study Mathematics beyond college.

Setting irrelevant goals which may not match learners' requirements could result in apprehension (Luttenberger et.al., 2018). Mathematics when learnt or taught with haste is perceived as undesirable with the sole aim of making students pass their examination with little effort to attain precision and displaying immaculate work (Zhou & Brown, 2015). By this, exposing one to varying instructional strategies that rely on behaviourist structure such as manipulation of symbols and the rote-memorisation of rules with little or no understanding instead of an integrated conceptual structure, can result in affective stumbling blocks of students (Zhou & Brown, 2015). The speed of the teacher during the instruction period is not the issue, the main problem remains the concept development and procedures. One could speed at any rate if clear procedures in concept development are established. Hence, emphasis is on clear procedural concept development.

Learners who are told by instructors the extent to which Mathematics is difficult and not doable believe in that. It is worth noting that it takes just a teacher to construct permanent Mathematics apprehension in students (Rogers & Wesley, 2017). Mathematics teachers in Ghana, in particular, until the introduction of the new curriculum for both Colleges of Education and Basic level, were not paying attention to applying topics taught to everyday life rather, all attention was focused on theory and solving of questions with the sole aim of getting students to pass their examination. The researcher was never told the essence of any Mathematics topic all throughout her education and so far, she has done little of that herself as a Mathematics teacher. If the students are made aware of the importance of the various topics to their lives and how the topics are applied in their daily lives, curiosity may be created among the students leading to exploration, investigation and analysis, in and outside the classroom.

Dowker et.al (2016) established the effect Mathematics phobia could have on preventing teachers from learning the needed essential Mathematics skills in order to deliver effectively as

Mathematics teachers. Blazar & Kraft (2017) explained that passing on of negative attitude from teachers to their students is likely to also affect their delivery in the classroom. Some people presume Mathematics to be easy at the basic level hence their decision to teach the younger children Mathematics Rogers & Wesley (2017). There is the need for mathematical understanding to facilitate the effective teaching of Mathematics . Hughes (2016) posited self-belief and self-confidence as a key instrument in Mathematics ability. Mathematics skills is obligatory together with willpower to curb the phobia.

Gender stereotyping, pedagogical incompetence and lack of relevant teaching-learning materials are possible factors that could hinder the teacher's delivery in class. Lack of confidence on the parts of both the teacher and students could also generate Mathematics anxiety (O'Leary, Fitzpatrick, & Hallett, 2017). The girls who look up to their female Mathematics teacher as a role model are limited if the role models are not up to the task (Olsson & Martiny, 2018). The girls are likely to believe it is normal for a woman to have a problem with Mathematics if the role model finds difficulties in impacting Mathematics knowledge. The Cognitive Social Learning Theory is a psychological theory that further supports the gender stratification hypothesis as a Cognitive Social Learning Theory. Young females are attentive at the behaviour of older females taking into account their conduct of everyday life (Sharma, 2016). Given that the girls observe the females failure to choose jobs which are in line with being an engineer or a mathematician or a scientist they may perceived these vocations unattainable for females (Rogers & Wesley, 2017).

Teachers' approaches towards Mathematics actually impact on students' Mathematics attainment. Adeyemi (2015) established that extraordinary Mathematics apprehension on the part of female basic school teachers had a significant negative effect on their female learners specifically. The over 90% of American basic school instructors being female (Beilock, Gunderson, Ramirez & Levine, 2010), poses a substantial difficulty for girls' Mathematics attainment in school. Fortunately, the Mathematics apprehensions and phobia of the teacher originate from stereotyping and perceptions including being made known that girls are not mathematically able and the corroboration that life isn't all about Mathematics.

Ato Kwamina and Offoe (2015) reported on findings of a study which suggested that teacher of Mathematics should adopt suitable instructional strategies to make their classrooms interactive. Teachers are to use multiple embodiments to promote mathematical reasoning and exploration. The another assertion made are the regular but appropriate use of supplementary programmes, technology (multimedia) and enriched and varying activities which could extend Mathematics beyond the classroom.

Another explanation to the performance gap in Mathematics is the innate biases in school-based assessment (Ato Kwamina & Offoe, 2015). This unfairness may be as a result of incompetence on the part of the teachers during assessment (Ato Kwamina & Offoe, 2015). A very important constituent when it comes to effective instructional delivery is adopting effective mode of assessment. Effective and fair assessment provide a reflection of learners' performance (Ato Kwamina & Offoe, 2015). Teachers, more often than not, tend to stereotype Mathematics as a male domain. In particular, they overrate boys' ability relative to that of the girls' (Sarouphim & Chartouny, 2017). They also established that most Mathematics homework or assignment given to students in Ghanaian high schools are not challenging enough to propel the mathematical reasoning among learner. The homework focuses and generate recalling of facts and principles learnt.

2.9 MATHEMATICS AND TEACHING LEARNING RESOURCES

Teaching learning resources have had many description in many ways by different educators, scholars, authors and planers of curriculum. Teaching learning resources refers to any object or material used to aid learning by making the learning environment facilitates or complements understanding (Zyl & Blaauw, 2012).

Though a considerable number of teaching traditionally depend on the learners' seeing and hearing, current trends place emphasize on the use of all the senses. Thus hearing, smelling and seeing, touching and tasting. Anini (2011) reported that teaching and learning materials employed in a learning environment should provide the learners the opportunity to acquire knowledge

through a majority if not all of the five senses. Teaching learning resources attract the learners attention and draw the learner into what is being taught (Ayoti & Poipoi, 2013).

Learners who are taught and learn with the aid of concrete manipulative materials from early elementary level through college perform better in Mathematics than those who are taught without it (Burns & Hamm, 2011). When real objects are used by learners in their everyday activities, they help learners a great deal in abstracting mathematical concepts and relating it to the real world (Adipo, 2015). Hunt, Nipper and Nash (2011) in their study "Virtual Vs Concrete Manipulative In Math Teacher Education" identified several seeming benefits associated with the use of concrete manipulative materials. These benefits comprised viewing information on mathematic visually and kinaesthetically. By this, you sequentially present mathematical concepts as you keenly involve learners in the Mathematics lesson (Hunt et. al, 2011). The gap between formal and informal Mathematics is bridged by good manipulative (Boggan, Harper & Whitmire, 2010).

Adipo (2015) reported on numerous studies which indicated that Mathematics achievement usually increases with the good use of manipulative materials. Teaching learning resources give learners the opportunity to have a first-hand observation experience. It also facilitates learning by exploration with the aid of the concrete materials (Adipo, 2015). Instructors and facilitators are expected to have adequate knowledge on how, why and when to use manipulative materials efficiently in a learning environment. Learners who are exposed to manipulative materials in Mathematics lessons outperform students who are not (Adipo, 2015).

Bušljeta (2013) reported that school become friendly if the environment is conducive and interactive. Teaching learning resources (TLR) were identified as a tool that promotes enthusiasm in the teaching and learning process. The report revealed further that TLR assisted both learners and teachers to discover themselves. The report postulated that TLR promotes child-centered method of learning and teaching through the participation of the learner.

A research conducted by Mischo and Maab (2013) established in Germany, that teaching learning resources have significant influence on Mathematics teaching and learning. Additionally, the study discovered that teaching learning resources help improve learners' performance in Mathematics

by 85.3%. A study by Iji, Ogbole and Uka (2013) reported from Nigeria that the use of improved and enhanced teaching learning resources improved the mean achievement scores of learners in geometry. This was made possible by the improvised teaching learning resources. It generated keenness and enlivening learning.

In their study 'Teaching Learning Resources and Academic Performance in Mathematics in Secondary Schools in Bondo District of Kenya', Yara & Omondi (2010) examination of the results of the study revealed that stationeries as teaching aids and classroom laboratories are important in the teaching and learning of Mathematics. These teaching learning aids include class rooms, teaching aids(chalk, board, ruler and protractor), stationeries, textbooks and laboratories affect academic performance of the learners (Yara & Omondi, 2010).

Karl (2017) gathered from his researched that information available strongly suggests a promotion of advanced engagement and motivation in students with game-based learning than when game-based learning is not used. This higher level of engagement with the Mathematics skill practice then led to higher academic skills achievement (Karl, 2017).

In concluding their study, Zwart et.al. (2017) stated that Digital Learning Material (DLM) could nurture constructive knowledge construction and learning outcomes (e.g. Noroozi, Busstra et al., 2012). DLM atmosphere has items such as online guidance, instructional clips, a collaboration tool and structuring of content. These resources supported learners to improve their Mathematics attainment significantly (Zwart et.al., 2017). They discovered that implementing the DLM enriched learners' domain-specific Mathematics skills for both proportion and numbers.

2.10 MATHEMATICS AND GENDER

2.10.1 Historical brief note

The people who lived in the eighteenth and nineteenth centuries made their contributions to Mathematics education, notably among them are Emilie du Châtelet (1706–1749), Maria Agnesi (1718–1799), Sophie Germain (1776–1830), Mary Somerville (1780–1872), and Ada Lovelace

(1815–1852) (Leder, 2019). See also Lewis 2017; Osen 1974. There was universal thread which manifested in interpreting their lives, however the focus and quality of their mathematical undertakings varied. A well-founded willpower to pursue Mathematics against all odds, atmosphere or surrounding that lauded education, plus a productive assistance aimed at their work from a an important and loyal friend or relative. Mary Somerville for instance, has a background where the education of male child was more essential as compare to the girl child. Given her condition, a significant guide made a huge difference. Premature widowhood presented Somerville the financial security which enabled her pursue mathematical studies. Consequently a second husband who was very supportive assisted her to nature her mathematical interests more rigorously (Leder, 2019).

Additional past but extra mundane instances of females' successful participation in mathematical pursuits could be gathered from an English publication which is the Women's Almanack or Ladies' Diary which was launched in 1704. After three years, the editor started including questions in mathematical contents. The approach continued till the last edition was issued in 1840 at the point where the Ladies' Diary and the Gentleman's Diary mentioned above merged (Leder, 2019).

The choice of succeeding editors to remunerate these early and well-designed results through the bringing together the successive year's diary together with the cataloguing of names of all the people who offered questions together with answers was remarkable (Leder, 2019). Till date one can confirm and trace the numerous mathematical contributions made by women to the Diary. A reflection on these amazing history the publications, Perl (1979) cited in Leder (2019) contended that the coming into being of the Ladies' Diary is an indication that stereotyping the inability of the female to participate, comprehend and appreciate Mathematics gained little believed during the 18th century as against recent times. An inference could be made through a critical examination of the work of Leybourn (1817) together with other sources. Inference from these studies indicate that most of the women who contributed to the mathematical aspect of the Ladies Diary' were mainly the daughters, wives or other close relations of men who were engaged in mathematical pursuits (Leder, 2019). It appeared decades ago that given a suitable environment together with the needed academic and personal upkeep, women were willing and were proficient to engage in mathematical pursuits.

Community interests together with research in gender disparities in participation and achievement in Mathematics broadened in the 1970s. The acknowledgement of crucial role played by Mathematics in education together with career opportunities propel stake holders, practitioners, researchers and policy makers to have greater interest in Mathematics development and its related issues (Leder, 2019). Fennema together with her colleagues seminal research in the 1970s could be well-thought-out as a significant promoter of the conduct of effective and scholarly research into gender issues in Mathematics development. Proof of the enduring together with the broad effect of their work could be deduced from numerous citations (Leder, 2019). Among the numerous citations are Walberg and Haertel's (1992) deducing that Fennema and Sherman (1977) publication was the most cited article in Social Sciences Citation Index for the period 1966–1988 (Leder, 2019). In September 2014, there was a report in the Journal for Research in Mathematics Education (JRME) that Fennema and Sherman's (1976) publication is the most regularly accessed article for the past three years. Going a further broad term, Lubienski and Bowen (2000) cited in Leder (2019) scrutinised forty eight major educational research journals accessible on the ERIC data base, which were published from 1982 and 1998. They discovered that for the equality group used in categorizing content of important articles, the topic gender and Mathematics had the most attention.

Hyde, Lindberg, Linn, Ellis and Williams (2008) identified the existence of a measurable differences as both the male and female progress into solving complex problems in Mathematics from high school with ($d = +0.29$ in favour of boys). This could be a predictor of the female underrepresentation in Mathematics STEM careers.

Lots of nationwide investigations conducted in the United State Armstrong (1981); Ethington and Wolfe (1984); Fennema and Sherman (1978); Levine & Ornstein (1983); Fennema and Sherman (1978); Ato Kwamina & Offoe (2015) concluded in general terms that gender disparities emerged along the academic ladder as the students advance into a higher mathematical course work in secondary schools and colleges. Attempts to explain the disparities resulted in the creation of two camps. Ato Kwamina and Offoe (2015) reported on the findings form 1980, 1983. The findings argued and explained a reflection of inherently rooted gender disparity in mathematical

capability. Other argued on the other, that the gap is a reflection of gender-role socialization, in which the male, more often than the female, is expected and encouraged to take up courses in Mathematics and the sciences (Eccles, 1987; Fennema & Sherman,1978; Meece, Eccles, Kaczala, Goff, & Futterman, 1982; Ato Kwamina & Offoe, 2015). The accumulative effects of the differences in socialization mostly are obvious in the presumed difficult materials.

Issahaq (2018) made this conclusions from his study "Gender and Mathematics achievement of students in Bimbilla College of Education Ghana". The study established the existence of gender differences in Mathematics performance. Students' performance in college Mathematics was evidently dependent on their gender. This confirms the global evidence in the Ghanaian context specifically Bimbilla College of Education.

Evaluations of studies conducted and published on Mathematics and gender during the first part of the 1990s, examples include Leder 1992, Fennema and Hart 1994, to mention but a few showed the existence of trends in performance difference in Mathematics between man and women which were reported two decades ago. The potential justifications for the continues existing of these conclusions have same composition as early studies. That is, environmental variables, comprising teacher, peer group, school and parent-related variables together with the impact on the wider society.

Different theoretical models were besought to support Mathematics and gender focussed investigations through the 1990s. The collaborations between gender, learner-related, and contextual variables such as cultural, socio-economic status and ethnic affiliations, continued to be explored, not only using the more traditional quantitative approaches but increasingly drawing on alternate methodologies that foregrounded social constructivist perspectives (Leder, 2019).

2.10.2 Contemporary times (21st century)

Themes together with directions that were tracked in the erstwhile decades dominated in most of the twenty first century research. Gender is usually added to the variables when exploring their impact on the learning of Mathematics without frequently excluding the other moderators. Morgan

(2014) noted that many are desiring to go beyond focusing on outcome from conventional education within the field of Mathematics education with their indicators of achievement or otherwise as social recognition, seeing identity together with participation is as important as scopes of social justice.

A large body of literature reports the under-representation of women in the Sciences, including Technology, Mathematics and Engineering: STEM (Catherine, 2017). Countless theories and concepts advance to explain this under-representation to include social and biological factors (Catherine, 2017). Catherine (2017) argue that self-confidence and efficacy are the main factors that could keep the women in STEM programmes and careers by stating that women pertinently competent in Mathematics often refuse to pursue a Mathematics -related profession as a result of low self-efficacy discernment perceived about their competence.

Casey, Nuttal and Pezaris, (2001); Odogwu and Lawal, (2018) also investigated the female participation in Mathematics on the African continent (Yarkwah, 2020). The female lack or low confidence in Mathematics participation at higher level affects Mathematics development in general. In their investigations into the representation of female Mathematics teachers, their career progression and interests in Mathematics education in Nigeria, Odogwu and Lawal (2018) affirmed the lack or low confidence of the female in dealing with Mathematics issues. The 187 Mathematics teachers sampled consisted of 105 male and 82 females. Their findings established that 68.4% of the women teaching Mathematics earned a degree from Mathematics education and its related courses. A greater number of this percentage (51.7%) out of the population teaching Mathematics were teaching at Junior Secondary School level whereas 35.2% women were found teaching Mathematics at the Senior Secondary School level. Evidence from the statistics is a clear indication that female teachers teaching Mathematics in Nigeria who are qualified to teach at the Junior and Senior High levels are mainly at the basic levels of education (Odogwu & Lawal, 2018).

Women involvement in highly prestigious occupations particularly in technology and “tough” science areas, have remained truncated irrespective of efforts that has been made by numerous worried countries. This low-representation of the females is focused mainly on the areas of

Technology, Mathematics, Engineering and Physics (Christie, O'Neill, Rutter, Young & Medland, 2017). The focal impediment to the acquisition of high-level Scientific and Technological knowledge has been the absence or inadequate Mathematics knowledge (Hassi et al., 2010).

Despite the efforts being made, Damarin (2008) argues that the volume of investigation, enquiry and studies conducted on this topic has considerably diminished in recent years. This is partly due to people perception that Mathematics phobia and its related problems are "solved." Big question then is, is Ghana as a nation strategically making efforts to curtail the menace or we are relying on the past findings of early researchers? This research believes in our reliance on earlier studies and there is, therefore, the need for more research to be conducted about the problem especially in Africa.

The unrelenting smaller number of women in the science-related courses is worth mentioning because the end results are the lack of a competent workforce in the science-related occupations. Its principal product is a salient example of professional gender segregation. Mann and Diprete (2013) question if Science is the ultimate frontier for professional gender equality. Although countless dynamics are contributing factors to the under-representation of women in Science, in recent times, the role of gender segregation at the high extreme of the mathematical attainment allotment has acknowledged much consideration (Summers, 2005; National Academy of Sciences, 2007). Che, Wiegert and Threlkeld (2012) made a discovery that science professionals tremendously achieve 90^{th} percentile or above in Mathematics in high school. Pope and Sydnoe (2010) confirm the disproportionately few females scoring at this level. Consequently, though both the achievement and participation gaps are being closed with the females surpassing males in college graduations, their unrelenting deficit in Mathematics attainment has considerable consequences.

It might be that efforts are being made, Damarin (2008) argues that the amount of research on this topic has significantly decreased in recent years and this is partly due to the perception that the problem of Mathematics phobia and it related issues among female students have been "solved" which does not give comfort to the African researchers. This is because in Ghana and majority of Africa countries, studies conducted on gender and Mathematics is a recent phenomenon. This is

partly because, until recently, most African societies did not view gender as an issue of concern due to their patriarchal social structures. Any research on gender differences in Mathematics education in Ghana or elsewhere in Africa need to be contextualised in order to capture the realities of the African social structure. "The African perceptive of gender in classroom practices is mainly rooted in studies conducted in North America and Western Europe. This researcher argues that there is a cultural angle in studies of social practices (Kitetu, 2004: 6-7). Applying Western cultural research scales on African studies without thorough contextual analyses of such scales may produce misleading results.

2.11 MATHEMATICS AND OTHER FACTORS

2.11.1 Socioeconomic variables

Socioeconomic variables have been observed to be an important aspect of the formation of spatial skills which create gender difference in children. Playing with materials which are spatially related foster and promote the development of spatial skills. Meanwhile socioeconomic factors could have effect on children's chances to be occupied with such activities which may promote the formation of their spatial skills (Liu & White, 2017). These activities however, have been considered generally as extra suitable for adolescent boys by our beliefs (Endendijk, 2015). Greater access therefore, to man sex-type playing objects might be elements in explaining boys' better visual-spatial skills.

Boe and Woods (2018) stated that the mother's professional status has an important influence on children's acquisition of visual-spatial skills through persuading the accessibility man sex-type toys. Kotsopoulos and Papaioannou (2017), in their study, reported that the socioeconomic status (SES) modified the gender differences in spatial skills. The male child in high and middle SES range perform better than girls when it is spatially oriented activities within the groups. These parents within the high and middle SES buy lots of toys and objects for their kids. The toys and game that calls for explorations, hunting, arranging logically etc. facilitates the formation of

special skills which is an essential skill in Mathematics knowledge acquisition. Interestingly, sex disparity did not exist in the low SES group on spatially oriented chores.

Biddle and Seth-Purdie (2013) identified three somatic dynamics and classified them as major dangerous elements for low cognitive achievement. These are substance or drug abuse (predominantly prenatal publicity), malnutrition, and lead exposure. A suggestion from the Centre on Hunger, Poverty and Nutrition Policy (1998) cited in Tette, Sifah and Nartey (2015) indicated that minor to moderate protein-energy or malnutrition possibly have slight influence on performance. Iron-deficiency anaemia troubles almost a quarter of the low-income kids living in the US (Roganović & Starinac, 2018). This deficiency related issues are known to thwart brain formation if it is severe. The function of nutrition in SES differs in brain formulation and is its resolution is challenging because nourishing status is intensely associated with a multitude of other kinfolk and environmentally friendly variables expected to influence on neuro-cognitive formation, which include all of the prospective causation mechanisms reviewed here (Goyal, Venkatesh, Milbrandt, Gordon & Raichle, 2015). Though the programme supplementing nutrition might in be principle used as a tentative manipulation of nourishing status only, in reality, the programmes, often, are combined with smoother non-nutritional systems of supplementation or touch kids' lives in non-nutritional manner that perpetuate the misperceive just like kids are barely absent or late to school after receiving breakfast from school (Goyal et.al., 2015). The programme by this is looking at a healthy child in a healthy mind for studies, and coming to school early which are key players in the teaching and learning of Mathematics . Over the past few decades, the agreement concerning the issue of nutrition in cognitive consequences of underprivileged kids shifted from principal basis to an aspect contributing indirectly through synergies through new eco-friendly shortcomings (Dominguez-Salas, Kauffmann, Breyne, 2019)

Lead which is a neurotoxin generated by flaking paint, mainly accrued in the bodies of low-SES kids likely living in deprived and unmaintained homes. Indications from meta-analysis of low-level lead exposure on IQ estimated 10 ugs/dL intensification in the lead is related to a 2.6 point decline in IQ (Pietschnig & Voracek, 2015). This low IQ has effect in Mathematics knowledge acquisition. Like nutrition, the consequence of lead synergises with additional ecological influences are extra noticeable in low-SES kids (Kostoff, 2018). For instance the small iron saved

make children very vulnerable to environmental lead (Fry, 2014). This has effect on school attendance

2.11.2 Socialisation

Socialisation refers to the assistance given to individuals to support them become members of one or more social groups (Breaux et.al., 2016). The study of socialisation comprises the investigation of prospects learners have to partake in and the procedure which enable them become mathematically knowledgeable. It also looks at the students' acceptance or rejection of those opportunities.

Most studies established limited Mathematics ability disparities, where it exists, between pre-school boys and girls keen on the initial limited existences in school (Grusec & Hastings, 2007). As a result, poor performance cannot be associated with ability difference if after this point girls perform poorly. Rather, there is the likelihood involvement of some kind of socialization (Grusec & Hastings, 2007). As a matter of fact, Ginsburg declared that a greater percentage of children of both sexes express desire for Mathematics and have already started learning the mathematical concepts even before they get to school (Darling-Hammond et.al, 2020).

Schools have strong effect on gender disparity through two primary sources. These are peers and teachers. Peers and teachers influence gender disparity directly with the provision of different learning opportunities and feedback for boys and girls (Bigler, Hayes & Hamilton, 2013). Peers and teachers are also foundations of learning about gender. Teachers introduce curricular materials which encompass sex stereotypic attitude and behaviour with demonstration of peers gender stereotypic behaviour and attitude. Children internalise gender prejudices and stereotypes. These in turn direct their own inclinations and behaviours (Lerner, Ketz & Jones, 2019).

Certain scholars' highlight the significant input socialisation have in supporting sex inconsistencies in Mathematics. A longitudinal study examined sex disparities in skills and knowledge in solving mathematical problem between extraordinary or very talented students. Kim (2013) hypothesised that the interaction of characteristics of Mathematics related complications

with kids' erstwhile socialisation manufactured such disparities. The twelve year old partakers with eighty three being boys and the remaining seventy six being girls, coming from predominately White families, participated in a tests involving two categories of homogeneous problem-solving in Mathematics: the CTBS and the GAUSS8. The outcome made it clear that even though there were more men than women in the high aptitude students on the CTBS, sex disparities did not exist on the GAUSS plus there was no overall sex differences at in performance of the tests amongst the same students. There was also a report that there is an improved performance if learners perceived Mathematics as doable by all and not the male domain. They argued as a result of their findings that sex disparities in brain structure might not be a justification for sex disparities in solving problem.

Lots of factors contribute to women loss of desire to pursue Mathematics. Among the factors is a deterioration or decline in self-esteem and defeat of the forces of socialisation which inspire women to pay attention to their bodies at the expense of accomplishment orientation or whole-person. Generally, the axiom, "Mathematics is not for female", and the conviction that female should not disclose their intellect and brain power lest it compromises their sexual attractiveness. Consequently, their societal role as a mother and or wife, a combination which squelch girls' attentiveness and desire in advanced Mathematics (Jordan, 2015). Furthermore, young girls in school are hardly given information about occupation and job possibilities needing proficiency in higher Mathematics or Mathematics at the higher level. The female are not privileged to meet women role models with prosperous Mathematics jobs. In broad-spectrum, role models could play a significant role in inspiring a young person's ambitions.

Parents at home, may involuntarily flop in providing support to promote the girl child's interest in Mathematics, either by giving all the support towards education to the boy child or by directing the support and interests elsewhere. The teacher's attitude towards the male students generally emphasize and reinforce that of the parents' message and actions (Jordan, 2015). Further, both the male and female are receiving information from someplace… subtle as it could be invisible, or unconscious but the messages are obviously getting delivered. In a study, fathers projected their sons' mathematical "IQ" at 110 on average, and their daughters' at 98; mothers estimated 110 for sons and 104 for daughters (Sarouphim & Chartouny, 2017).

Female role models in Mathematics department are very scarce in the various universities in Ghana. As of the time of the studies there was no woman heading any Mathematics department in Ghana. Out of the total of hundred and eighty seven (187) that enrolled for Mathematics in the year 2000 when the researcher enrolled for a BEd Mathematics programme, only twelve (12) were women. The story was not different when she enrolled for MPhil Mathematics in the year 2006. Out of the total of twenty four (24), three (3) were females. One scarcely hear of a women heading Mathematics intensive fields like Volta River Authority, Energy Ministry, Finance Ministry, Atomic Energy to mention but a few. This has effect on the girl child, the environment make her believe Mathematics and Mathematics intensive fields are no go area for girls.

2.12 CONCLUSION

The chapter define Mathematics phobia as Mathematics weakness in students that deal with the psychological dimension of learning. Distressing memory which is described as the creation of uneasiness and helplessness in concentrating contribute greatly to Mathematics phobic situations and could impact and influence learners' mathematical achievement substantially. Dreger and Aiken are the first scholars who recognised Mathematics anxiety and identified the occurrence they named "number anxiety," which is autonomous of generalised anxiety, causing performance of students to be relatively lower in Mathematics than their counterparts who have the same capabilities. Symptoms of Mathematics phobia include nervousness, uneasy emotion to trouble or difficulty with breathing while making efforts to execute mathematical task, improved heart rate, sweaty, sticky damp hands, troubled stomach, dizziness, to mention but a few.

Mathematical skills was defined as being able to apply a known mathematical skills in a proper and an appropriate manner. Parents could be the main source of transmission of the mathematical skills. Teachers of Mathematics, the chapter established could contribute to Mathematics phobia and anxiety. This could result from their classroom conduct, relationship with learners, content and pedagogical knowledge etc. The use of guided discovery method in arriving at rules and formulas by teachers could reduce abstract nature of Mathematics to a very large extent.

A wide range of literature explored explained the gender differences in Mathematics participation and performance. Further studies stressed on environmental factors as the basis of the gap. The environmental issues and justifications are focused on how the girls are coerced into considering Mathematics as unimportant, invaluable, unachievable, or part of the identity of boys. Research on the gender gap in Mathematics involvement and attainment has reduced in recent years with the believe that the gender gap is closed. This research believes we are relying on early researches hence the need for more research to be conducted into the problem especially in Africa.

CHAPTER THREE

THEORETICAL AND CONCEPTUAL FRAMEWORK

3.1 INTRODUCTION

In the opening introduction of their book, 'Still Failing at Fairness' Niemi (2010) posed a question and this research believes the question should be posed again in this research because of the linkage in the topic to their book. "Didn't we actually unravel this problem years ago?"

Very often, immediately one is questioned, "What is your topic, thesis or research on?" Supposing one responds with sex preconceived notion, gender construction or sex accomplishment gap, one is likely to get this response.

"Didn't we unravel this problem centuries back?"

The researcher was asked the same question when she presented a paper on "An Examination of Gender Differences in Mathematics Participation and Performance in Ghanaian High Schools: Analysis of WASSCE Results." The question remains "Did we actually unravel the problem centuries back?"

Until 2019 when Karen Uhlenbeck received it for the first time, Fields Medal, the "Nobel Prize of Mathematics " has not been conferred on any woman (Hyde & Janet, 2009). Nonetheless, females have made many intense and significant contributions to Mathematics over the centuries, from Hypatia of Alexandria in *ca.* 400 CE to Professor Maryam Mirzakhani of Stanford University in the 21st century. Most importantly Marie-Sophie Germain, Ada Lovelace, Emmy Noether, Dame Mary Cartwright, Grace Hopper, and Julia Robinson were included in between. Ingrid Daubechies, Dusa McDuff, Marina Ratner and Karen Uhlenbeck are included in the contemporary memberships of the Mathematics section of the U.S. National Academy of Sciences. Meanwhile, these prominent women in Mathematics left footprints and deserve to be acknowledged

emphatically. Evidently, women well-endowed and with intense mathematical talent all over the world specifically in Ghana actually exist, one of such is a Ghanaian lecturer in the University of Education Winneba, Gloria Armah, Ph.D.

This chapter discusses and motivates the explores the chosen theoretical framework for the study as well as conceptual framework as they pertain to the Mathematics development, female participation in Mathematics and Mathematics phobia among female students.

3.2 THEORETICAL FRAMEWORK

The theory underpinning the study is Bandura's Social Learning Theory.

3.2.1 Social learning theory

Social Learning Theory is a theory of social behaviour and learning. There is however more to learning. Bandura (1977) stated in the Social Learning Theory, that behaviour is learnt or picked from the surroundings or environment through the practise, procedures and processes of learning by observation. Bailey and Clerk (2013) unlike Skinner, believes that human beings are full of life information processors. They further think about the bond and relation between their behaviour and its consequences. There is no way learning by observational can transpire without the cognitive procedures at play. Youngsters learn from the individuals who are with them as they behave in numerous means. This has been demonstrated through the renowned Bobo doll experimentation (Cherry, 2018). People who are observed are referred to as models. Virtually in every community, kids are usually enclosed by a lot of persuasive and powerful models, example; fathers and mother in the household, adults also in the family, characters on the TV programmes of children, friends who are their peer assemblage and their instructors who teachers them at school. The models mentioned set instances and demonstrate example of exemplary behaviour in their collective ways which children observe and imitate; mannish and girlish, anti-social and pro (Waismeyer & Meltzoff, 2017). Teenagers attentively observe a greater number of such people who to them are models translating their behaviour. The children, later end up duplicating the observed behaviour. Kids could imitate the observe behaviour irrespective of the nature. Whether 'sex-

appropriate' or no 'sex-appropriate', there exist a good amount of processes and procedures which makes it very probable for children to replicate that behavioural qualities which the social order reckons suitable for the appropriate gender.

Children seek approval from parents or peers, this approval in the first place are very likely to imitate the people they perceive similar to itself. Subsequently, children are more likely to imitate the behaviour which is modelled by the people of the same sex (Simpson, Murray, Paukner & Ferrari, 2014). Moreover, the people around the children will also respond to the behaviour imitated either with reinforcement and or collaboration or punishment. Imitation of a model's behaviour by children have consequences. Where rewarding, children are most likely to continue imitating the behaviour. When parents see their little girls consoling their teddy bear saying things like, "What a kind girl you are", it is rewarding for the children. It is more likely that they will repeat the behaviour over and over. The behaviour then has been reinforced. This reinforcement could be internal or external. It can also be positive or negative. On the other hand, if it is an external reinforcement, the child feels happy about acceptance. A child's behaviour is in a way believed to have earned endorsement because it requires endorsement. Both positive and negative reinforcement have little impact and bearing when the reinforcement presented externally cannot be compared to that of the individual's needs (Bouxsein, Roane, & Harper, 2011). Reinforcement can either be positive or negative, however the most important factor is the fact that it usually brings a change in an individual's behaviour. Furthermore, the child will also take into consideration the other people around him/her. What then happens to people as they decide to emulate other's activities? This is called mediated strengthening (Bazgir, Fathi, Rezazadeh, Mozdziak, & Asgari, 2017).

The vicarious reinforcement eventually relates to an attachment to a specified model(s) which have potentials envisage to be gratifying. Usually kids will naturally envisage a number of models which they can recognise and relate to. These could as well be persons who are in their environment, it could be their blood relation or imaginary characters especially people in the media. What motivate their identity with a particular model is the quality the model may exhibit, which the particular child will desire to have or adopt. There is the occurrence of identification with other personality or models (Northwestern University, 2018). This encompasses attracting or embracing witnessed

or observed traits, beliefs, attitudes and beliefs of the individual who one is identifying with. Identification as used or adopted by the Social Learning Theory relates to Freudian word which is also associated or related to the Oedipus complex. Both are for instance involved in co-opting, embracing or implementing someone else's behaviour. Conversely, through the Oedipus complex, children could identify only with equivalent gendered parent, while the Social Identity Theory would have the person who could be a kid or a grownup could possibly identify with other individuals. To identify is unlike imitation this is because it might encompass a quantity of traits which is being adopted and implemented whereas imitation generally encompasses replicating a particular behaviour or traits (Essays UK., 2018).

3.2.2 Historical background of Social Learning Theory

Social learning theory is a hypothetical learning process and social behaviour which proposes that behaviours can be obtained by watching and mimicking other behaviours (Bandura, 1971). The theory was propounded by a Canadian psychologist Albert Bandura. The promulgation of this hypothesis indicates an identity which does not as it were comprise of discernible conduct, as conventional psychologists accept. Instead the cognitive procedures play a vital role within the changing or acing of conduct patterns (Janse, 2018). It states that learning could be a cognitive handle which occurs in a social setting and can happen through perception or coordinated instructions, which could be without a motor duplication or direct reinforcement (Bandura, 1971).

The objective of the social learning theory is to demonstrate that a person can learn in different ways. Individuals make choices based on self-reflection, but the environment in which the individual finds themselves impacts primarily on the way they carry on and learn. The learner, who is the individual at the center of this hypothesis, forms distinctive driving forces in several ways (Janse, 2018).

3.2.2.1 Operant conditioning

Making a distinction between two categories of behaviour: respondent and operant behaviour. Respondent behaviour is an automated response to stimulus. When an individual's retina

encounters a shining light, the individual begins to blink. This reflex is automatic and inadvertent. Operant conditioning on the other hand, is completely intentional and can be controlled. An individual works in their environment and gets reaction in the form of consequences. These reaction of the feedback guarantees the fact that the individual will or will not alter their behaviour. (Janse, 2018).

The moment an individual is born, the growth mechanism called observational learning, begins to work. Efficiently, the individuals learn by observation. By this, the individual watch what other individuals do. The reason for somebody to mimic the conduct of another is shown as observational fortification. By this, the individual observe the results an individual encounters from engaging in an activity. Example a student getting a compliment from his or her teacher with respect to a cumbersome calculations made. The classmates listen to the compliment, and they are persuaded to also consider even a much more cumbersome assignments (Janse, 2018).

The same guideline works in another way. If a student comes late to class, he will be reprimanded not to come late the next time, it can take the form of a punishment. The classmates witnessing this end up drawing conclusion for themselves that it is important to be on time. In any case, these forms of observational reinforcement do not work in all cases. Often times, reinforcers are personal and can alter with the advancement of the learner.

Material reinforcement could have an adverse impact such that the source of intrinsic motivation can be misplaced. A vital component of the method that initiates the modification of conduct is the observation of the results that certain conduct. Be that as it may, not all conducts are worthy of emulation. Conduct can as it were be changed when a person has total control over the circumstance and when they can perceive certain results before they happened. Bandura calls this concept self-effectivity (Janse, 2018).

Social learning theory considers the arrangement of one’s character to be a learned reaction to social jolts. It emphasizes the societal setting of socialization instead of the person intellect. This theory hypothesizes that an individual’s character is not the item of the oblivious (such as the conviction of psychoanalytic scholars), it is rather as a result of modeling oneself in reaction to the

desires of others. Behaviours and states of mind create a reaction to support and gain support from persons around us. Whereas social learning scholars recognize childhood encounter as imperative, they also recognize the character individuals obtain as a means to mold a character more by the behaviours and demeanors of others (Crossman, 2020). Social learning theory has its roots in brain research and was molded significantly by a psychologist Albert Bandura. Sociologists regularly utilize social learning theory to get the targeted deviance and wrongdoing (Crossman, 2020).

Many studies identified insignificant complications relating to behaviourism which motivated Bandura to opine his theory (Social Learning Theory). None could provide sufficient evidence enough to reduce the influence of Behaviourism's. When combined with Bandura's attentiveness in social modelling, the mental depiction or demonstration together with mutual determinism, the results is an emerging source for a transformation in the learning theory.

Kohler (1927) disclosed the possibility of apes building novel resulting in "insight learning". This shows that even animals play a very active role when learning as authorized through Behaviourism. Tolman and Honzik (1930) established the fact that rats are able to learn devoid of reinforcement by holding inner "cognitive maps" of mazes run by them. They refused to use the maps formed as motivation and or reinforcement. This shows a distinction between performance and learning.

Rotter (1954) confirmed the possibility of influenced responses which can place a personality in a condition such that the presentation of cognitive dynamics may generally affect learning. None singlehandedly provided substantial evidence significant enough to reduce the influence of Behaviourism, nevertheless when joined with the interest of Bandura's in social modelling, cognitive exemplification together with reciprocal determinism, the products are the fundamentals of change in the learning theory.

3.2.3 Basic concepts in the social learning theory

Observational Learning, the social learning theory explained as, individuals learning by observing other individuals exhibit their behaviour. Observational learning clarifies how children adopt

behaviours by observing the behaviour of the people around them, and inevitably, mirroring them. Talking of the "Bobo Doll" experiment(s), Bandura involved a grown-up who is entrusted to act antagonistically to a Bobo Doll whereas the children watch him. Afterward, Bandura gave the children the privilege to play in a room with the Bobo Doll. He asserted that the children imitated the cruelty toward the doll, which they had watched (Development of Play in Humans, 2018).

Children are encompassed in society by numerous influential models, such as parents and guardians in the family, characters on television screen especially children's television programs, friends of same age together with teachers. Illustrations of behaviour by these models are observed and imitated. Examples include feminine and masculine, anti-social and many others. Children take into serious consideration a few of these individuals (models), encode them, imitate and demonstrate the behaviour observed. This is done whether the behaviour is 'gender appropriate' or not. There are however a number of developments that make it more likely for a child to replicate the behaviour seen and appreciated by society as suitable for its gender.

The child, to begin with is more likely to give attention to and mimic those individuals comparable to itself. Thus, it is more likely to mimic behaviour modeled by individuals of the same gender. In addition to this is the responses of the individuals around the child to the behaviour it copies with either punishment or reinforcement. A child continues to imitate a behaviour which was rewarding when (s)he imitated it the first time. For example, should a little girl consoling her teddy bear be given such remarks as 'what a sweet mum, what a kind girl, what a nice person' she is very likely to repeat mimicking the behaviour. There is reinforcement in her behaviour (McLeod, 2016).

Reinforcement could be internal and or external. It could as well be negative or positive. An approval given to a child from parents or peers for something is an external reinforcement. The joy that follows the approval is an internal reinforcement. The child would demonstrate a behaviour (s)he believes would earn him/her approval since it desires the approval each time. The impact of Negative or positive reinforcement is very little especially if the reinforcement which was offered externally does not really correspond to the person's needs. Reinforcement could be positive or negative, however whether positive or negative it often leads to a transformation in an individual's behaviour (McLeod, 2016).

Further the child considers critically what happens to the other individuals anytime (s)he has to decide whether or not to imitate the person's actions. An individual learns through observation of the consequences of the behaviour of other individual who are models. Example a young boy observing a bigger brother receiving reward for a specific behaviour is most likely going to mimic the bigger brother's behaviour expecting same reward. This type of reinforcement is called vicarious reinforcement. This is an attachment of the sort to particular models with qualities seen as fulfilling. Children learn from individuals in their immediate world, including older siblings or fantastic personalities or individuals within the media. They are inspired to identify with a specific model base on the possession of a quality which the child would like to exhibit (McLeod, 2016). We identify with others by adopting an observed behaviours, beliefs, values and attitudes of the individual being identified with. Identification used by social learning theory is closely related to the Freudian term the Oedipus Complex, McLeod (2016) as explained in details earlier.

3.2.4 Mediational processes

Social Learning Theory is regularly portrayed as the 'bridge' between conventional learning theory which is, the behaviourism, and the cognitive approach. This is as a result of its focus on mental (cognitive) factors involving learning. Unlike Skinner, Bandura (1977) accepted that people are dynamic data processors as they think about the relationship between their behaviour and its consequences. Observational learning may not happen unless cognitive forms were at work. These mental variables intervene (that is, mediate) in the learning process for the determination of a new response if needed. Therefore, people don't consequently observe the behaviour of a model and mirror it. Prior to imitation, there exist few thought, and this thought is called mediational process. This happens between watching the behaviour (stimulus) and the copying or not of the response (McLeod, 2016). The mediational process of social learning theory is modelled in Figure. 3.1 below.

Behaviourist Model **(**only study observable / external behaviour**)**

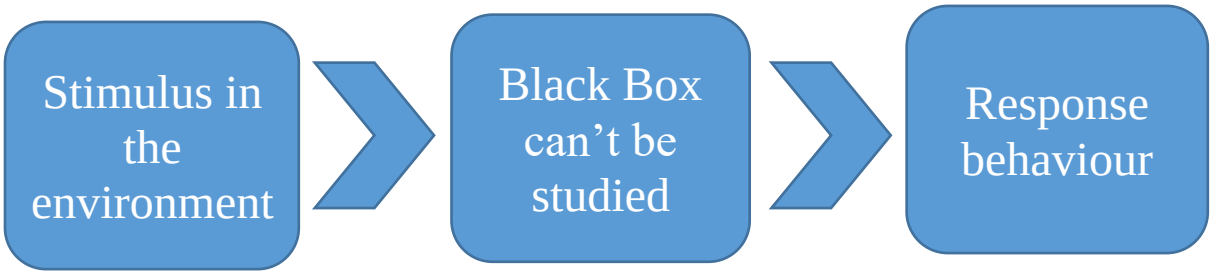


Figure 3.1: Mediational process

Bandura proposed four mediational processes, which include the following:

Consideration: the degree to which we are exposed to or noticed a behaviour. There must be some attraction for the imitate a behaviour to take place. Numerous behaviours are observed on a day by day basis, of which majority are not critical. Attention is very important in the determination what influence a behaviour on the person mimicking it (Kurt, 2019).

Retention: how to accumulate acquired knowledge, it is very critical. We can remember a fraction of what we were taught in school. That is why behaviour could be noticed all the time but to remember it all the time does not guarantee the prevention of imitation. It is necessary to memorize a behaviour formed in order to perform it later by the individual observing (McLeod, 2016). Social learning is not usually immediate, hence the process is vital in such cases. Where the behaviour has to be reproduced shortly after observing it, there is the need for a reference point (Kurt, 2019).

Reproduction: this usually refers to an individual's capability to demonstrate the behaviour that a model demonstrates. We see many behaviour which are adorable and we get attracted by wanting to imitate it. This is however not usually conceivable. We are usually restricted by our physical capability hence, we are not able to, in the event that we wish to replicate the behaviour. This

influenced our decision making, especially whether to mimic the behaviour or not. Imagining the scenario of a woman who is 90 year old, struggling to watch others dance on ice. She is very likely to appreciate the admirable skills but will not endeavor to mimic it since she is physically incapable (Kurt, 2019).

Motivation: the desire to perform a behaviour and the prizes and penalties following the exhibition if the behaviour is seriously considered by the person observing the behaviour. In case the seen rewards exceed the seen punishment, (should there be any), the behaviour at that point is very likely to be imitated by the observer. In the event that the vicarious reinforcement is not seen to be vitally sufficient to the spectator, they will at that point not copy the behaviour (McLeod, 2016).

3.2.5 The application of social learning theory in this study

Social learning theory has extensively, been applied to the understanding of violent behaviour and or cruelty (Bandura, 1973) in addition to psychological disorders, particularly from the viewpoint of behaviour amendment. Again, theoretically it underpins the modus operandi of behaviour modeling which is used extensively in training programs. Bandura directed his work on the concept of self-efficacy in a variety of contexts in the 70s. (e.g., Bandura, 1997). Television commercials are examples of the popular and persistent social learning situations globally. Some television commercials do suggest the use of some drinks, cosmetics, costumes etc. makes an individual particular and win the admiration of attractive people. Depending on the factor or elements and processes involved which could be a motivation or attention, the viewers may model the exhibited behaviour in the commercial thereby buying the advertised product.

The Social Learning Theory advocates learning through observation. It could take the form of a mentor or model demonstrating a task or behavior physically or giving a verbal description of a task. For the purposes of this study, female mathematicians are the mentors and or role models who demonstrate to females that Mathematics is a subject area everyone including female could confidently explore. Female Mathematics teachers influence their female students positively especially if the female teachers demonstrate mastery over the pedagogical and content knowledge in their delivery. Socializing agents and role models are significant factors of this theory and this

study because while making academic choices, individuals depend on gender-appropriate behavior from others. This is because girls are observant to the behavior of other women and how they lead their everyday lives. If they perceive that women are not choosing careers that are on the same lines as being a scientist or a mathematician or an engineer, they might feel that these careers are unachievable for women.

3.2.6 Critical evaluation of the social learning theory

McLeod (2016) asserted that the social learning theory was not fully explained. The approach of the social learning as he explained, takes into serious consideration thought processes and recognizes the key role they play in determining the imitation of a behaviour or not. As a result, social learning theory gives a more comprehensive clarification of human learning by acknowledging the key role of the mediational processes.

Though the theory could clarify a number of very complex behaviours, it could not explain adequately how a whole range of behaviour is developed, including feelings and thoughts. There are lots of cognitive regulations over a person's behaviour. Experiences of violence do not call for a reduction in such behaviours. For this reason Bandura altered his social learning theory and renamed it in 1986 as Social Cognitive Theory (SCT), describing better how knowledge is acquired from social experiences (McLeod, 2016). Female students are motivated by female mathematicians, engineers, medical doctors, etc. they see either on the national television, or in society.

A few reactions of social learning theory emerged as a result of its commitment to the environment. This is because it remains the principal encouragement to behaviour. It is limited to the description of behaviour exclusively in terms of nurture or nature and efforts underrating the complexity of the human behaviour. It is most probable that behaviour result from interaction between nurture (environment) and nature (science) (Kurt, 2019).

The theory could not fully clarify everything there is to behaviour. This particularly is the case in the absence of role model in an individual's life to mimic or adopt a given behaviour from.

Unearthing mirror neurons are biologically supported to the social learning theory. In spite of the fact that research on the issue was in its earliest stages the discovery made recently on mirror neurons in primates could constitute a neurological premise for impersonating a behaviour. They are neurons firing whether the animal itself does something or observes another perform the action (McLeod, 2016).

3.2.7 Implications of social learning theory on teachers and student learning?

This theory can certainly be utilised in impacting positive behaviours on learners. Teachers on the other hand can utilise positive role models in extending desirable behaviours. This could result in the creation of complete change in the culture of a school. The benefit from positive role models is not only to the individual student in and out of school but the whole students population most importantly the class the individual finds him or herself (Kurt, 2019).

Classroom procedures and strategies, for example empowering and building self-efficacy in children are deepened in the theory of social learning. For instance, students get motivated and encouraged by a teacher who has positive influence on his/her students. This positive energy and lifestyle together with verbal support help in building self-efficacy, the conviction in one's capacity to excel in different circumstances. Bandura established that an individual's self-efficacy has an impact on how tasks, challenges and goals are approached.

The people with solid self-efficacy see challenges as assignment to masters, create profound desire in the exercises they are involve in, develop a solid sense of commitment to interest and activities, and rebound from setbacks and disappointments effortlessly. Those with a weaker sense of self-efficacy on the other hand, dodge challenges and assume that difficult situations and tasks are beyond their capacities. They think adversely around their outcomes and disappointments, and easily lose confidence in their capacities (Kurt, 2019). It is the responsibility of the Mathematics teacher to create self-efficacy in his/her student especially the female student who may think Mathematics is a no go area for them. This self-efficacy if created in the girl child according to the social learning theory translates the challenges in Mathematics study to a mere assignment which they need to master.

Bandura further stated that the use of personal experience as a self-tutor, in other words, learning virtually everything from self-experience is difficult and might be slightly perilous. He propagated that more of a person's life deepened in social encounters, hence watching others is normally profitable in knowledge and skills acquisition (Kurt, 2019). Women in Mathematics are social agent who could serve as a mirror for young girls. There is the need to identify and use them as role models. These role models according to Bandura could impact positively on young girls who encounter them.

In conclusion, observation is a powerful tool that plays an effective role in knowledge acquisition. It plays effective role in demonstrating understanding of concept learnt, its retention and the application of concepts learnt to everyday life. This study appreciates Albert Bandura for his social learning theory commitment.

3.3 CONCEPTUAL FRAMEWORK

The importance of applications of Mathematics in everyday life notwithstanding, Mathematics is often well-thought-out as a difficult subject. Studies have demonstrated that a lot of students have difficulties learning and this is reflected in their poor output in Mathematics. A major contributing factor is the apprehension a person might conceive towards Mathematics. Mathematics apprehension may use the following provisionary description. Mathematics phobia or anxiety or apprehension is the uncertainty, sinking feeling, insecurity and hopelessness one has towards Mathematics and arithmetic. Mathematics phobia affects learner accomplishment, achievement and attitudes towards Mathematics significantly (Dowker, 2017). It could, for instance, lead to nonperformance and avoidance of Mathematics. In describing Mathematics avoidance and performance, Preis and Biggs (2001) developed a cycle as illustrated in Figure 3.2.

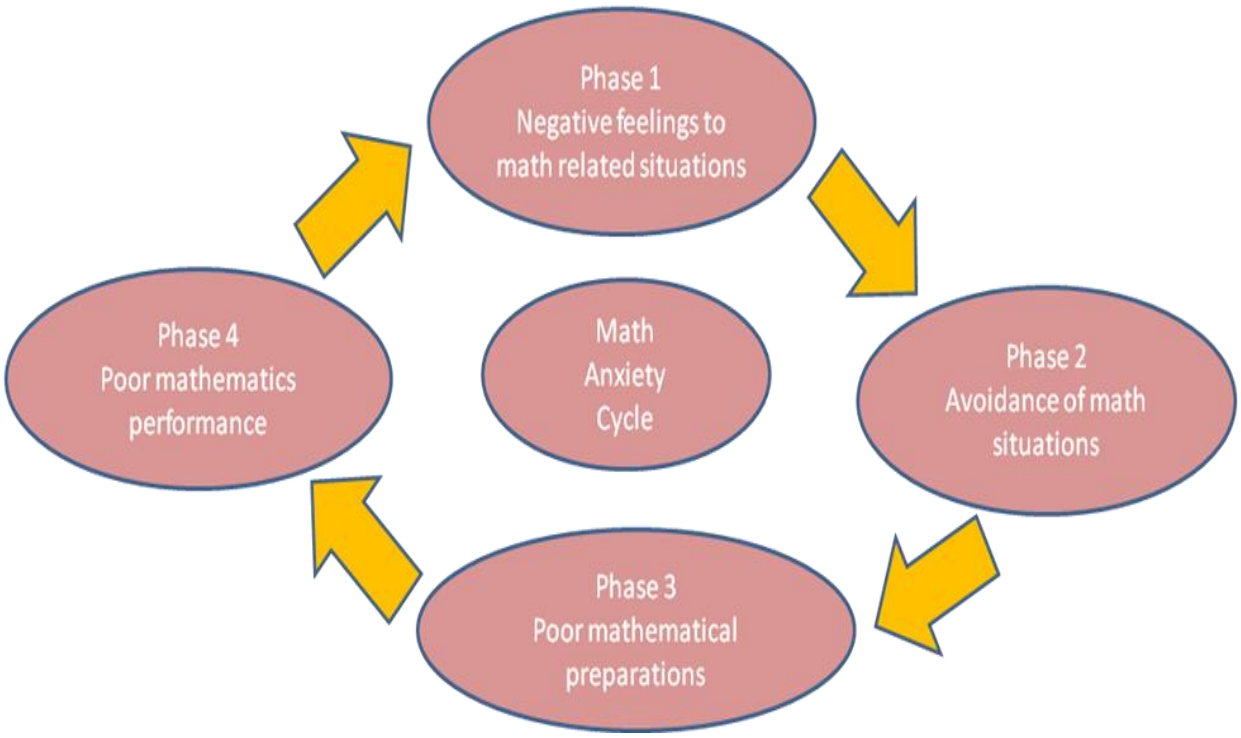


Figure 3.2: The cyclic nature of Mathematics avoidance and Mathematics performance (Preis & Biggs, 2001)

In phase one, the individual encounter and is exposed to Mathematics in a undesirable way, develops negative feelings towards Mathematics -related circumstances. This subsequently might be a consequence of their previous adverse and undesirable experiences developed through an encounter with Mathematics. This eventually will result in phase two where there is gradual avoidance of mathematical situations, which is also followed by the third phase where there is poor mathematical preparation due to the avoidance, and finally there is the fourth phase characterised by non-performance in Mathematics. This when resulted in monotonous cycle becomes problematic especially to break when the Mathematics apprehensive persons clinch that they cannot cope and tolerate any Mathematics related conditions.

Studies show that children develop Mathematics phobia predominantly at the elementary school level. This is the point where they gradually move from concrete to operational and abstract thinking (Hughes, 2016). It is therefore imperative that Mathematics phobia is identified in a child at an early stage where the teacher can possible help the child overcome the phobia. Mathematics teachers ought to be equipped and trained with the mandatory abilities to be cognizant with

Mathematics phobia among their learners and the treatment thereof in the classroom. Most grounds of the teachers' effect with respect to the creation of Mathematics phobia among their pupils have been suggested in literature review of this study. These include:

- inadequate or lack of content knowledge of teachers;
- attitudes of classroom teachers towards Mathematics teaching and learning;
- the pedagogical knowledge of teachers; and
- Mathematics anxiety in teachers.

3.3.1 Inadequate or lack of content knowledge of teachers

Großschedl, Welter and Harms (2019) defined content knowledge as being knowledgeable in the topic at stake. For example ability to demonstrate master over Mathematics together with its structure. It includes, the representation and formulation of a subject, so that it becomes understandable to others. Another example is demonstrating understanding in making the teaching and learning of a specific topic either easy or difficult. (Rollnick & Mavhunga, 2017)

Majority of the teachers teaching basic school Mathematics in Ghana and elsewhere (example United States of America, United Kingdom, New Zealand) are generalist classroom teachers teaching a range of subjects from Mathematics to Science to ICT to English etc. (Norton, 2019).

A prominent evidence of the relationship between teachers' Mathematics Content Knowledge and teaching ability is the extraordinary performance put up in the East Asian countries international tests. The evidence is obviously clear in tests such as Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMMS) (Mullis, Martin, Foy & Arora, 2012; Organization for Economic Co-operation and Development [OECD], 2014). Emerging data from the test shows that a very high proportion of students from the East Asian countries meet international benchmarks as compared to the Western countries counting Australia, Britain, the US, and Modern Zealand (Norton, 2019). African countries particularly Ghana did not meet the international benchmarks. You can only give what you have,

a teacher with inadequate Mathematics knowledge will have a negative effect on his students. The girl child being the most vulnerable is likely to be the most affected.

Forms of support aimed at improving trainee teachers' Mathematics Content Knowledge have identified the emphasis placed on pre, during and post teacher training processes including graduation. For instance, Krainer, Hsieh, Peck, and Tatto (2015) reported the predominant Mathematics Content Knowledge of prospective teachers at the primary level in the East Asia, thus Singapore and Taiwan, over the US. Additionally, Norton (2019) detailed the prevalent Mathematics Content Knowledge of Japanese and Chinese teacher trainees compared to their peers in Finland, Ireland and Britain. It is worth noting that the prevalent commendations for Mathematics instructional method are socially sensitive. Primary teachers of Mathematics in East Asia, play the guide role together with teacher dominated instruction with a little or no learner control (Leung, Park, Shimizu, & Xu, 2015). Teacher training has undergone a major reform in Ghana. Effective 2022 teacher trainees will graduate with degree in Ghana. As part of the reforms, trainees are specializing in Primary School, Junior High School, Technical, Science etc. teaching. This reforms narrowed the scope of teacher training courses aiming at mastery of specific subject areas and specific levels of instruction delivery at the basic level of education in Ghana.

3.3.2 Attitudes of classroom teachers towards Mathematics teaching and learning

Barmao, Githua and Changeiywo, (2015) attested that teachers remain the key agent of change in every school. Teachers play a vital role in the successful implementation of school policies and initiatives. The school's success of initiatives and policies depends to a large extent on the teacher's support and attitude. It is necessary for the teachers to demonstrate positive attitude towards streaming in Mathematics classes since the attitudes of the teachers are interconnected with their obligation to the policy. The fulfillment of Kreiter and Kinicki (2007) work influence teacher-student interaction greatly.

The attitude of the teachers towards girls and boys as Mathematics students might influence the behaviour of the students in Mathematics classes. The teachers' states of mind determines the

learners' perceived expectations of performance (Pahle, Hyde & Allison, 2014). Their interaction and relationship with students in Mathematics class is also greatly influence (Barmao, Githua & Changeiywo, 2015). Societal stereotypes have excessive influence on the teacher's attitudes. Fryer and Levitt (2010) also stated that girls and boys are treated by teachers in different way using strategies that portray the societal norms and convictions about gender differences. The action of the teacher affects the learners' thoughts, reasoning, solving problems in class and contributing to classroom discussions.

McCoy, Smyth and Burke (2012) in their study observed the contrasts within the way teachers interact with girls and boys especially in coeducational science and Mathematics classes. Boys were observed as individuals who seek out and receive a lot of teachers attention and consideration. They often call upon more male students than females' students to solve problems and participate in lessons. Such attitude make the female student timid and not ready to be actively participate in class discussions. This could result in low self-esteem. It could also lead to loss of interest in Mathematics resulting in low performance in the said subject. This finding is reinforced by Gina and Moshe (2001) who observed that teachers presume boys as their best Mathematics students and consequently concentrate more on them than the girls. McCoy et. al. (2012) added that besides the differential treatment given to boys, and girls in a coeducational classes by teachers, girls' in single sex Primary schools in Ireland are more likely to have positive attitude towards Mathematics than their partners in a coeducational setting. The study again observed that boys were more positively inclined towards Mathematics than females. Be that as it may the study found small contrasts in the attitude between girls and boys in single-sex schools towards Mathematics. This seemingly suggest that single sex settings harness and promote positive attitude towards Mathematics for both girls and boys (Barmao, Githua & Changeiywo, 2015).

3.3.3 The pedagogical knowledge of teachers

Being mathematically Knowledgeable and being knowledgeable in mathematical representations relate to having a good Mathematics content knowledge. Being knowledgeable in teaching Mathematics and managing students in the teaching and learning processes relates to pedagogical content knowledge (Rollnick & Mavhunga, 2017). Pedagogical content knowledge refers to the

possession of expert knowledge in the subject, content or topic to be taught by a teacher together with the ability to manage learners in in the learning process adequately.

Report on pedagogical content knowledge by Turnuklu and Yeşildere (2007) gives the indication that efficient instructors possess comprehensive knowledge of presenting the subject matter to learners. Pedagogical content knowledge should incorporate the knowledge of learners together with their characteristics, understanding of educational contexts, values and purposes, knowledge of educational end, and their historical and philosophical bases. By this, pedagogical content knowledge can be referred to as the instructor ability to change content to what is pedagogically effective and adaptable relating to everyday life. It should take into serious consideration the background displayed by the learner (Turnuklu & Yeşildere, 2007).

Learners, especially the girl childs' inability to demonstrate understanding leading to constant failure in Mathematics remains a topic of interest to researchers. The teachers' knowledge of the subject matter often draws growing attention from policy makers globally. A teacher is able to break down mathematical content into concrete and life relating aspects if (s)he is well equipped in pedagogical content knowledge (Tsafe, 2013). The mathematical knowledge of the teacher, together with pedagogical competence and insight into the development of learners mathematical reasoning are vital to the improvement of students' achievement in Mathematics (Arthur & Evelyn, 2006 cited in Tsafe, 2013). No wonder he stated that excellent benchmarks, curriculum, instructional materials together with assessment are vital but not sufficient enough to improve students' learning and performance in Mathematics (Tsafe, 2013).

3.3.4 Mathematics anxiety in teachers

Mathematics anxiety refers to the persistent tension, apprehension and fear related to conditions numbers. Mathematics anxious individuals experience unpleasant apprehensions which affects their performance in Mathematics (Ramirez et. al, 2018). The consequences of the anxiety of a Mathematics teacher goes beyond the individual teacher. This is because the Mathematics anxious teachers cannot trust their ability to successfully carry out their teaching and learning processes to the admiration of all. That is, teaching with confidence and self-efficacy (Ramirez et.al, 2018).

The teachers' Mathematics anxiety has an influence on their students' Mathematics learning and performance. Numerous quantitative studies, (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Hadley, & Dorward, 2011; Beilock, Gunderson, Ramirez & Levine, 2010) as well as qualitative studies (Bryant, 2009; Furner & Berman, 2003; Sloan, Daane, & Giesen, 2002; Vinson, 2001; Swetman, 1994; Ring, Pape, & Tittle, 2000; Karp, 1991; Martinez, 1987; Kelly & Tomhave, 1985; Larson, 1983; Lazarus, 1974) have reported the negative relationship that exist between the teacher's Mathematics anxiety and improvement in learners Mathematics attainment. There exist a relationship between how teachers feel about Mathematics and learning outcomes of their students.

Early researches established the fear modeled by Mathematics anxious teachers around Mathematics and its teaching. This modeled fear harms learning of Mathematics (Beilock et al., 2010; Stoehr, 2017). An anxious Mathematics teacher in a qualitative study, reveals the following:

> *I almost cried in front of my students on a particular day whiles teaching a concept, because I couldn't get it either. . . . I was aware that if they saw their teacher getting frustrated with the Mathematics, it will have a lasting if not a lifelong impression on them. (Gresham, 2018, : 97)*

Beilock et al. (2010) found a similar effect in their study, they disclosed that young girls with Mathematics anxious female teachers were very likely to model themselves around these anxious female teachers. This is an endorsement of the old-fashioned gender stereotyping, which classifies women as being bad in Mathematics. The girl child ostensibly perceive their female Mathematics teacher's insecurities about Mathematics and validate the fact that the females is not expected to excel in Mathematics. Beilock et al. indicated that confirming traditional gender stereotyping relate inversely to Mathematics learning all through the school year.

These findings and some others arose the researcher's interest hence the conduct of the research about Mathematics phobia.

It is evident from literature that Mathematics phobia and nervousness is not only limited to learners. It could as well be existent in teachers and instructors. Ramirez et.al. (2018) postulated that Mathematics phobia and anxiety originate from teaching approaches. Educators have also been tangled to the non-academic performance of their learners, and also to the usefulness and efficiency of basic school teachers. Stoehr (2017) argued that the anxiety and phobia for the teaching of Mathematics is a recurrent and persistent anxiety of many teacher training students. Apprehension and phobia for the teaching of Mathematics might replicate in an actual or seeming skills and knowledge shortfalls in the content of Mathematics and the teaching skills in Mathematics, reminiscences of previous manifestations of failure in Mathematics or existence of Mathematics nervousness and phobia in the teacher himself or herself.

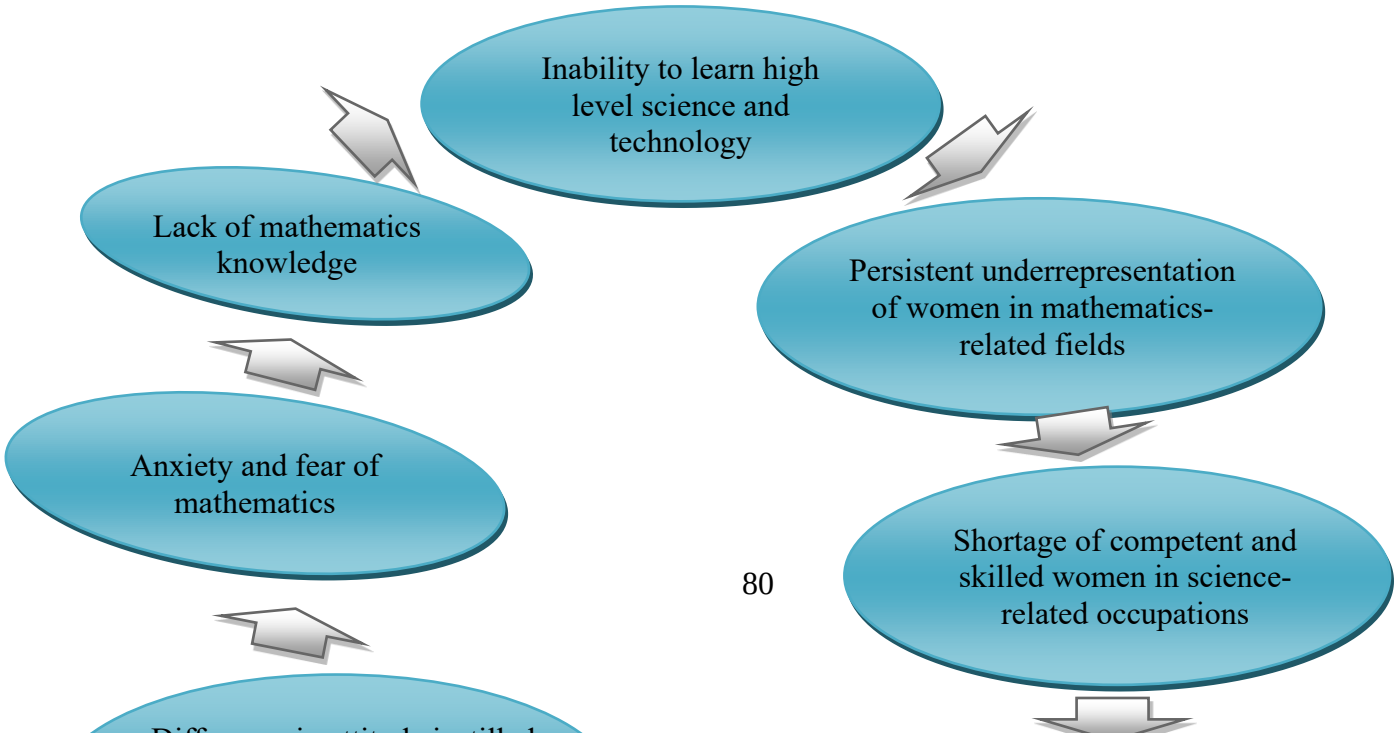
It is assumed largely that numerous factors cause Mathematics apprehension and phobia. These are categorised as societal, environmental, personal and pedagogical (Sofowora, 2014). The research concentrated on the mathematical pedagogy and anxiety of teacher trainees enrolled in a programme at PABO1 in the Netherlands, and were training to be primary school instructors. Taking the outcome of the preceding research consideration, there is every indication that teachers transfer their Mathematics nervousness and phobia to the students. The key determination of their research was:

- to examine the indications if any, of Mathematics nervousness and phobia in Dutch teacher trainees enrolled in the study year 2010-2011 in the teacher training programme at the PABO of the Hoge school van Amsterdam;
- to find the existing relationship between the students' Mathematics anxiety level and their performance in a mathematical skills test if any; and
- to explore students ability to overcome their anxiety thereby improving in their skills test through training sessions plus tutoring by peers.

The level of Mathematics apprehension and phobia were evaluated by a self-report apparatus designed through literature of research which were proven to be very appropriate for use especially with Primary Pre-service teachers. The skills test in Mathematics referred to above is WISCAT-

pabo. Its purpose was to determine the mathematical knowledge and skills of the pre-service teachers to final year at the primary school.

The test is compulsory for all Dutch students through to their first year of PABO. In order to continue with their teacher-training programme, they are supposed to pass the test. There was an exploration of the test apprehension of students not passing the skills test. The test is very important to the pre-service teachers and that constituted the reasons for conducting it. The exploration was because it might possibly be a supplementary factor. Adding to the measurement of Mathematics apprehension and phobia of the year one students together with investigation of the efficiency of the support provided in overcoming the said apprehension and phobia to enable them to be successful in the skills assessment, the study further explored the pedagogic content knowledge of the will-be educators in the course of their pre-service education. The researchers shared facts, findings and understanding of Mathematics apprehension and phobia with the prospective educators as they deliberated on the causes, symptoms and assessment of Mathematics apprehension in the workshop. In juxtaposition with the workshop, the prospective educators observed their learners within a week of teaching practice as they reported on all symptoms of Mathematics apprehension. The researcher further shared observations made by them through their teaching practice sessions plus the plans and approaches they intend to adopt to assist them get rid of Mathematics apprehension in their classrooms all the time. Figure 3.3 is a pictograph of the study's perceived Mathematics avoidance and its effects.



From the diagram above, negative messages received from home, society and even the school create anxiety, and fear of Mathematics in the individual before Mathematics is introduced to him or her. As explained by the Social Learning Theory, pupils adopt, practice and model the messages they hear around them. Mathematics anxiety in elementary school students indicates that its onset coincides with early years of schooling. This could in part, be due to social learning from parents and teachers with Mathematics anxiety or negative perceptions of Mathematics.

Parents or teachers might give children mixed messages about Mathematics (Etheridge, 2016). They might emphasise how highly difficult Mathematics is and at the same time tell them how Mathematics skills are of essential importance for their future achievements. By this, pupils may see nothing wrong with poor performance in Mathematics though they may want to occupy prestigious positions. Dowker et. al. (2016) observed that Mathematics anxiety in mothers was significantly predictive of Mathematics anxiety in children. This could be so for exceeding expectations as well. As pointed out by Ibaishwa (2014), children of parents with excessive expectations whose love and acceptance is conditional to how well children live up to these anticipations, have a high degree of anxiety. These circumstances might lead to self-consciousness about one's performance and to anxiety arising from not living up to the high standards of parents. Children's excessive self-critical attitude might cause anxiety disproportionate to their failure in living up to these expectations. Studies show that low self-esteem, confidence and efficacy are closely related to Mathematics anxiety (Uusimaki & Nason, 2004; Woodard, 2004). Negative school experiences might also contribute to the development of Mathematics anxiety (Bursal &

Paznokas, 2006). For example, teachers' threatening deal with anyone who gets it wrong and exhibiting authoritarian attitudes could lead to fearsome classroom climate in which learners might hesitate to ask questions or answer the teachers' questions. Furthermore, learners fearing their Mathematics teacher might have a conditioned reaction to Mathematics as well. Observing teachers giving Mathematics homework as punishment could also cause learners to perceive Mathematics as unpleasant (Şahin, 2008). Pupils will model this behaviour of punishing others with Mathematics.

Highly anxious participants are basically less capable in Mathematics; they are incapable when it comes to performance in the necessary calculations at the same level of accuracy as low-anxiety individuals. Literature documents that there is indeed a significant relationship between Mathematics phobia and anxiety and Mathematics competence or achievement, a correlation of -.31 in Daches and Rubinsten (2017) meta-analysis. If the correlation holds across all levels of problem difficulty, then competence and Mathematics phobia and anxiety are completely confounded, and performance differences cannot be uniquely attributed to either factor.

Phobia and anxiety create the lack of mathematical knowledge as the individual tries to avoid it. The avoidance and lack of mathematical knowledge prevent the individual from learning high-level Mathematics due to lacks mathematical foundation. An obvious but unfortunate consequence of the avoidance tendency is that, compared with people who do not have Mathematics phobia and or anxiety, individuals who are extremely Mathematics anxious end up with lower Mathematics capability and accomplishment. They are exposed to less Mathematics in school and apparently learn less of what they are exposed to; as a result, they show lower achievement as measured by standardised tests (Dowker, et.al. 2016).

The empirical relationship is of moderate strength, which is a correlation of -0.31 for college students, which is sufficient to enough to pose a dilemma for empirical work. That is, when highly Mathematics anxious individuals perform poorly on a test, their poor performance could in fact, be due to low competence and achievement rather than heightened Mathematics phobia and anxiety. If the relationship between anxiety and competence holds for all levels of Mathematics difficulty, then variations in competence will contaminate any attempt to examine Mathematics

performance at different levels of Mathematics anxiety. Fortunately, there are ways out of this dilemma. One is to test additional samples of participants on untimed, pencil-and-paper versions of the Mathematics problems studied in the laboratories. For example, Artemenko, Daroczy, and Nuerk (2015) found no anxiety effects on whole-number arithmetic problems when participants were tested using a pencil and paper format. However, when participants were tested online, when they were timed as they solved the problems mentally under time pressure in the laboratory, there were substantial anxiety effects on the same problems.

Ashcraft, (2002) also took a second approach (Dowker et.al. 2016). In brief, they administered a standard Mathematics achievement test to individuals with low, medium, or high Mathematics anxiety and replicated the overall result reported by Daches and Rubinsten (2017), which is, Mathematics attainment decrease as Mathematics anxiety and phobia increases. Nevertheless, scores taken on the accomplishment test had advantage of the line-by-line upsurges in difficulty. With respect to this grading procedure, they established the none existence in Mathematics anxiety effects whatsoever on the first half of the test, which measured performance on whole-number computational problems. Effects of anxiety were ostensible only on the second half of the test, which did the introduction of percentages, mixed fractions $\left(example\ 10\frac{1}{4}, 7\frac{2}{3}\right)$, equations with unknowns, and factorization. There existed a strong negative correlation between Mathematics anxiety and accuracy in these problems. Consequently, persons who are highly Mathematics anxious lack in global deficit when it comes to Mathematics competency, and they could perform as well as their peers on whole-number arithmetic problems. Investigations of advance Mathematics, nevertheless, need to critically contemplate on the capability-anxiety correlation. There is a reason to be suspicious somehow of this correlation between competence and anxiety. This will lead to persistent under-representation of women in Mathematics-related fields creating a shortage of competent and skilled women in Science-related occupations, hence presenting a model of occupational gender segregation.

3.4 JUSTIFICATION OF CONCEPTUAL FRAMEWORK FOR THE STUDY

Quality Mathematics education is not mandatory for only those aiming at studying Mathematics and science in the universities, it is a requirement for entry into the various tertiary programs and

careers (Lomibao, 2016). Hence a compulsory credit in Mathematics as a requirement to tertiary institution irrespective of the discipline pursued is no news in Ghana. Interestingly majority of the students especially the girls, are Mathematics phobic and anxious. There is a decline in participation in Mathematics especially among females as they progress on the social and academic ladder.

The global emphasis on science, technology, engineering and Mathematics (STEM) education generally highlights the significance of putting in place highly qualified teachers who can deliver the mathematical instructions needed by the 21st century child (Levine, 2013). The Basic level Mathematics is the fundamental and critical stage where basic concepts and persevering attitudes are often taught by female instructors. In spite of the training given to all teachers including the female who recounted Mathematics anxiety and phobia, passed on this state of mind to their students resulting in diminution in accomplishment (Beilock et al, 2010). Such teachers spend little time in teaching Mathematics (Levine, 2013).

Nonetheless, the female role in scientific development in African is widely recognized as significant and a determinant in the continent's reinforcing, building of technological and scientific capacities. This is because no such African country could manage leaving fifty percent (50 %) of its populace out of its developmental processes (Leder, 2015). In the mist of all of these, Mathematics remains the only critical filter in job placement, prestigious position both in academia and the cooperate world (Mireku et.al., 2015).

3.5 CONCLUSION

The theory underpinning the study is the Social Learning Theory. Pupils model and adopt the Mathematics phobia exhibited by their parents, teachers and the entire society. Mothers expressing how they had difficulty studying Mathematics, female teachers who qualify to teach Mathematics at the secondary levels teaching Mathematics at the basic levels female teachers exhibiting anxiety and phobia of Mathematics are all characters girls pick from the society. These norms contribute to their low participation in Mathematics. Just like some parents, teachers and the entire society, girls see nothing wrong with poor performance in Mathematics because the entire society agree

that Mathematics is a no go area for girls. Campbell (1995) established that girls' low confidence, low self-esteem and self-confidence in themselves as scholars in Mathematics together with their discernment of Mathematics as challenging is based on what they see and hear from home as per the Cognitive Developmental Theory, and this contributes greatly to their phobia. It is not surprising Fennama (2000) says girls who do single-sex schooling or who are in out of school projects in Mathematics, and refuse to perceive Mathematics as a completely men dominion inclined to have greater success in Mathematics . Preis and Biggs (2001) concept diagram of a cycle describing Mathematics avoidance and performance was adopted for the study.

The study adopted a conceptual framework from Preis and Biggs (2001) which has four phases revolving around Mathematics anxiety cycle. The study then came up with a seven phase model on Mathematics avoidance and its effects based on the adopted model.

The study identified lots of gaps in relation to gender and Mathematics achievement key of which was Kitetu's pronouncement that the African understanding of gender differences in Mathematics participation and achievement is mainly based on findings from the West. The study aim at adding to knowledge and closing the gap by adding to the general body of knowledge and research work in the area of Mathematics development and female participation with a view to addressing Mathematics phobia among female students in Ghana.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 INTRODUCTION

The focus of this chapter is on how the study was carried out. It discusses the research design, research method, population, sample and sampling techniques, research instrument, validity and reliability of the research instrument, as well as the data collection procedure and method of data analysis. This is to make the study part of the general body of knowledge and research work in the area of Mathematics development and female participation. This dissertation seeks to address the issue of Mathematics phobia among female students.

4.2 CONSIDERATION OF RESEARCH PARADIGMS

Mathematics education, traditionally was modelled and formulated within a perspective called the procedural-formalist paradigm (PFP). This PFP holds Mathematics as objective set of organized logical facts, procedures and skills optimized over a long period of time (Ellis & Berry, 2005). It is generally agreed, that there exits an evolution of paradigms that guide thought and action over time (Hargreaves & Shirley, 2012; Scharmer, 2018; Scharmer & Kaufer, 2013).

The first man to use the term “paradigm” to indicate a philosophical way of thinking in 1962 was Thomas Kuhn, an American philosopher (Kivunja & Kuyini, 2017). This worldview is the thinking or perception, or a set of shared opinions, or school of thought that inform interpretation or meaning of the research data. Lather (1986) cited in Kivunja and Kuyini (2017) explained research paradigm as fundamental reflections of a researcher’s opinions of the world (s)he lives in and intends to stay in. It entails the abstract opinion together with principles which shape the researcher’s perception of the world; how (s)he acts within and interprets the world (Kivunja & Kuyini, 2017).

In organising this dissertation, the study took into consideration the three research paradigms reported by Hussain, Elyas and Nasseef (2013) and viewed them in relation to current research into factors that hamper the acquisition of Mathematics knowledge by females in Ghanaian tertiary institutions and my research problem. The three research paradigms viewed by this study are interpretative research paradigm, positivist paradigm and the interpretive paradigm.

The dissertation seeks to produce an objective and replicable knowledge, using descriptive survey design together with quantitative research method. Structured, predetermined questionnaire, seeking out the construct, concept and dimension on factors that hamper the female growth in Mathematics education was used. Ertmer and Newby (2013) reported that the paradigm was associated with the cognitive theory of learning which tussles to yield accurate results as established theories are usually susceptible to change. Recent research on gender disparities in this paradigm originates from the physical sciences and is focused on the disparities in participation and achievement by the female. Analysed in this study were: a collation of descriptive comparisons of male and female enrolment into Mathematics programmes, description comparisons of theoretical and conceptual relationship between maths knowledge among boys and girls, societal factors that contribute to women falling out in the field of Mathematics, the role of the school, the home and the teacher in the decline of girls in Mathematics education and section e:effect of the decline of Mathematics knowledge on the woman.

Pranas, Jolita and Regina (2018) reported that the interpretative research paradigm adopted by the methods used in this study deals with demonstrating understanding and making sense using informal interview and interaction with respondents. Dagar and Yadav (2016) reported that the social learning theory central to this paradigm is often a constructivist one in which the mind actively make sense of knowledge gained by observation. The interpretative paradigm uses a particular and concrete instance to suggest and illuminate the general case; it provids a rich base which allows its readers to identify and empathise with the subjects studied.

Positivism is considered as "science study" or "scientific technique", “grounded on rationalistic, empiricist idea which originated from Francis Bacon, Aristotle, Auguste Comte, Emmanuel Kant, and John Locke” (Mertens, 2005:8). The Positivism relates to a number of schools of

thought including the naturalism, empiricism, behaviourism, determinism, scientism, and reductionism. Additionally, it "replicates a deterministic idea where effects or outcomes are defined by causes" (Creswell, 2003:7).

This critical-theoretic paradigm is similar to the interpretative paradigm however it concentrates, not only on is gained as knowledge, but on the favourable social inferences as well. That is, social transformation in the positive direction. Recent studies on gender focus on remedying gender disparities. Fox (2015) reported that research on gender in this paradigm is transformed from accounts based on stagnant classifications to socially varying and vibrant classifications. The dynamic in this instance is created by a demonstration of relationships in power and the realization is through constructing differences. In this case, gender is a classified relation generated and regenerated by societal practices; it is a social construction of reality.

4.3 RESEARCH DESIGN

Omari (2011) defined research design as a distinct plan posited to enable a research answer its questions. Creswell and Isack (2015) described research design as the structure, plan and strategy of a research conceived to help find solutions to the research questions as well as control variance. The framework constituting techniques and research methods chosen by this study defines its design.

The descriptive survey describes the current position of an identified variable, in this case factors that contribute to the disparities in Mathematics participation and performance among females beyond secondary school. The descriptive design provided information about the naturally occurring behaviour, attitudes or other characteristics of a particular group in solving a given Mathematical problem. Descriptive studies are conducted to demonstrate associations or relationships among things in the world around humans. To explore opinions in accordance with respondents, representation of the population, the normative survey approach and evaluation were used under the descriptive method. For this study, the survey was very appropriate because it supports the researcher in formulating generalisation. Gay (1992) retains that a descriptive survey is useful when it comes to exploring a range of educational problems including assessment of

attitudes, opinions, demographic information, conditions and procedure. To be able to investigate the different variables that contribute to the decline in the number of women in Mathematics as they climb the social and academic ladder to be able to form generalizations, the survey method was chosen in conducting this study. Additionally, Fink (2002) makes it clear that the descriptive survey deals with documenting, describing and observing features of a condition in their natural state rather than giving explanations to it. This design facilitates the production of good responses from an extensive range of people. Babbie (1990) also explained the descriptive survey as being very useful for generalising from a sample to a population so that inferences can be made about the characteristics, attributes or behaviour of the population.

A descriptive survey involves asking a number of individuals the same set of questions either by mail, telephone or in person. Several writers such as Leddy and Ormrod (2010); Gay (1992), Fink (2002), and Babbie (1990) describe the advantages of a descriptive survey. They asserted its provision of much more precise design of events which seeks the explanation of people's opinion and conduct on according to data collected at a point in time. To Creswell (2002), other usefulness of the descriptive survey include the budget of the design and swift reversal in collecting data.

According to Leedy and Ormrod (2010), "descriptive research examines a situation as it is. It does not involve changing or modifying the situation under investigation, nor is it intended to determine cause-and-effect relationships". Osuala (1993), however, maintains that there is some amount of difficulty in designing questions which are clear, not misleading and can be answered when using the descriptive survey. This stems from the fact that the results of survey can differ considerably. It could as well generate a unreliable results. This is because they investigate into personal issues, many people, as a result, may not be completely honest. Also Fraenkel and Warren (2006), discovered that receiving a satisfactory number of questionnaires returned completed in order to make though provoking analysis is an extra snag of the descriptive survey design. On the other hand, there is a critical demand on the researcher when survey design is used. If this is not carefully managed, it could jeopardize the whole research.

The researcher took the following steps to correct the weaknesses associated with the descriptive survey. The items on the questionnaires were channelled by the guidelines provided by Leedy and

Ormrod (2010). This kept the questions short, respondent's task simple, providing clear instructions, using simple, clear, unambiguous language, and thus giving a justification for items whose purpose could be imprecise and conducting one or more pilot tests to determine the validity of the questionnaire. The reason was that experienced researchers conduct a test on newly designed questionnaires to ascertain the clarity and effectiveness of the questions if they will solicit the desired information. It is against this backdrop that the descriptive survey design was considered by this researcher as the most appropriate to assess the factors contributing towards the drop out of women in Mathematics as they progress academically.

The researcher used the quantitative methods Rahman (2016) defines quantitative research as a research strategy that emphasises quantification in the collection and analysis of data. Quantitative design is the systematic investigation of phenomena through gathering quantifiable facts and performing statistical, mathematical or computational analysis. it tries to find answers to concrete questions by generating numbers and facts. The goal is to establish a 'representation' of what the population do or what a respondent thinks (Barnham, 2015). It attempts to investigate the answers to the questions starting with how many, how much, to what extent (Rasinger, 2013). In other words, the method lays heavy stress on measuring something or variables that exist in the social world.

The quantitative method tolerates the formulation of the research problem in very explicit and set terms (Khalid & Dileep, 2012). It minimises subjectivity of judgement (Charleston, Gajewska-De & Chapman, 2018). It is generally deductive in its approach. The quantitative approach focuses on obtaining numerical findings from the use of the questionnaire. It is used to answer questions on relationships within measurable variables with an intention to explain, predict and control a phenomena. Quantitative study usually ends with confirmation or disconfirmation of the hypothesis tested. (Gay, Mills & Airasian, 2009). Quantitative research drives widely on steps which guide the research process (Fraenkel, Wallen & Hyun, 2012). The quantitative research process along with its various designs is fairly well established with little flexibility in terms of the strategies and techniques employed. It operates on the principle that nothing should be left to chance, therefore no aspect of the research design is permitted to emerge during the process which is in line with this study's fundamental principles.

The quantitative findings can be generalised to an entire population or a sub-population due to its involvement with a larger sample randomly selected (Rahman, 2016). Apart from the sampling, data analysis is less time consuming because of the use of statistical software such as SPSS (Raman, 2016). Rahman contented in their study on TOEIC tests, that it sample reflected the bigger section (2300) of TOEIC test-taking populace which helped in making the research truth-worthy (Rahman, 2016). The quantitative research design is mainly based on the positivist concept of measuring variables (Rahman, 2016). Several variable are conveniently managed by the quantitative research design. For example, it observed in a research of second language eloquence by Préfontaine, Kormos and Johnson (2016) that several variables such as class were used: variables beginning, intermediate and advanced; native speaker (British, American, and Canadian).

The afore mentioned merits of the quantitative research design offered a more comprehensive approach to finding answers to the research questions especially since many questions in Mathematics phobia among female students involve more variables.

Information was collected from the mathematicians across the academic ladder and statistical data on students' enrolment for B.Sc, B.Ed Mathematics, M.Ed, M.Sc, M.A, M.Phil Mathematics and Ph.D Mathematics using each approach concurrently.

The quantitative research design brought about the "to what extent", "know what" and "know why" these are the fundamental questions in the research design. The research merged the questionnaire and enrollment data in this study, typically by bringing the separate results together in the interpretation during the analysis.

The study was directed towards the ideas, opinions, and attitudes of female students towards Mathematics as they progress academically. A questionnaire and structured interview guide were used as instruments in collecting data

4.2.1 Justification of the design for this study

The research problem, research questions and the purpose sometimes result in or call for a methodology which combines the advantages of diverse quantitative designs without necessarily following the philosophical presumptions inborn in those designs. Under the circumstance, choosing and selecting a quantitative research design provided the needed flexibility (Schoonenboom, & Johnson, 2017).

Quantitative research study allows broader inquiry. It entails a countless number of subjects, and improves the overview of the outcomes (Babbie, 2010). Accuracy and objectivity of results are ensured when qualitative research design is used. For the most part, quantitative strategies are outlined to provide synopses of data supporting generalities about the phenomenon that surrounds the study. To achieve this, quantitative investigation often comprises few factors and numerous cases; it utilizes endorsed methods to guarantee reliability and validity.

Quantitative studies allows the implementation of conventional criterions. The meaning of this is, the study could be replicated, analyzed and matched with related studies. A summary of vast sources allows comparisons over categories and over time. Finally, a personal prejudice can be dodged by maintaining a distance from partaking subjects together with the utilization of established computational methods. (Nagel, Towell, Nel, & Foxall, 2016)

4.3 RESEARCH METHODS

The tool used is survey. To be precise descriptive survey, was used without a deliberate effort to control the variables. Survey is defined as "bringing together facts from sample of individuals through their responses to questions" (Check & Schutt, 2012, p. 160). It allows for a diversity of methods to put together participants, collect data, and utilize various methods of instrumentation. Survey can use quantitative research strategies (using questionnaires with numerically rated items), qualitative research strategies (using open-ended questions), or both strategies (i.e., mixed methods). As it is often used to describe and explore human behaviour, surveys are therefore frequently used in social and psychological research (Singleton & Straits, 2009).

4.4 PARTICIPANT SELECTION

4.4.1 Population

Population according to Kaul and Kaul (1992), Fraenkel and Warren (2006), refers to the entire set of individuals (subjects or events) with collective observable features which the study is interested in. Noori (2018) defines population as a group of elements or cases whether individuals, objects or events that conform to specific criteria and to which we intend to generalise the results of the research; also referred to as target group. Fink (2002) refers to population as any collection of a specified group of humans or non-human entities. Fink (ibid) maintains the criterion for the inclusion of a unit into a survey is based on the characteristics of respondents who are eligible for participation in the survey.

The population for the study comprised all university students in Ghana. Both the male and female population of undergraduates, graduates and Ph.D students were considered.

4.4.2 Sample and sampling technique

A sample, according to Ortell, Switonski, Delaney (2019) is a portion or subset of a larger group. It represents a portion of a population with important characteristics such as gender, age and status, which are proportionately distributed in both groups. The importance of samples lies in the accuracy with which they represent or mirror on the target population. Leedy and Ormrod (2010) emphasised on the careful selection of the sample. This is to enable the researcher to identify the features and or characteristics of the entire population which is in the same proportion. It also identifies the relationships the research seeks to examine among the total population. According to Ortell et.al. (2019), sampling is efficient and precise in that those resources that might go into collecting an unnecessary number of individuals or groups can be spent on other activities of the research. It helps to focus the survey on precisely the characteristics of interest samples, which were expected to be representative of the population. Samples are, therefore, chosen by means of sound methodological principles.

Sample size has no fixed rule regarding the number to be selected and ideal percentage to work with. Decision on number or percentage of the population to be sampled depends on the conditions of the study situation (Hammarberg, Kirkman, Lacey, 2016).

Purposive sampling, a non-probability sampling method, was employed in selecting the respondents. According to Palinkas (2015), purposive sampling is used when researchers use a special skill about some group to select subjects who represent the population. Etikan, Abubakar and Alkassim (2016) agree that purposive sampling is based on the researcher's knowledge of the population. Judgement is made about which subjects should be selected to provide the best information to address the purpose of the research. Guetterman (2015), on the other hand, argues that researchers intentionally select individuals and sites to learn or understand the central phenomenon. The standards used to choose individuals and sites depend on whether they are information-rich (Etikan et.al., 2016). The participants were said to be information-rich as they either had a first degree or higher in Mathematics.

The researcher, therefore, focused on individuals who studied Mathematics in college or had a higher degree in Mathematics. This is because the mathematicians were likely to mention factors that contributed to the fall out of women in Mathematics as they progress academically. They were also expected to objectively discuss their experience and how they survived it to the level that they were. The balloting method was used to select from the sampled size from the selected institutions. This was in line with the guidelines provided by (Osuala, 1993 cited in Osuala, Onwuagboke, & Chukwudebelu, 2015). Together with the simple random sampling the balloting method could be used to select the sample size. The balloting method refers to the random selection of numbers, with each number corresponding to a subject or item, in order to create the sample (Crossman, 2019). A simple random sample technique call for a real sampling frame and the list of all the person involved in the sampling frame. List of Mathematics students were collected from the various Mathematics departments in the eight sampled institutions. A sampling frame was then created out of the list by numbering every member in the department sequentially and then randomly selecting the members from the entire population.

The simple random sampling (balloting) was chosen because of its ease of use. Unlike more complicated sampling methods, such as stratified random sampling and probability sampling, there is no need to divide the population into sub-populations, no need to take any other additional steps in selecting members of the population at random. It is meant to be an unbiased representation of a group and considered a fair way to select a sample from a larger population since every member of the population has an equal chance of getting selected.

The population consisted of about thirty five thousand (35,000) students. Of these, about twenty seven thousand nine hundred (27,900) were undergraduate students, seven thousand (7000) were Master's students and one hundred (100) were Ph.D students. Out of these thirty four thousand, a total of two hundred and forty one (241) undergraduate, one hundred and nineteen (119) first degree holders, ten (10) graduate students, twenty eight (28) master's degree holders and two (2) Ph.D students were randomly sampled from thirty five thousand (35,000) populaiton in the eight universities. This is in line with guidelines provided by Gay et al. (2009) as cited in Leedy and Omrod (2010) that if the population is above 5000, then 400 should be sampled. Permission letters to obtain data from staff and students in the Mathematics departments were sent to all University authorities and the Heads of Mathematics Department in the sampled Universities. The Heads of Department approved of the given out list of students in the department which was used to create the sampling frame for the balloting. The balloting method was used to select the four hundred respondents. Getting the necessary information from the heads of departments of the universities involved was not easy. However, the researcher explained the relevance of the data as far as the research was concerned.

4.5 RESEARCH INSTRUMENTS

Primary data, (questionnaire) and secondary data, which is enrolment of students into the Mathematics department in UCC were used. Appendix A, Appendix B and Appendix C were employed. A self- designed questionnaire (Appendix A) was the major instrument for the data collection. Two strategies were adopted in distributing the questionnaire, one was through the mail and two was done face to face. Questionnaires were sent through mail to the Ph.D and Master's students who were hard to reach. A total of 550 questionnaire were distributed. Two hundred and

seventy (270) to undergraduate, one fifty five (155) to first degree holders, fourty (40) to graduate students, seventy (70) to master's degree holders and fifteen (15) to Ph.D students. The responses to the items were designed on a four-point Likert scale. Thus; Strongly Agree (SA) 4, Agree (A) 3, Disagree (DA) 2, and Strongly Disagree (SD) 1. There was a 72.7% response rate. Extract of the questionnaire is shown below.

"**SECTION B: THEORETICAL AND CONCEPTUAL RELATIONSHIP BETWEEN MATHEMATICS KNOWLEDGE AMONG BOYS AND GIRLS.**

Do boys and girls learn Mathematics under the same conditions?

Use a four-point scale ranging from Strongly Agree (SA) 4, Agree (A) 3, Disagree (DA) 2, and Strongly Disagree (SD) 1.

Construct

6. Mathematics is a very difficult subject and must be reserved for only brilliant boys.

   1 2 3 4

Concept

9. Boys usually explore, lay bricks etc., activities that facilitates the development of their spatial skills giving them an upper hand when it comes to performance in Mathematics .

   1 2 3 4

(See Appendix A - Questionnaire For Cross-Sectional Survey).

Space was created for errors since findings from the sampled population would be generalized across the sampled institutions and Ghana in general. The reason for the Likert scale was that it is easier to construct and score more than the Thurston or Guttman scales (Osuala, 1993). In addition, the Likert type scale produces more homogeneous scales; allows the subject to indicate the degree or intensity of feelings, and permits the spread of variance.

The respondents were made up of both men and women who did BEd and BSc in Mathematics or had a higher degree in Mathematics and were given time to answer the Likert type scale questionnaires from their institutions where they were randomly selected. This provided useful information to support theories and concepts in the literature and later allow for participants to provide personal experiences (Creswell, 2002).

Questionnaires are particularly advantageous whenever the sample size is large enough to make it uneconomical for reasons of time or funds to observe or interview every subject. The sample size for the study was very large, and questionnaire made it easy for the researcher to reach out to respondents in and outside Ghana at the time of the data collection. It permits a wide coverage at a minimum expense, both in cash and effort. Its coverage in geographical terms is wider than any other technique and can reach out to individuals who are normally difficult to contact. The questionnaire elicits more candid and more objective responses and it does not demand any form of identification (IEDE, 2006). The study was able to reach out to all respondents across the country either by face to face or through email. The questionnaire were administered through the manual deliver and web (email and Whatsapp) delivery. The questionnaire was piloted in the University of Ghana and tested with Cronbach's alpha.

4.6 VALIDITY AND RELIABILITY OF INSTRUMENTS

4.6.1 Validity

Validity refers to how well an instrument measures what it is intended to measure. Valid is inferred from the Latin word "validus", which means strong. The legitimacy of an instrument for estimation (test for example), is the point at which the instrument measures what it asserts to measure (Mlambo, Jelsma, Rusakaniko, Dale & Chingono, 2017). Legitimacy is based on the quality of the collection of diverse evidence (such as construct validity, face validity, etc.).

Validity in psychometrics, has a specific application called test validity: the point where theory and evidence support the translations of test scores entailed by anticipated use of the tests (Elsworth, Nolte & Osborne, 2015). The concept of scientific validity is generally accepted as

addressing the reality in terms of statistical measures hence philosophical and epistemological issues including question of measurement. The logical use of a term is narrower, connecting it to the relationship between the premises and conclusion of an argument. The end of an argument is genuine in the event that it is sound. This implies that the argument is substantial and its premises are genuine (Miyazaki, Fujita & Jones, 2017)

Statistical or scientific validity by contrast is not a deductive claim which is certainly truth preserving; it is however, an inductive claim that remains genuine or false in an undecided way. This is why logical or factual legitimacy could be a claim or, competent as being either powerful or powerless in nature; it is never essential nor certainly genuine. This has the impact of making claims of logical or factual validity open to elucidation as to what the truth of the matter is. Validity is critical since it can assist in deciding what sort of tests should be utilized. It can also enable researchers to opine their positions without a doubt as they strategize moral, lost – effective ways that further thoughts and discussions (Miyazaki, Fujita & Jones, 2017).

There are three major categories of validity: content validity, construct validity and criterion validity. Content Validity takes into consideration whether the instrument adequately covers all the content that it ought to with regard to the variable (Heale & Twycross, 2015). This includes checking if the instrument entirely covers the domain which relates to the variable, or develops it with the intension to measure. In a Mathematics study with concentration on phobia and anxiety, an examination of the content validity covers the entire content with emphasis on the themes that had gotten more in-depth or prominent in scope. The face validity is a subset of content legitimacy, where specialists give their opinion about whether a stated instrument take account of the concept it is expected to measure (Heale & Twycross, 2015).

The second, construct validity alludes to whether inferences could be drawn round a test score relative to what is being learnt (concept). Example, should an individual score high in a survey measuring anxiety, and can a conclusion be drawn that the individual is highly anxious? Considering another example of a test in medicines requiring calculations in dosage might test Mathematics knowledge instead (Heale & Twycross, 2015).

Three sources of evidence could be utilized in testing the existence of construct validity in the instrument used in a research:

1. Homogeneity – means the instrument can measure one construct.
2. Convergence – it usually occurs when the instrument is being used to measure concepts close to the other instruments. That means this task cannot be performed where there is no similar instruments available
3. Theory evidence – this becomes clear once conduct is closely related to theoretical intentions of the measured construct within the instrument. An example would be, if anxiety is measured by the instrument; it is expected that participants whose scores are higher demonstrate symptoms of anxiety even in their day-to-day lives (Korb, 2012).

The third and last measure of validity is criterion validity. It refers to any instrument that can measure the same variables. In seeking to find the degree at which diverse instruments can measure the same variables, correlations can be conducted. Criterion validity is measured in three different ways:

1. Convergent validity – this demonstrates how highly an instrument is interconnected with instruments that measure related variables.
2. Divergent validity – this shows how poorly an instrument is correlated to instruments that measure different variables. For instance, there ought to be a lower association between an instrument measuring motivation and one measuring self-efficacy.
3. Predictive validity – this refers to an instrument having a high correlation with future criterions. Example would de scoring high in self-efficacy in relation to performance of task that seeks to predict the probability of a participant completing a task (Heale & Twycross, 2015).

Validity, in this study refers to the provision of data by an instrument true to what was being studied (Taherdoost, 2016). Instrument of this nature can ensure the elimination of distortions from extraneous variables, thus ensuring the validity both externally and internally (García-Pérez, 2012).

4.6.2 Reliability

Reliability in this study refers to the degree to which findings of the study are independent of accidental conditions of the research (Liew & Noraini, 2017). A situation of such nature ensures regularity of results in the event of duplication of the study (Southall & Wason, 2016). This study also ensured reliability through the use of enrollment into the Mathematics emerging from sections of the population. Controversial issues or deviations and diversions from elements within the population such as investigations on male participation and performance in Mathematics , decline in the number of women is as a result of enrolling in universities outside Ghana etc. were noticed. They were followed by constructive and objective discussions in order to maintain and retain the reliability of the instruments that were used to collect data.

The reliability of any given measurement refers to the extent to which it is a consistent measure of a concept. Cronbach's alpha is one way of measuring the strength of that consistency (Goforth, 2015). High quality tests are important to evaluate the reliability of data supplied in any research study. Cronbach alpha is a commonly employed index of test reliability. The coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors extracted from dichotomous and/or multi-point formatted questionnaires or scales. The higher the score, the more reliable the generated scale is. Sorkum (2019) has indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the literature. Sharma (2016) argues that low value of alpha could be due to a low number of questions and consequently the low correlations among pairs hence some items may be deleted. If alpha is too high and very close to one another then it may suggest that some items are redundant as they are testing the same question but in a different guise. A maximum alpha value of 0.90 has been recommended (Streiner, 2003 cited in Sharma, 2016). Cronbach alpha was calculate in this study at $\alpha = 0.871$.

In a quantitative study, the second measure of quality is consistency, or the exactness of an instrument. This means that the degree or extent to which an instrument for a study is reliable has the same outcome in the event that it is used within a similar condition on rehashed occasions. Example of reliability and validity is an vigilant clock that is set to ring at 8:00 every morning,

however, it has been set for 7:30. It is extremely dependable (it rings reliably at the same time daily), it is validity was however questionable. (It did not ring at the expected time). It's critical to contemplate reliability and validity of tools (instruments) being used to collect the data in the conduct or critiquing of a research. Tools for the study were carefully selected to ensure reliability and validity.

4.7 DATA ANALYSIS

Enrolment of undergraduate, graduate and Ph.D students from 2012 to 2016 into the Mathematics department at the University of Cape Coast (UCC) was analysed. The enrolment data was to provide trends of women participation in Mathematics at the various levels of education. Questionnaire was administered to respondents in the eight sampled institutions. The data went through a four step process for validation and identifying any fraud; to infer whether each respondent actually completed the questionnaire completely. There was screening to make sure that respondents were chosen as per the research criteria. Procedures ensured that the data collection procedure was actually followed. Completeness: making sure that the questionnaire actually had all the relevant information to answer the research question. The data was then edited to check for error. For example, respondents may skip fields accidentally or fill them incorrectly. The researcher conducted basic data checks, check for outliers, and edit the raw research data to identify and clear out any data points that may hamper the accuracy of the results. Hence the enrolment data from UCC and questionnaires were coded after the check for errors, omissions, legibility and consistency with Cronbach alpha. The coding was done by grouping and assigning values to responses from the survey. Four hundred (400) respondents were sampled to complete the questionnaire. The study wanted to find the average age of the respondents so, age buckets were created categorizing the age of each of the respondent as per these codes simplifying age brackets, rather than a massive range of individual ages. Cross-tabulation was used in analysing the data. Cross-tabulation uses a basic tabular form to draw inferences between different data-sets in the study. It contains data that is mutually exclusive or have some connection with each other. The outcome was then described and interpreted using descriptive statistics. Iterative research methodology was employed. By this, both Appendix A and B were analysed systematically, repetitively, and recursively.

4.8 ETHICAL CONSIDERATIONS

Research ethics is a multifaceted construct. Essentially it is concerned with the principles of good and bad conduct, it reflects various epistemological paradigms and methodological practices within particular social and cultural contexts (Hall, Moreau & Trussell, 2012).

Ethical clearance was sent to University of South Africa (UNISA). Permission and application were sent to the Department of Mathematics: University of Ghana Legon, Kwame Nkrumah University of Science and Technology, University of Professional studies, University of Cape Coast, University of Education Winneba, University of Development Studies, Valley View University College, Central University, Accra Institute of Technology to distribute questionnaire to some randomly selected members of the departments. Application was also sent to the University of Cape Coast for enrollment data into Mathematics (see Appendix D and E.)

The Heads of Departments were engaged in a discussion on the permission. Some Heads of Department and their colleagues had their own reservations. Some were uncomfortable with the time the researcher will engage the students thinking it will go into their instructional time. Others said they don't even see the finding of such studies after they have contributed. On the part of the students, whiles other were curious and wanted to learn from how questions are constructed for such study, others were not ready to spend their time completing questionnaire. The researcher engaged all, from HODs through staff and to students. Fortunately the questionnaire was not lengthy and it was self-explanatory. Others said it was fun answering some of the questions.

Confidentiality was assured to all who gave out information for the study and it was enforced. The data was securely conserved in a locked file cabinet to which only the researcher had access. Subsequently the collected data involved learners in a tertiary institution in which ethics approval were sought from their respective universities.

4.9 CONCLUSION

This chapter looked at the research design and method, the population for the study, the sampling technique and sample size. It explained the data used for the study, how the data was processed and analysed. The chapter again looked at ethical issues and Cronbach alpha was calculated at $\alpha = 0.871$. The researcher acted as both researcher and, to some extent, change agent though the role was not explicitly the purpose of the study. This dual role of practitioner-researcher helped specifically because the researcher has gone through and survived the odds and encountered girls who would want to pursue Mathematics yet feel it is a domain for men, the role of teachers, parents, school and society at large in the gender disparities in Mathematics participation and performance.

The ensuing chapter will look at basic information of respondents, theoretical and conceptual relationships, the role of the school, home and teacher in the decline in the women participation in Mathematics and the effect of the decline of Mathematics knowledge.

CHAPTER FIVE

ANALYSIS AND DISCUSSIONS

5.1 INTRODUCTION

The focus of this chapter is on data analysis and discussions of the field information. It covers the basic information of respondents, comparison of the theoretical and conceptual knowledge of Mathematics among males and females, societal factors that contribute to women falling out of Mathematics Education, the role of societal institutions as well as the effects of Mathematics anxiety and phobia on females.

5.2 BASIC INFORMATION OF RESPONDENTS

The basic information of respondents covered the institutions they studied at, their gender, age, the highest level of education attained and the kind of degree pursued. This basic information was deemed necessary to achieve the purpose of the study.

5.2.1 Institutions used for the survey

The main institutions sampled for the study were the University of Ghana and Kwame Nkrumah University of Science and Technology (KNUST) which constituted 16.3 percent each of the total number of respondents. These two public institutions had the highest number of respondents as they offer an extensive Mathematics courses. The next institution with a high level of respondents is Central University which is a private institution representing 16 percent. The institution with the least number of respondents was University of Professional Studies UPSA which constituted only 3.5 per cent of the total number of respondents. Figure 5.1 below shows the percentage of each institution in a pie chart form.

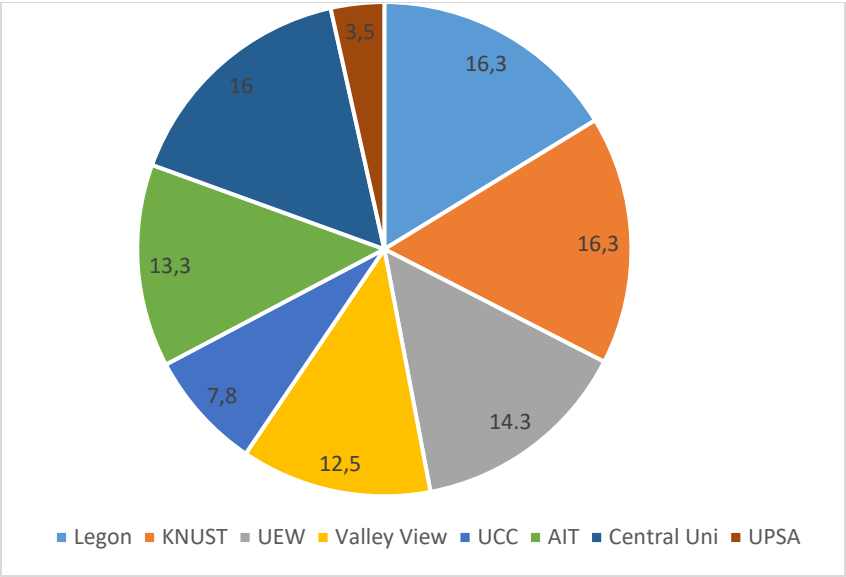


Figure 5.1: Institutions used for the survey

Source: Researcher's Construct, 2017

5.2.2 Gender distribution of respondents

The gender distribution of respondents, which was the most important basic data for the study, was investigated. It was realised that only 21.3 per cent of the sampled population were female and the rest were male, an indication that women are underrepresented when it comes to higher education in Mathematics . Figure 5.2 shows the gender composition of the respondents.

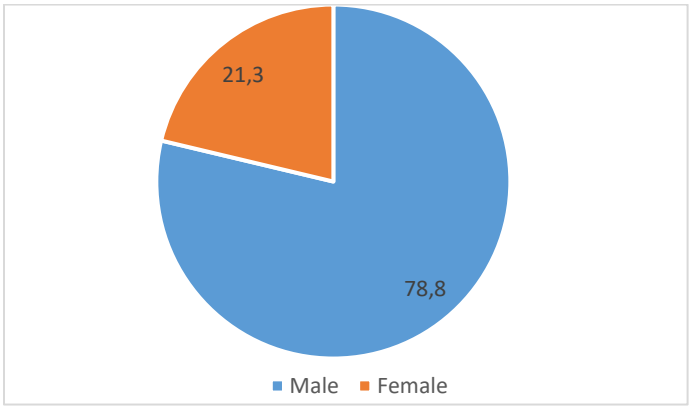


Figure 5.2: Gender distribution of respondents

Source: Researcher's Concept, 2017

5.2.3 Age range of respondents

The age range of respondents indicated that the majority of the respondents were between the ages of 21 and 30 (49.5%) and 40.5 per cent were between the ages of 15 and 20 years. This gave an indication that people who study Mathematics in tertiary institutions are in the youthful age group as only 5.8 per cent and 4.3 per cent were between the ages of 30 and 40 and above 40 years respectively. Figure 5.3 below shows the age range of the sampled population.

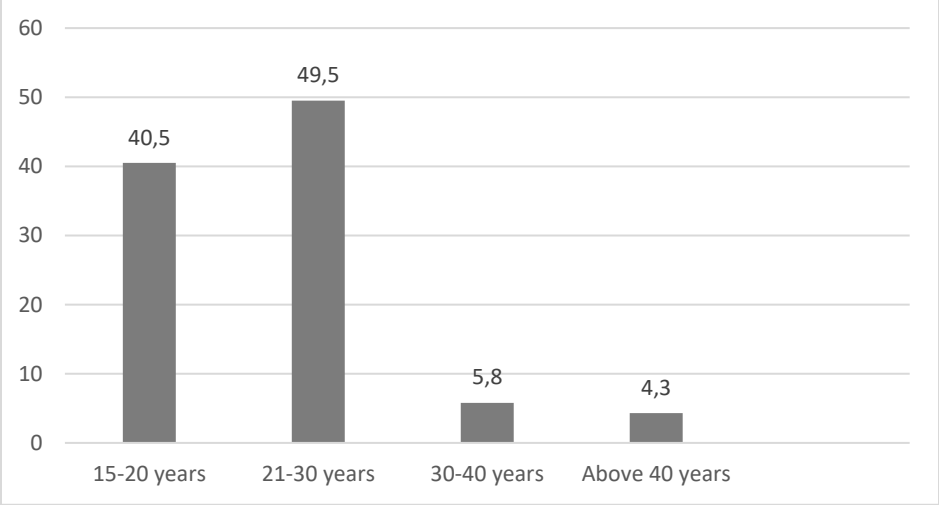


Figure 5.3: Age range of respondents

Source: Researcher's Construct, 2017

5.2.4 Highest level of education attained by the respondents

The highest level of education was important to the study in the sense that it spelt out the experience of the individual respondent in the field of Mathematics hence the knowledge of the respondent as far as the problems of Mathematics teaching and learning are concerned. Sixty point two per cent (60.2%) of the respondents were undergraduate students studying Mathematics, Mathematics and Statistics, Mathematics and Business, Actuarial Science, Mathematics with Economics and Statistics in the sampled universities. The next highest proportion was the first-degree holders in the above-mentioned courses; they constituted 29.8 per cent. Ph.D students

constituted 0.5 per cent, Master's students constituted 2.5 per cent and Master's Degree holders constituted 7 per cent. See figure 5.4 below for the illustration of this information.

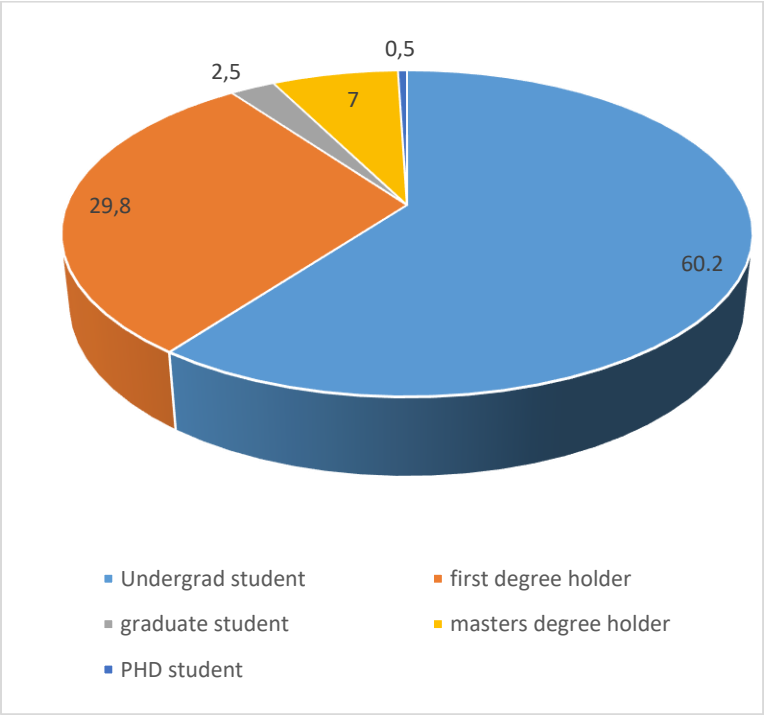


Figure 5.4: Highest level of education attained by respondents

Source: Researcher's Construct, 2017

5.2.5 Degrees pursued by respondents

The degree pursued by respondents was also assessed and it was found that a majority of the respondents were studying their first degree in Mathematics, Mathematics and Economics, Mathematics and Business or Actuarial Science. This represented 61.8 per cent of the total number of respondents. About 37.7 per cent were studying towards their Master's degree and only 0.5 per cent were pursuing Ph.D courses, which constituted the lowest proportion. Figure 5.5 shows this information.

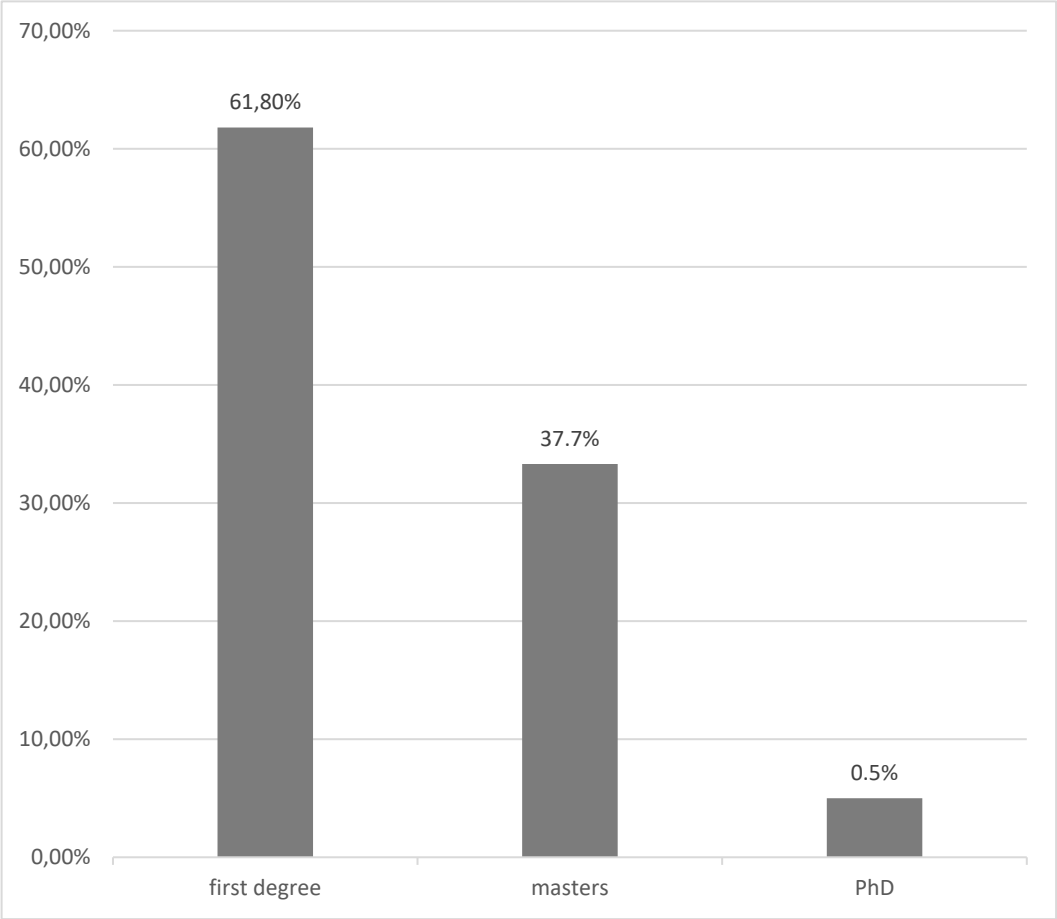


Figure 5.5: Degrees pursued by respondents

Source: Researcher's Construct, 2017

5.2.6 Comparison between gender and the highest level of education attained

The study assessed the number of female respondents who had attained a certain level of education in Mathematics. This was to confirm the findings of the research that few women further their education in Mathematics-related fields. Table 5.1 shows a cross tabulation between gender and the highest level of education attained by respondents.

Table 5.1: Cross-tabulation of gender and the highest level of education attained

	The highest level of education attained	**Total**

		Undergrad student	first degree	graduate student	Master's degree holder	Ph.D student	
Sex	**Female**	45	27	4	9	0	85
	Male	196	92	6	19	2	315
Total		241	119	10	28	2	400

Source: Field Survey, 2017

It is evident from Table 5.1, that 85 out of the 400 sampled population were females. This represents 21.25% of the population. It is, therefore, evident that the female constituted the smaller group in the sample. This was not deliberate but as a result of the scarcity of female students in the Mathematics departments at the sampled institutions. A majority of the few ladies had their first degree in Mathematics. There was no female Mathematics Ph.D student and only nine had obtained their Master's degree and four were graduate students. This confirms the general trend of low enrollment for females in Mathematics for all the levels of academic pursuit. Appendix C (1) is evident (enrollment of students into Mathematics programme from 2012-2016) given the distribution of women within the said period. For instance, out of the total of ninety-four (94) who were enrolled for MSc, MPhil in Mathematics and Statistics, only thirteen (13) were women. Out of the fifteen 15 who were enrolled for Ph.D Mathematics between 2012 –2016, only two (2) of the fifteen (15) were females. From Appendix C (2), undergraduates' enrollment from 2012-2016, out of a total of 58 students registered to pursue Mathematics at the undergraduate level only seven students were females. Only two (2) out of the fourteen (14) individuals who enrolled for Ph.D in Computer Science were female. From the analysis, Appendix C and limited literature on the study from the Ghanaian perspective, Damarin's (2008) assertion of reduction in research on this topic as a result of the perceived assumption that the problem has been "solved" is clearly reflecting. The problem is existing and there is limited literature in Ghana. The study identified the persistence of gender differences in the number of students who took Advanced Mathematics courses (Catherine, 2017) and who pursued Mathematics-related careers (Jacobs, 2005).

Findings from this study support an earlier study by Smith, Smith and Verner (2013) who found that in Australia and Sweden, more males than females studied the most demanding Mathematics courses at school and in higher education.

5.2.7 Comparison between institutions and gender

The study assessed the sampled institutions with the highest number of females studying Mathematics courses. Table 5.2 presents the institutional gender comparison.

Table 5.2: Cross-tabulation of gender and institution

		Name of institution								Total
		Legon	KNUST	UEW	Valley view	UCC	AIT	Central Uni	UPSA	
Sex	Female	17	8	12	12	10	7	15	4	85
	Male	48	58	46	38	22	45	48	10	315
Total		65	66	58	50	32	52	63	14	400

Source: Field Survey, 2017

From Table 5.2, Legon had the highest number of female Mathematics students (17) followed by Central University (15). University of Education, Winneba and Valley View followed with (12) each then UCC 10, Kwame Nkrumah University of Science and Technology 8, Accra Institute of Technology 7 and University of Professional Studies Accra 4 which is the least number of students sampled for the study. Kwame Nkrumah University of Science and Technology had the highest number of males followed by Legon and Central University. This was followed by University of Education, Winneba, Accra Institute of Technology, Valley View, the University of Cape Coast and UPSA. University of Professional Studies Accra had the lowest number of both female and male respondents.

5.2.8 Comparison between institutions and the highest level of education attained

A comparison was done between institutions and the highest level of educational attainment. This was done in order to assess which institutions had the highest number of students attaining a specific level of Mathematics qualification. Table 5.3 shows a summary of the cross tabulation of the responses gathered.

Table 5.3: Cross-tabulation of institutions and the highest level of education attained

Name of institution	The highest level of education attained					**Total**
	Undergrad student	First degree	Graduate student	Master's degree holder	Ph.D student	
Legon	40	20	1	4	0	**65**
KNUST	43	15	0	7	1	**66**
UEW	35	18	3	2	0	**58**
Valley view	34	14	1	1	0	**50**
UCC	18	12	1	0	1	**32**
AIT	33	15	2	2	0	**52**
Central Uni	36	13	2	12	0	**63**
UPSA	2	12	0	0	0	**14**
Total	**241**	**119**	**10**	**28**	**2**	**400**

Source: Field Survey, 2017

From Table 5.3, the students sampled from Legon were sixty-five (65), out of this number forty (40) were undergraduate students, twenty (20) of them were first degree holders, and four (4) were Master's degree holders. No Ph.D student was available for sampling in Legon. Sixty-six (66) respondents were sampled from Kwame Nkrumah University of Science and Technology and out of this number, forty-three (43) were undergraduate students, fifteen (15) were degree holders, seven (7) were Master's degree holders and one (1) Ph.D student.

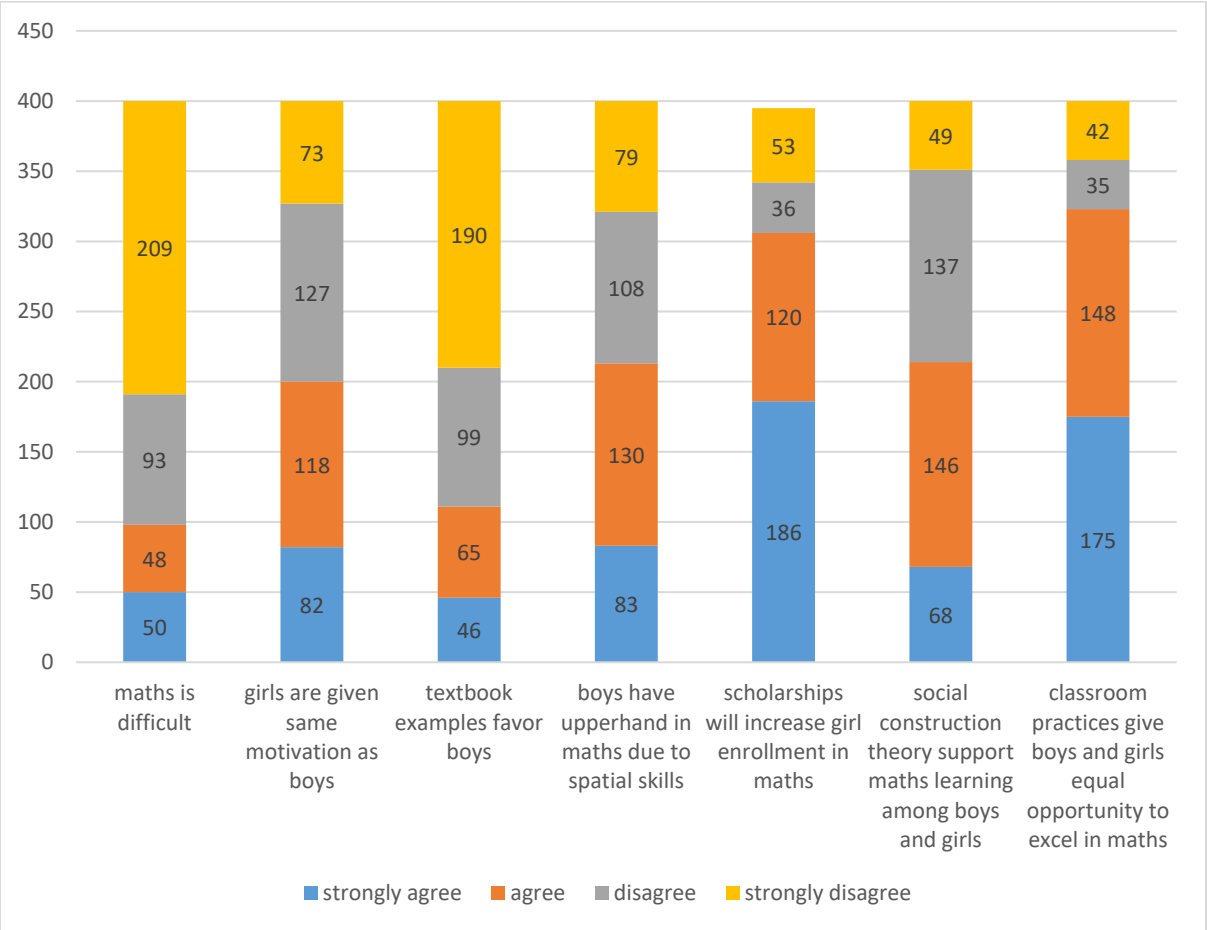
University of Education, Winneba had fifty-eight (58) respondents and out of this number, no Ph.D student was sampled. Majority of the respondents, thirty-five (35) were undergraduate students with eighteen (18) of them being first degree holders, three (3) graduate students and two (2) Master's degree holders. In Valley View University, fifty (50) students were sampled and out of these, thirty-four (34) were undergraduate students, thirteen (13) degree holders and one (1) Master's degree student and one (1) Master's degree holder. In UCC, thirty-two (32) students were sampled. Of these, eighteen (18) were undergraduate students, twelve (12) were first degree holders, one (1) graduate student and one (1) Ph.D student.

At Accra Institute of Technology fifty-three (53) students were sampled and out of this number thirty-three (33) respondents were undergraduate students, fifteen (15) were degree holders, two (2) were graduate students, two (2) were Master's degree holders and no Ph.D student was sampled. Central University had sixty-four (64) respondents with thirty-six (36) undergraduate students, twelve (12) first degree holders, two (2) graduate students, twelve (12) Master's degree holders and no Ph.D candidate. Lastly, University of Professional Studies Accra had only twelve (12) respondents with two (2) being undergraduate students and fourteen (14) being first degree holders.

5.3 THEORETICAL AND CONCEPTUAL RELATIONSHIP BETWEEN MATHEMATICS KNOWLEDGE AMONG BOYS AND GIRLS

The theoretical and conceptual association between Mathematics knowledge among boys and girls were assessed based on certain constructs, concepts and dimensions. These constructs, concepts and dimensions covered how the biological construction of females contribute to Mathematics anxiety and phobia, the perception of the level of difficulty associated with Mathematics and the level of support the female receives, among others. Responses were analysed using a four-point Likert scale. Figure 5.6 below shows a summary of the responses.

Figure 5.6: Theoretical and conceptual relationship between Mathematics knowledge among boys and girls



Source: Researcher's Construct, 2017

5.3.1 Mathematics is difficult and should be reserved for males

From figure 5.6, fifty (50) respondents strongly agreed that Mathematics is a very difficult subject and must be reserved for only brilliant boys. Forty-eight (48) agreed, ninety-three (93) disagreed and two hundred and nine (209) strongly disagreed. Further analysis showed that, out of the fifty (50) respondents who strongly agreed, forty-five (45) were female and twenty-two (22) out of the forty-eight (48) who agreed were also females. On the other hand, the majority of those who strongly disagreed that Mathematics is difficult were males representing one hundred and thirty-two (132) respondents. Out of the ninety-three (93) who disagreed, the male constituted eighty

(80). This gave an indication that most females felt Mathematics is difficult and hence must be pursued by males.

Even though Mathematics remains a vehicle to a successful and prestigious position both in academia and the corporate world, and could be pursue by any person who is determine to, it needs commitment and constant practice. Both the male and female should be given the same opportunity to practice as well as stay committed. Another exaggerated general argument is that Mathematics is the easiest subject and can be pursued by everyone since it is based on principles. To this point, it is belief that if girls are relieved of the numerous house chores and are given enough time to study, they can match up to boys in participation and performance in Mathematics. This argument is often supported by the simplistic logic prevalent in African communities that the girl child is always with mummy cooking all the meals, doing all the dishes, washing all the dirty clothing while the boy is either playing with friends outside or engaged with daddy doing things that promote the development of spatial skills. In conclusion, this study identified Mathematics as a domain for all should both the male and female be given equal opportunities.

The finding is consistent with that of Salifu (2017), which saw students early in Junior High School in the Tolon District regarding Mathematics as a male-domain and a subject for the high achievers. It is again consistent with that of Uwineza, Rubagiza, Hakizimana, and Uwamahoro (2018), who deduced from their study that Mathematics tend to be perceived as a no go area for the female both in teaching and learning. It is also consistent with the findings of Odogwu and Lawal (2018) which saw female teachers qualified to teach in senior high schools in Nigeria teaching in junior high schools for the avoidance of encountering and teaching higher Mathematics. Finally the finding is consistent with that of Yarkwah (2020) which says that even when the female performed equally well in Mathematics as the male, they demonstrate negative attitudes when it comes to participation in Mathematics as a result of the greater phobia and anxiety they have towards the study of Mathematics .

5.3.2 Girls are given the same motivation and support as boys in the home, school and society to study Mathematics

Comparing the level of motivation each gender receives in the study of Mathematics, it was found that eighty-two (82) respondents strongly agreed that girls are given the same motivation and support at home, in school as well as in the society. Out of this number, sixty-seven (67) were male. Of the one hundred and eighteen (118) respondents that agreed, seventy-six (76) were male and of the one hundred and twenty-seven (127) that disagreed, one hundred and nineteen (119) were male. Of the seventy-three (73) that strongly disagreed, thirty (30) were female. This gave an indication that most females believe they receive little motivation from home, school and society in the pursuit of their mathematical ambitions.

The above statistics confirms a common practice in an ideal rural African family set up that most females do not receive the necessary support from home as they are mostly engaged with house chores instead of dedicating their time to study as boys do. In this set up mum will always ask her daughter to allow the brothers to study while she was expected to help mum do all the cooking, dishing and cleaning of the kitchen. At school females are not motivated and challenged by their teachers because of the assumption that the male performs better than the female in Mathematics . Lastly, society believes that Mathematics is difficult and, therefore, should not be pursued by women. Even if females learners fail to do a problem on the board correctly, she is told not worry because it was meant for the boys. This affects the progress of females academically in the field of Mathematics.

The finding is consistent with that of Boateng and Gaulee (2019) which discovered the smothering of silver lining of support given both the male and female by gender inequity which was underpinned by deep-seated patriarchy. This culture of the Ghanaian beliefs in the relegation of the girl child to the boy child (Boateng & Gaulee, 2019)

5.3.3 Textbooks examples give the impression that Mathematics is a boys' thing

Considering the notion that textbook examples give the impression that Mathematics is a boys' thing, forty six (46) respondents strongly agreed and out of this number twenty (20) were female. Sixty (60) agreed and out of that twenty-two (22) were females. Considering the number that

disagreed, ninety-nine (99), only thirteen (13) were females. One hundred and ninety-five (195) strongly disagreed and of these, thirty-five (35) were females. From all indications, more females think and agree that textbook examples situate Mathematics as a boys' thing. To support this argument is the fact that in textbooks, females are always portrayed as traders, nurses, teachers, cooks, and domestic workers, while the male is portrayed as an engineer, medical doctor, pilot, driver and businessman. It is very rare to come across a female's picture in these professions. In conclusion, textbook examples do not portray Mathematics as a boys' thing.

The study is consistent with the findings from Uwineza et. al., (2018). They identified some classroom conduct including the pedagogy and conduct of the teacher together with the nature and scope of Mathematics . The study is also consistent with Ajai and Imoko, (2015) discovery in their study, "Gender Differences in Mathematics Achievement and Retention Scores: A Case of Problem-Based Learning Method". They discovered that achievement and retention in algebra by students are not dependent on their gender but the function of pedagogy of the teacher.

5.3.4 Boys usually explore and lay bricks; activities that facilitates the development of their spatial skills giving them an upper hand when in Mathematics performance Mathematics

It is evident from the abundance of literature that the kind of games children engage in contribute to the formation of the brain which may have an effect on their IQ. Boys usually explore, lay bricks and hunt. These are all activities that facilitate the development of their spatial skills giving them an upper hand when it comes to performance in Mathematics. This study sought from respondents their level of agreement with this concept and it was discovered that eighty-three (83) of them strongly agreed. One hundred and thirty (130) agreed, one hundred and eight (108) disagreed and seventy-nine (79) strongly disagreed. The overall assessment of this concept showed that the number of respondents who were in some level of agreement was more than those who disagreed. However, the females were neutral with this concept. Those who agreed were as many as those who disagreed.

In support of the above data analysis, it is true that games at the early stages of development can positively or negatively affect the formation of skills in children. Some games help them develop the desire to explore and discover and these skills are very important in Mathematics. There are some games that are directly linked to Mathematics and when children are able to play such games, they view Mathematics as one of those they play. At times those games are instrumental even in the teaching of Mathematics. The kind of game counts, that means that not every game is essential for Mathematics learning. Relevant games that children play is where they count, manoeuvre, search, explore and discover. All of such games create the desire for Mathematics and it enhances their performance once they start learning actual Mathematics. Lastly, it must be mentioned that Mathematics is life; everything including games are Mathematics. The right game, right timing and right place help the children to become better mathematically. Giving a doll to a girl child for playing with at home, singing lullaby to put it to sleep, cooking in the sand for the doll etc. while the boy child has a manipulative game where he is supposed to arrange objects in a particular order to form a shape. The boy ends up a critical thinker whereas the girl child ends up a good communicator, with difficulty solving problems involving logic. In conclusion, games are very important in the development of spatial skills and the teaching and learning of Mathematics and what is important is the type of games that the children play.

The finding is consistent with that of Chizary and Farhangi (2017) study, which concluded that Mathematics learning among female students at second grade of primary school is greatly influence by educational games, which result in the increase of their IQ. The study is also consistent with Chizary and Farhangi's report on how efficient educational games are to learning. Amini, Sadegh, and Zadeh, (2012) also in their survey "Learning Methods Based on the Computer Game", showed that learning methods which are based on the computer game could enhance students' motivation in Mathematics. Azimi, Vaziri and Kashani (2012) discovered from their study, a significant progress in the attitudes to learning by students who were taught using computer games than the students who were taught by traditional method. They therefore recommended the use of educational computer games in teaching the various sciences.

5.3.5 Incentives and special packages such as scholarships for girls who decide to pursue higher study in Mathematics will increase the number of women in the field

The idea that incentives and special packages such as scholarships for girls who decide to pursue the higher study of Mathematics will increase the number of women in the field, was explored. It was realised that one hundred and eighty-six (186) respondents strongly agreed, one hundred and twenty-five (125) agreed, thirty-six (36) disagreed and fifty-three (53) strongly disagreed. A majority of the respondents agreed to the fact that incentives could be a motivation for females to study Mathematics. Majority of the respondents indicated that incentives can influence positively the belief that Mathematics is not for women.

There are instances where some brilliant but needy students who were the best in Mathematics in their class had to abandon their education along the way because their parents could not afford the school fees. One such very intelligent girl would have studied Mathematics if there was scholarship for her to continue her education after high school. She got married after our secondary education.

In conclusion, many girls may be motivated to pursue Mathematics as they progress academically if there are special packages for them in the form of scholarships, bursaries, stationery etc.

The finding is consistent with that of Navarra-Madsen, Rodney and Hynds (2010). In their pilot study, they discovered that given the needed academic and financial support, grade point averages, retention and graduation rates in STEM are higher compared to when the STEM scholars are not funded. Amanullah (2013) clearly proved from his study, “Scholarship and girls' Education: Impact and Effectiveness Study on Incentive Sub Component” that performance of students in school enrollment, attendance, promotion, behaviour and grades improved remarkably as incentives were awarded to students. Drop-out and repetition rates also decreased considerably among the awardees.

5.3.6 In sociological theories, gender is a social construction rather than a biological given, would you say the same theory supports Mathematics learning among boys and girls?

In sociological theories, gender is a social construction rather than a biological given. The sources of gender differentiation lie more in social and institutional practices than in fixed properties of the individual. The opinion of respondents was sought on whether they believe the same theory supports Mathematics learning among boys and girls. It was discovered that sixty-eight (68) strongly agreed, one hundred and forty six (146) agreed, one hundred and thirty-seven (137) disagreed and forty nine (49) disagreed. This showed that many people believe that the same theory supports the learning of Mathematics among boys and girls as the number of people who agreed was more than those who disagreed.

The statistics above somehow confirms the belief that the same theory supports Mathematics learning among boys and girls because girls are only influenced by society. Same teachers, same teacher preparation, same curriculum, same form of assessment is used in the classroom. Another important issue to be considered is the role of social myths as they do affect the behaviour of girls. They want to please society, so they try to fit into society. In addition there are other different theories supporting the learning of Mathematics among boys and girls. It is argued that they have a different biological make-up; boys are brave, girls are shy, boys can even sit on the floor to learn, and girls will have difficulty sitting and learning on the floor. This, therefore, emphasise that different theories support the learning of Mathematics among boys and girls.

A point also worth noting on this problem is that single parents and poor families would choose to educate their boy child over the girl child. In certain communities, girls are given in to early marriage sometimes to help cater for the other siblings and the entire family. The girls are expected to help mothers do the cooking after school, boys can be learning or playing around. Some cultural practices encourage girls to be timid; they are not supposed to talk when adults, especially men are talking. For this reason, such cultures see women who do otherwise as arrogant.

Bevan (2001) came up with an assertion that a distinction between preferred learning styles by both male and female exist, however the practice of setting seems to give birth to the implementation of uniform instructional strategy.

5.3.2 Classroom practices, such as pedagogy, classroom setting and teaching-learning materials give both boys and girls an equal opportunity to excel in Mathematics

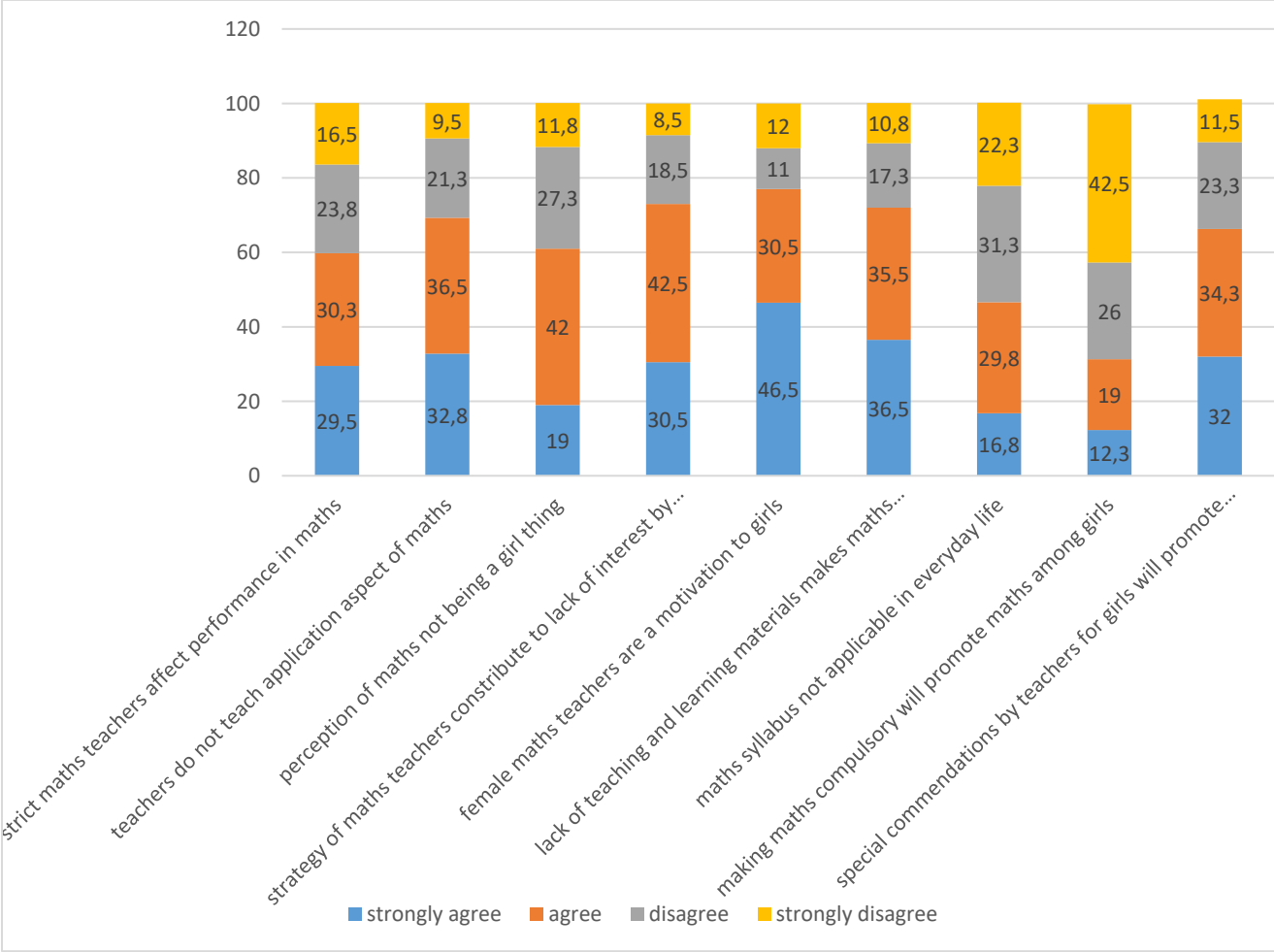
Classroom practices, such as pedagogy of the teacher, classroom setting and teaching-learning materials give both boys and girls equal opportunity to excel in Mathematics. Respondents' opinions were sought on this and it was realised that one hundred and seventy-five (175) respondents strongly agreed, one hundred and forty eight (148) agreed, thirty-five (35) disagreed and forty two (42) strongly disagreed. It is evident that majority of the respondents admit that Mathematics anxiety and phobia in the female is not as a result of unequal opportunities in the classroom. They argued that there are no separate teaching-learning materials for boys in the classroom. Both boys and girls especially in mixed schools learn in the same classroom and same learning environment. Same instructions, examples and assessment are given to both. Hence both have same opportunity in the classroom to participate and perform in Mathematics.

The finding is consistent with that of Uwineza et. al., (2018) study which showed that some classroom conducts including the pedagogy and conduct of the teacher together with the nature of the content of the topics in Mathematics can possibly influence the attitude of students especially during adolescence period. They also advocated for continuous training in modern trends in pedagogy and effective assessment as a result of the disparities in performance in school and national examination. The finding is also consistent with the finding of Kreiter and Kinicki (2007), Asante (2010); Tsafe (2013); Pahle, Hyde and Allison (2014); Ato Kwamina and Offoe (2015); Barmao, Githua and Changeiywo (2015); O'Leary et.al., (2017); Cooper, Downing, and Brownell (2018); Uwineza et. al (2018), Rozgonjuk, Kraav, Mikkor, Orav-Puurand, Täht (2020).

5.4 THE ROLE OF THE SCHOOL, THE HOME AND THE TEACHER IN THE DECLINE OF GIRLS IN MATHEMATICS EDUCATION AS THEY PROGRESS ACADEMICALLY

The effects of certain constructs, concepts and dimensions of the roles teachers, the home and the school play in the decline of the number of girls in Mathematics education as they progress academically was assessed. This was done by seeking the level of agreement or disagreement of respondents with specified constructs. A summary of the responses is shown in Figure 5.7 in a component bar chart form.

Figure 5.7: The role of the school, the home and the teacher in the decline of girls in Mathematics Education



Source: Researcher's Construct, 2017

5.4.1 The role of the school in the decline of Mathematics knowledge

5.4.1.1 The role of the syllabus in the decline of Mathematics knowledge

Considering the topics in the Mathematics syllabus, the researcher decided to enquire if the topics are related to, and are applicable to our everyday activities. About sixteen point eight per cent (16.8%) strongly agreed and twenty-ninepoint eight per cent (29.8%) agreed. The percentages above are an indication that the minority of respondents agreed with this construct. The above statistical analysis talk to the age-old concern among learners about the relevance of Mathematics content. The belief, especially females, is that the topics taught do not in any way relate to life experiences. The feeling is that it would be easier to study Mathematics if the topics in the syllabus were parallel to real-life situations. A question was once asked by a learner on what does s/he need perpendicular lines for as a child and the concept of pie for. Does a learner really need to learn logarithm.

Thirty one point three per cent (31.3%) of respondents on the other hand disagreed and twenty two point three per cent (22.3%) strongly disagreed. According to these respondents some Mathematics topics cannot be related or associated with real-life activities and experiences because they are rather foundations of other topics either in Mathematics or Science. Therefore, it should not affect the performance of girls in any way. Their understanding is that the relationship between the topics and everyday life activities are just an omission on the part of the teachers who teach the subject. It is the teachers' duty to find a way to relate the topics to everyday life as they teach their learners. In conclusion, the abstract nature of Mathematics is not as a result of the relationship between the content of the syllabus and everyday practice. The main issue is how the topics are treated by the teachers. Reluctance on the part of the teacher to link the topics to everyday life could be a basis of poor performance by the female.

This finding is in line with that of Orton and Frobisher (1996); Cornell (1999); and Austin and Wadlington, (1992) who stated that Mathematics thought of abstractly and that could be a cause

for anxiety and phobia. They suggested that the application of guidelines should be in a way that students can remember. Teaching Mathematics without an investigative, open-ended approach can affect the performance of students. The findings is also consistent with that Tsafe (2013), who discovered the important role curriculum, instructional materials together with assessment play in improving students' learning and performance in Mathematics.

5.4.1.2 Applying force and punishment to get girls to participate in MMathematics

The issue of whether forcing pupils to learn Mathematics and whether applying punishment promotes Mathematics among girls saw the following from the respondents. About twelve point three per cent (12.3%) of respondents strongly agreed and nineteen per cent (19%) agreed, indicating that the minority agreed with the use of punishment to force more girls into studying Mathematics. These respondents believed that this would encourage girls to learn Mathematics to avoid being punished. The majority of respondents, on the other hand, constituting forty two point five per cent (42.5%) strongly disagreed and twenty-six per cent (26%) disagreed. Considering the above data analysis, it is clear that forcing pupils to study Mathematics would further affect participation and performance. Some learners are forced to change school because the Mathematics teacher keeps punishing them for not doing their Mathematics home work. Other learners always stay out of Mathematics class under the pretence of being sick because they know the Mathematics teacher will punish them for non-performance. By this, students would do rote learning just to impress the teacher. In summary, the use of punishment as a strategy affects the participation of women in Mathematics as they progress academically.

5.4.1.3 The role of incentives in the decline of Mathematics knowledge

Incentives such as a special handshake for girls who do well in Mathematics could promote Mathematics development among girls. Respondents were asked to state their level of agreement and it was realised that thirty-two per cent (32%) strongly agreed and thirty fourpoint three per cent (34.3%) agreed. A respondent said "I remember when I was called in front of the whole school for being first in our end of year Mathematics examination. The feeling was great, it's a moment I can never forget. I resolved to work hard to maintain the position." Another respondent said "he

could simply not take it when a girl was named as the best Mathematics student in his class. He promised to be the next person whose name will be mentioned. He worked hard towards it and he achieved it. It is clear from the above that respondents agreed to the use of incentives to motivate girls to study Mathematics. On the other hand, twenty three point three per cent (23.3%) disagreed and eleven point five per cent (11.5%) strongly disagreed. According to those respondents, the girls need more than mere incentives. They believed that support in the form of scholarships, educational materials, and extra tuition if the need arose could do a lot in supporting the girls than mere handshakes.

The finding is consistent with that of Amanullah (2013) which saw punctuality and regularity among learners when incentives and scholarships were awarded.

5.4.1.4 The role of teaching-learning materials in the decline of Mathematics knowledge among girls

In addition to teaching strategies, the use of teaching-learning materials and their influence in Mathematics teaching and learning was investigated. Respondents were asked to state their level of agreement or disagreement with the use of the teaching-learning materials, making lessons less abstract. It was discovered that about thirty-six point five and thirty-five point five per cent (36.5%) and (35.5%) strongly agreed and agreed respectively, which constituted the majority of the responses. The majority of the respondents admitted that teaching-learning materials make Mathematics less abstract and very friendly irrespective of gender. Hence teaching aids can increase female participation and performance in Mathematics.

The shortage of teaching-learning materials is concrete reality in most public schools in Ghana such that many learners never had the privilege to study using teaching-learning materials. It is also true that some learners especially at primary school level, might not have the experience of seeing their teacher using any material in any of the Mathematics lessons they sat in. Mathematics lessons become abstract and learners sometimes easily forgot what they were taught. The available materials are used under a few circumstances such as pointing to the football in the class as a sphere, and the cupboard as a cuboid. Others admitted that they had experienced this a few times

and it had a positive influence in their Mathematics achievement. At times teachers had to be innovative and use whatever objects are available to elucidate their points. This may be confusing at times because the objects may not have a uniform shape, e.g., using the egg as an example for the spherical shape, not all egg eggs are spherical in shape.

Seventeen point three per cent (17.3%), on the other hand disagreed and ten point eight per cent (10.8%) strongly disagreed. Even in the absence of the teaching-learning materials, which are not readily available in most cases, Mathematics teachers do their best to make the lesson more understandable. The circumstances are same for both the boys and girls in the same class. Hence the use or other wise of a teaching learning material cannot be a contributing factor to females not excelling in Mathematics.

The finding is in line with that of Ameyaw (2019), which identified the use of teaching learning materials as a catalyst to pupils demonstration of understanding in basic Mathematics concepts. It is also in line with that of Ampiah (2008) who specified in his study that, the use of the "chalk and talk" technique fails in enhancing the understanding of pupils. However, the use of structured techniques and approaches together with available relevant teaching learning materials efficiently enhance pupils understanding. It is also consistent with that of Yara and Omondi (2010) which showed that teaching learning resources include class rooms, textbooks, teaching aids (chalk, board, ruler and protractor), stationeries and laboratories have effect on students' academic performance. Osei and Mensah (2018) indicated that, inappropriate and inadequate teaching and learning materials affect performance of learners positively. It also affirms Bizimana and Orodho, (2014) study which made an indication that teaching and learning materials should be used during delivery of a lesson to enhance understanding of the lesson. Tomlinson (2012) also advocated for the display and explanation of teaching learning material at the introductory stage of a every lesson. This they established that relevant teaching learning resources arouses the interest of students and enhance recollection of previous knowledge.

5.4.2 The role of the home in the decline of girls in Mathematics education as they progress academically

The societal belief that Mathematics is not a girls' thing contributes largely to the fall out of women in Mathematics as they progress academically. Seeking the respondents' views on this, about nineteen per cent (19%) of the respondents strongly agreed and forty-two per cent (42%) agreed with the statement. In a typical Ghanaian home, girls are supposed to help with the house chores, and boys have a choice not to. The compulsory nature of the inclusion of girls in the house chores takes a fraction of the girls' study time and affects the performance and participation of girls in Mathematics.

Alternatively, respondents representing twenty-seven point three per cent (27.3%) and eleven point eight percent (11.8%) per cent disagreed and strongly disagreed respectively to the statement. A counter argument can be made that societal perception does not really influence females to fall out of Mathematics education and point towards the IQ of the person as the attribute that influences the decision made by the person. To that effect it must be stated that women who pursue Mathematics are seen as hard, super intelligent and brave. This prevents some girls from studying Mathematics because they think they may not match up to these expectations. In an extreme scenario a girl was called a witch in secondary school because she was always first. In another case the girl was described with masculine features in secondary school. The findings of this study confirm that of Tobias (1978), who purports that females thought they may end up inviting social disapproval if they were good at Mathematics.

Gudyanga et. al. (2016) identified cultural stereotype as a blockage to female participation in Mathematics beyond secondary school level. Boateng and Gaulee (2019) also discovered the effect of the relegation of the girl child to the boy child as a nuisance in the learning of Mathematics. Fletcher (2009) discovered that fathers are second most influential factor in their daughters decision to study Mathematics. Kwame et. al. (2015) findings revealed that the few girls who opted for elective Mathematics in high school did so because of the influence they got from their social background

5.4.3 The role of the teacher in the decline of girls in Mathematics Education as they progress academically

5.4.3.1 The teaching strategies of Mathematics instructors

It is believed the teaching strategies of Mathematics instructors contribute largely to the lack of interest in the subject. Respondents were asked to share their opinions and it was gathered that about thirty point five per cent (30.5%) strongly agreed and forty two point five per cent (42.5%) agreed with this statement. Some explanations gathered from the interviews conducted indicate that teachers presume girls will not perform well when it comes to Mathematics even before evaluation of their lessons. They are, therefore, comfortable with whatever output the girl child makes. Generally teachers expect more from boys than girls and this is not challenging enough to the girl child in the study of Mathematics. Teachers have higher expectations regarding the male as compared to their expectations of the females. Consequently, boys are challenged right from childhood and are always urged to put in extra effort to improve their performances.

Alternatively, eighteen point eight and eight point five per cent (18.8%) and (8.5%) disagreed and strongly disagreed respectively with the statement. It was concluded that some teaching strategies could lead to poor performance of the girl child in Mathematics .

The finding is in line with Brady and Bowd (2005) provision of evidence of how certain inappropriate teaching strategies affect performance. They found out that the assumption that students should be able to understand a concept after a brief explanations of concepts, giving few examples after teaching a concept, not giving class exercise under the pretence that there is not enough time and embarrassing students led to Mathematics anxiety and phobia. Ajai, and Imoko, (2015) discover in their study, “Gender Differences in Mathematics Achievement and Retention Scores: A Case of Problem-Based Learning Method” that achievement and retention in algebra by students are not dependent on their gender but the function of pedagogy of the teacher. Uwineza et. al., (2018) also report that gender inequalities in performance might originate greatly from examinations processes and conducts. The scope of examination, they observed are not set on examinable objectives. This they explained is due to the fact that different set of people set the

national examination while another set of people set the school examinations. Iwu and Azoro (2017) also asserted that brilliant girls are sometimes discouraged by guardians and counsellors from pursuing advance science and Mathematics. These counsellors and guardians do their best to convince these females on how difficult Mathematics is and how the end results is not worth the sacrifices they will have to make in pursuing Mathematics. Iwu and Azoro (2017) confirmed the important role the school plays in female access to science through the implementation policies of the school as far as the curriculum is concerned.

5.4.3.2 The role of strict Mathematics teachers in the decline of Mathematics knowledge

The perception that the attitude of very strict Mathematics teachers affect the performance of their students especially the girl child in Mathematics was explored. It was realised that a little over half of the respondents had some level of agreement as about twenty point five percent (20.5%) strongly agreed and thirty point three percent (30.3%) agreed. They further argued that the behaviour of extremely strict Mathematics teachers frighten their students and it creates an illusion in their minds about the subject the teacher teaches.

On the other hand, twenty-three point eight percent (23.8%) and sixteen point five percent (16.5%) disagreed and strongly disagreed respectively. Their level of disagreement was explained, students take courses which have strict instructors much more seriously than those with less strict instructors. Respondents associated various courses with their respective instructors. The teachers' attitude plays a very crucial in determining the learners' liking or dislike of a subject. In certain instances some learners have even dropped out of school because of the humiliation they suffered daily form teachers. Therefore, in a patriarchal society the girl child is always at the receiving end of the local cultural biases against women. In conclusion, the fear of strict Mathematics teachers could directly relate to or play a key role in the students' Mathematics phobic condition.

5.4.3.3 The role of female Mathematics teachers in the decline of Mathematics knowledge among girls

A notable question that still lingers is if female Mathematics teachers are a source of motivation to girls in Mathematics learning. The following answers were given from respondents in relation to their level of agreement or disagreement. About forty-sixpoint five and thirty point five per cent (46.5%) and (30.5%) strongly agreed and agreed respectively constituting the majority of the responses. Respondents explained further that girls see female Mathematics teachers as role models. As a result, they are motivated to study harder to become like them. One respondent added that girls feel that once a fellow woman has been able to beat all the odds in Mathematics education, they can also do the same. A respondent said "I was challenge to work harder when I had a female Mathematics teacher in secondary school"

Other respondents also raised a point about women being more patient than men. Some respondents admitted that all female Mathematics teachers they had experienced were very patient; this they admitted was a source of motivation to them. Alternatively, the few who disagreed indicated that both male and female Mathematics teachers could be patient or impatient. Some confirmed to having come across more patient male Mathematics teachers than female Mathematics teachers. The percentage of respondents who disagreed and strongly disagreed constituted eleven and twelve per cent (11%) and (12%) respectively.

The finding is consistent with the Social Learning Theory, Bandura (1977) which states that behaviour is learnt or picked from the surroundings or environment through the practise, procedures and processes of learning are by observation.

The findings is also in line with that of Sharma (2016) which says that young females are attentive at the behaviour of older females taking into account their conduct of everyday life.

5.4.3.4 Teaching the application aspects of Mathematics topics

The construct that Mathematics teachers usually do not teach the application aspect of the topics they teach leading to girls' inability to relate their everyday life to the Mathematics they learn was explored. It was found that 32.8% strongly agreed and thirty-sixpoint five per cent (36.5%) agreed to the statement. This means that a total percentage of sixty-nine point three (69.3%) of the total

respondents agreed with the construct explained that girls are able to relate well with topics that are applicable and relate to their daily lives. Some respondents emphasised that women are less adventurous than men; hence they prefer demonstration and practical lessons to link with what they do.

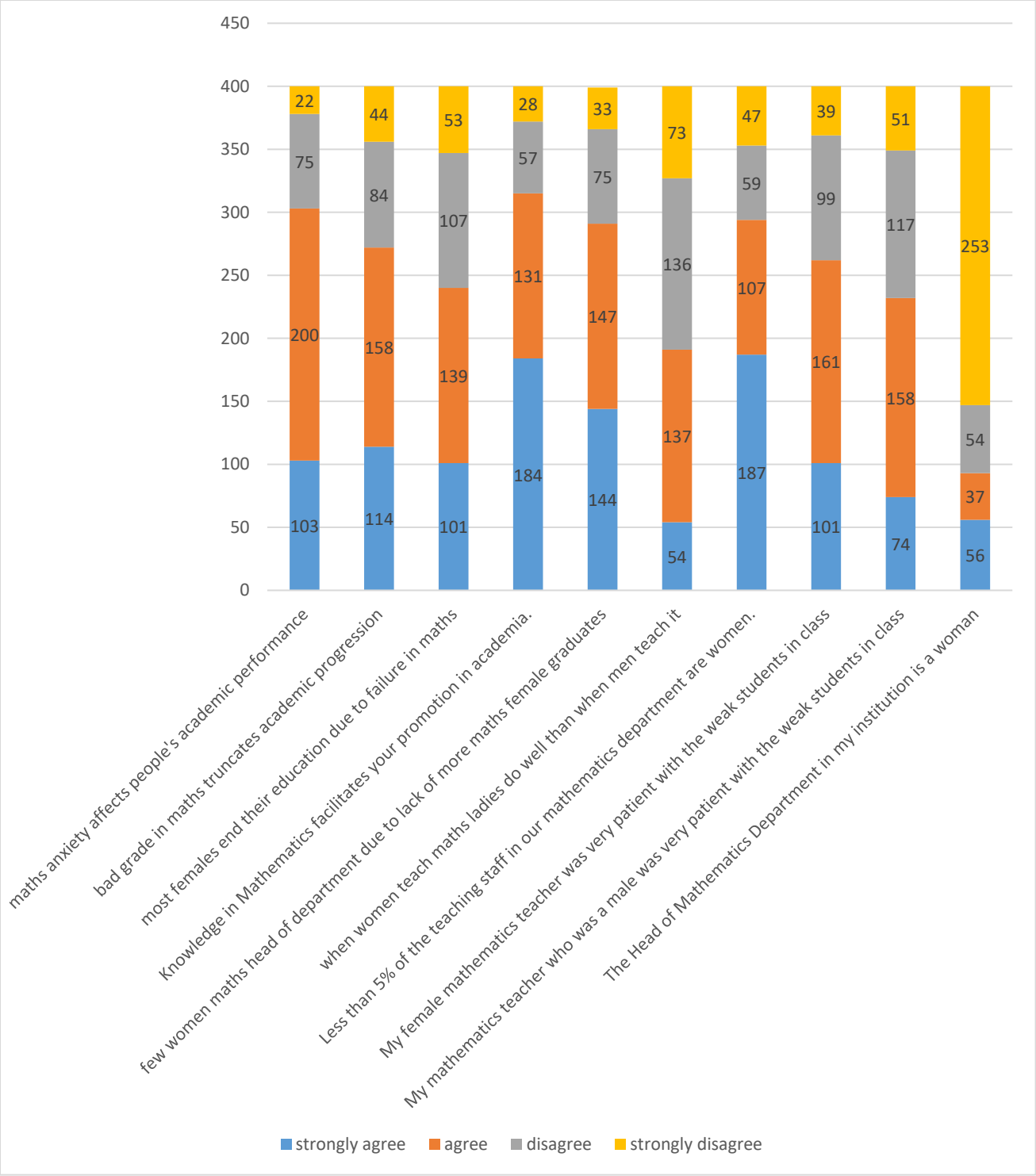
Alternatively, twenty one point three per cent (21.3%) disagreed and nine point five per cent (9.5%) strongly disagreed indicating that teachers teach what they are supposed to teach hence it is a person's perspective that affects how applicable the Mathematics they learn is in their daily lives. It was, therefore, perceived that the failure of teachers to teach the application aspects of Mathematics affects the females' performance.

Further engagement with respondents had one of them say "my teacher will always say 'it is a formula, chew it baba'". Another said "my teacher never related any topic to life situations". An interesting one was when a respondent said 'we always assumed pie to be a snack, fish or meat pie". Bueno and Agustin (2019) establishes that if Mathematics is described as laying the technique into practice, learners on the other hand could believe that it just follows rules that leads you into finding the appropriate solutions. Such rote learning could lead to Mathematics phobia and anxiety. This is similar to the findings above.

5.5 EFFECTS OF THE DECLINE OF MATHEMATICS KNOWLEDGE ON THE PROGRESS OF THE WOMAN

The study went further to assess the effects of the decline of Mathematics knowledge on the female. A summary of the responses is shown in figure 5.8 in a component bar chart form.

Figure 5.8: Effects of the decline of Mathematics knowledge on the woman



Source: Researcher's Construct, 2017

5.5.1 Effects of Mathematics anxiety and phobia on academic progress

One the effects of the decline in Mathematics knowledge identified as a result of Mathematics phobia and anxiety is its influence on people's academic progress. Respondents were asked to state their level of agreement with this construct and it was realised that the majority of the respondents agreed. Specifically, one hundred and three (103) respondents strongly agreed and two hundred (200) agreed. Some students do not progress academically due to their poor results of Mathematics. Those who are determined not to give up, may repeat the exam for several years until they get a good grade. This delays their studies. Failing Mathematics may mean failing in life for learners.

In Ghana, Mathematics is a requirement for admission to both secondary and tertiary education programmes. This explains why a decline in Mathematics knowledge affects academic progress. About seventy five (75) and twenty two (22) respondents disagreed and strongly disagreed respectively. The policy of using performance in Mathematics as a determinant for secondary school and university admissions is challengeable. Some people argue that academic progress depends more on other factors including the willpower of the individual. Determination is key, any person determined to excel does so in the midst of all the circumstances and hindrances.

The finding is in line with that of Yarkwah (2020). He discovered that the female demonstrate negative attitudes in Mathematics participation even when they perform same as the male because of the greater phobia and anxiety they have towards the study of Mathematics .

5.5.2 Effects of non-performance in Mathematics on advancing on the social and academic ladder

It is a popular knowledge that people with poor grades in Mathematics cannot further their education. Respondents were asked to share their opinions on this with examples from their own experiences. One hundred and fourteen (114) of the total respondents strongly agreed and one hundred and fifty eight (158) of them agreed. Respondents agreed to a slogan which is no Mathematics, no progress on the academic ladder.

Eighty four (84) and fourty four (44) respondents, on the other hand, disagreed and strongly disagreed respectively. There are opportunities to advance on the educational ladder without good

grades in Mathematics. A good example is the one of people who join the mature students programme, go to Polytechnic for a diploma or an HND and Vocational institutions, an opportunity they could have lost but for the matured programme. Therefore, Mathematics is not the only requirement for further education and thus cannot hinder an individual from climbing the social and academic ladder.

The finding is in line with the declaration made by El Yacoubi (2015), that though there is equity in education in most of the developed countries, the girl child enrollment into mathematical studies is relatively low.

5.5.3 Effect of Mathematics anxiety and phobia on the females

The study went further to enquire about the rate at which Mathematics anxiety and phobia cause the female to end their education and dreams in academia. About one hundred and one (101) respondents strongly agreed and one hundred and thirty nine (139) agreed that most of their mates who ended their education as a result of failure in Mathematics were mainly females. A visit by the researcher to a remedial home revealed that about seventy four percent (74%) of the inmates who are working towards passing their secondary school Mathematics were females. The majority of these respondents affirmed that females constitute a larger population in this category.

On the other hand, one hundred and seven (107) respondents disagreed and fifty three (53) strongly disagreed. This is in line with the assertion made by Friel (2014) that Mathematics phobia and anxiety has a contrary relationship with outcome in Mathematics and achievement.

5.5.4 Effects of Mathematics knowledge on promotion in academia

The opinion of respondents on whether knowledge in Mathematics promotes someone in academia and elsewhere was sought. The majority of the respondents agreed with the statement. Specifically, one hundred and eighty four (184) strongly agreed and one hundred and thirty six (136) agreed. In their explanations, they were emphatic on the fact that Mathematics remains a foundation to a number of disciplines hence its knowledge has the likelihood of promoting a person in academia.

On the other hand, the few who disagreed argued that knowledge in Mathematics cannot promote a person in academia unless that particular discipline the person studies has its foundation rooted in Mathematics . From Figure 5.8, fifty seven (57) respondents disagreed and twenty eight (28) strongly disagreed. It can, therefore, be predicted that knowledge in Mathematics can facilitate promotion in academia per the information gathered.

Mathematics was described by Mireku et. al., (2015) as a filter to prestigious positions and employment. Fajemidagba et. al., (2012) also described Mathematics as a core science subject and tool for the development of any science-based discipline.

5.5.5 Appointment of female heads of Mathematics departments and its relationship with Mathematics knowledge

It has been realised that there are a few women heading departments in the Physical Science Faculties especially Mathematics due to their non-availability in the field. The majority of the respondents agreed with the statement with one hundred and fourty four (144) strongly agreeing and one hundred and fourty seven 147 agreeing. This confirmed that in the various institutions, women were hard to come by as Heads of Mathematics Departments and where available, they were usually very few. The common experience from students is they have never had a female head of department all through their university education. Seventy five (75) respondents on the other hand disagreed and thirty three (33) strongly disagreed. This suggests that Mathematics phobia and anxiety bring about a decline in Mathematics knowledge reducing the number of women in the Mathematics department as they progress academically. This results in the non-availability of women who head the Mathematics department.

5.5.6 Effects of the performance of female Mathematics teachers on the performance of female students

It has been mentioned earlier that girls could be motivated by their female Mathematics teachers in their study of Mathematics. These female Mathematics teachers serve as role models to the girls they teach especially if they have mastery over the content, pedagogy and content pedagogical knowledge. For this reason, the study had interest in finding out if female Mathematics teachers can influence the performance of the girl-child positively. The number of respondents who disagreed was more than those who agreed. Specifically, fifty four (54) respondents strongly agreed and one hundred and thirty seven (137) agreed, whereas one hundred and thirty six (136) disagreed and seventy three (73) strongly disagreed. The statistics reveals that both the male and female teachers can have negative or positive effects on the female students.

5.5.7 Number of female Mathematics teachers that respondents have encountered in their departments

Respondents were asked their level of agreement or disagreement with the construct that less than 5% of the teaching staff in their Mathematics department were women. This was confirmed by the majority of the respondents. A greater number either strongly agreed or agreed. From Figure 5.8, one hundred and eighty seven (187) strongly agreed and one hundred and seven (107) agreed. On the other hand, fifty nine (59) disagreed and fourty seven (47) strongly disagreed. This suggested that Mathematics phobia has an effect on students' performance resulting in a decline in the number of females in the Mathematics department as they progress academically. This has resulted in a few numbers of women teaching Mathematics in the Ghanaian universities where the respondents were sampled from.

5.5.6 Effects of the attitude of female teachers on the decline of Mathematics knowledge among girls

Research indicates that teachers' attitude towards Mathematics impacts greatly on the practice and strategies of teaching (Uusimaki & Nason, 2004; Charalambos, Philippou & Kyriakides, 2002;

Ernest, 2000). Anxious Mathematics teachers impact negatively on their students by transferring their anxieties onto them. This study saw the need to investigate if the female Mathematics teacher impacts negatively or positively on her students. The study found one hundred and one (101) respondents who strongly agreed and one hundred and sixty-one (161) who agreed. This means that the majority shared the opinion that female Mathematics teachers were a little patient with the weak students in their classes.

Beilock et al. (2010) disclosed that young girls with Mathematics anxious female teachers were very likely to model their teachers. Bharadwaj, De Giorgi, Hansen and Neilson, (2016) also showed in their study that the addition of the teachers' gender as an descriptive variable does not really change the gender disparity much.

5.5.6 The effects of the attitude of male Mathematics teachers on the decline of Mathematics knowledge

As explained earlier, the attitude of teachers has a profound impact on learner's performance in Mathematics. The effects of the attitude of male Mathematics teachers were also investigated. It was realised that the majority of the respondents confirmed that they had male teachers who were as well patient with weak students. Specifically, seventy four (74) respondents strongly agreed and one hundred and fifty eight (158) agreed. Alternatively, one hundred and seventeen (117) respondents disagreed and fifty one (51) strongly disagreed. The experiences of learners about impatient male Mathematics teachers who punished weak students severely and also got annoyed with the students' minimal mistakes are not far-fetched, especially those who are not too knowledgeable are very aggressive and are ready to beat students with the least provocation.

Musau and Migosi, (2013) discovered that the gender of the teacher does not really have any obvious influence on students' performance in Mathematics.

5.5.10 Confirmation of the number of female heads of departments by respondents

Respondents were asked to state the gender of their heads of departments. It was established earlier that few women head Mathematics departments due to their shortage in the department. In this section, respondents were asked to state whether or not their heads were females in order to confirm the construct that few females head Mathematics departments. About fifty six (56) strongly agreed and thirty seven (37) agreed, whereas fifty four (54) respondents disagreed and two hundred and fifty three (253) strongly disagreed. This gave a confirmation that few women are heads and have ever chaired the Mathematics Departments in Kwame Nkrumah University of Science and Technology, University of Cape Coast, Central University, University of Ghana, University of Education, Accra Institute of Technology, University of Professional Studies - Accra and Valley View University; as the sampled institutions.

This finding is in line with the findings of some studies which confirmed females as being few in high-powered careers as CEOs and those holding Ph.Ds, most importantly in Finance, Business, Science, Technology, Engineering and Mathematics (Bertrand, Goldin & Katz, 2010; Ginther & Kahn, 2004; 2009; Smith, Smith & Verner, 2013).

5.6 CONCLUSION

From the data gathered for the study, there are more men in Mathematics department than women. The few women who participate in Mathematics fall off as they climb the social and academic ladder. The study differential motivation is in favour of boys for the study of Mathematics. It was established that when presented with equal opportunities, girls will participate and perform in Mathematics at the same rate as boys. The home, the school, the society, the teachers teaching strategies, teaching learning resources and role models contribute significantly to the non-availability of the equal opportunity

The African girl child is supposed to do all the house chores at the time the boy child is dedicating his time to study and they are both subjected to the same forms of assessment. Some teachers do not take the mood swing of the girl child especially because of menstrual crumps into consideration. Some girls end up facing the greatest embarrassment during menstruation in school.

Most classroom tables and chairs are not gender sensitive hence the girls child partly concentrate and participate in the lesson and is cautious of herself at the same time.

Introduction of incentives, scholarships and other forms of motivation could go a long way to motivate more girls into the study of Mathematics. By this, where the education of the boy child is chosen over that of the girl child, there will be some form of support to enable her achieve her goal of being in school and studying Mathematics. Types of games children are introduced to play a key role in the formation of their spatial skills. Games can also break complex theories in Mathematics lessons down to concrete and interesting lesson which will be attractive to both the weak, average and excellent students.

The use of appropriate teaching learning materials reduce the abstract nature of Mathematics to both the boy and girl child. Hence participation and performance of both the boy and girl child will improve if teachers use appropriate strategies and vary the strategies with the relevant resources. Using punishment as a strategy causes more harm than good. The girl child is not motivated to study Mathematics through punishment as they progress on the social and academic ladder.

The study could not confirm textbook examples portraying Mathematics as boys domain. Textbook examples were said to have given fair treatment to both the boy and girl child as far as the study of Mathematics is concerned. However the study confirms that females assumed they may attract social disapproval if they mathematically skilled. The limited number of role models deeply rooted this belief.

CHAPTER SIX

MAJOR FINDINGS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter discusses the major findings of the study from chapter five as they relate to the literature, the theoretical and conceptual frameworks introduced in chapters two and three. It also includes the implications of the study, recommendations for improvement of practice, suggestions for future research, delimitation and conclusion.

6.2 OVERVIEW OF THE STUDY

The discussion of findings, which relate to the five research questions, is presented, followed by the discussion of findings on the five research questions. The research questions and discussions were as follows:

a) What societal factors contribute to women falling behind and not able to participate in the field of Mathematics as they progress in the academic and social fields?
b) To what extent do teaching learning resources contribute to the participation and performance of the female in Mathematics education?
c) What role does the school play in the declining enrolment in Mathematics if any, of girls as they progress academically?
d) What role, if any, does the home play in the declining enrolment in Mathematics of girls as they progress academically?
e) What role do teachers play in the declining enrolment in Mathematics , if any, of girls as they progress academically?

Literature was reviewed on Mathematics phobia and anxiety, Mathematics and the teacher, Mathematics and gender, Mathematics and other factors. A new conceptual framework 'Mathematics avoidance and its effect' was provided from an adopted framework from Preis and

Biggs conceptual framework on Mathematics avoidance and performance as a cycle. The Social Learning Theory was the main theory underpinning the study.

The quantitative research method was used in this study and eight universities were randomly sampled. Four hundred (400) undergraduates, master's and Ph.D students were purposefully selected for the study. Data was collected using questionnaire and Document analysis. Cross-tabulation in basic tabular form was used to draw inferences between different data-sets in the study.

6.3 SUMMARY OF MAJOR RESEARCH FINDINGS

This section discusses the empirical research findings of the analysis from chapter five as they relate to the literature, the theoretical and conceptual frameworks introduced in chapters two and three. It also includes the implications of the study, recommendations for improvement of practice, suggestions for future research, delimitation and conclusion. The summary of findings is presented in five themes that emerged in this study.

6.3.1Gender differences in enrolment into Mathematics programmes

Considering the gender distribution of respondents in this study, a very small percentage of women were within the sampled population; the majority were males. There was no deliberate attempt to discriminate against the females in any form. The outcome was as a result of the scarcity of the female students in the department of Mathematics. It is, therefore, evident that females constituted the smaller group in the sample and in Mathematics departments. Majority of the few ladies had their first degree in Mathematics. The numbers reduce as they climb the social and academic ladder. The numbers confirms the general trend of low enrollment of females in Mathematics at all levels of academic pursuit. The enrollment of women from 2012 to 2016 into the Mathematics department at the University of Cape Coast further explains the small number of women in the sample.

6.3.2 The contribution of the school to the decline in the number of girls in Mathematics education as they progress academically

6.3.2.1 Incentives and special packages

Findings from the study perceived incentives and special packages such as scholarships for girls who decide to pursue higher studies in Mathematics could have a positive influence on the enrollment of women in the Mathematics department. The study gathered that incentives can positively influence girls' participation and performance in Mathematics. This is because many women, including the brilliant but financially challenged would have the opportunity to study Mathematics, influence other women's lives through role modelling and by this increase the number of women in the Mathematics department. This study concludes that many girls may be motivated to pursue Mathematics as they progress academically if there are special packages to support their study.

6.3.3 The contribution of teaching learning resources to the growth of the female in Mathematics education

In addition to teaching strategies, the study arrived at the positive impact of the use of appropriate Teaching Learning Materials (TLMs) in Mathematics teaching and learning. TLMs set students to manipulate, explore, investigate and arrive at solutions. These processes make Mathematics less abstract and very approachable irrespective of one's sex. It is interesting to note that some respondents indicated that they never had the privilege to study using TLMs; the results of which made their Mathematics lessons more abstract resulting in forgetting easily what they were taught.

6.3.4 The teacher's contribution to the decline in the number of girls in Mathematics Education as they progress academically

6.3.4.1 The attitude of Mathematics teachers

The study discovered the negative impact Mathematics phobic teachers make on their students by transferring their anxieties to them. The teacher serves as a role model, facilitator and a catalyst to the teaching and learning process. The students especially the girl child is likely to conclude if the facilitator demonstrates anxiety or phobia in their Mathematics delivery, then Mathematics is really not friendly. The students are likely to conclude that even the teacher does not like it because of its supposedly complex nature.

6.3.4.2 Teaching strategies of Mathematics instructors

The findings are consistent with the findings from other studies indicating that teaching strategies of Mathematics instructors contribute largely to the lack of interest in the subject. Teachers presume girls to be a weaker sex when it comes to Mathematics even before the evaluation of their lessons. As a result, teachers accept any performance put up by the girl child whilst a lot more is expected from the boy child. Some teachers of Mathematics do not use the needed resources in teaching. They give formulas without deriving the said formulas, some respondents put it as "my teacher will always quote a formula on the board, when you ask why it is so, the response is 'it is a formula, chew it'". Another respondent said "I don't know what teaching aids are, my teacher never used any such in teaching me". Examples given by teachers, textbook examples, teaching Mathematics abstractly, demonstration of phobia or anxiety by teachers, lack of adequate content, pedagogical and pedagogical content knowledge contribute to lack of interest in Mathematics causing Mathematics phobia among female students in particular.

The study established that Mathematics teachers usually do not teach the application aspect of the topics they teach, by this, girls are not able to relate their everyday life activities to the Mathematics they learn. What is the need for putting in much efforts into studying a difficult subject which is not so useful in life? What is the motivation?

6.3.4.3 Female Mathematics teachers

Findings from the study established that female Mathematics teachers are a source of motivation to girls in Mathematics learning. Girls see female Mathematics teachers as role models, and as a result, they are motivated to study harder to become like them. They are also inspired and challenged by these female teachers into believing in their capabilities to advance in Mathematics . A Mathematics phobic female teacher however has a negative effect on her female students.

6.3.5 The contribution of the home to the decline in the number of girls in Mathematics Education as they progress academically

6.3.5.1 The kind of games children are introduced to

The findings of this study concur that boys usually engage in activities that facilitate the development of their spatial skills, giving them an upper hand when it comes to performance in Mathematics . The study, based on this result, agrees that the kind of games children are engaged in contribute significantly to their mathematical abilities, play a very instrumental role in the development of their spatial skills and the teaching and learning of Mathematics. The study can make the conclusion that the kind of games girls are engaged in at the early stages of their lives contribute to the decline in Mathematics knowledge among girls as they progress academically.

6.3.5.2 Societal myth

Societal myth according to the findings of the study contribute largely to the decline in Mathematics knowledge among women as they progress academically. In a typical Ghanaian setting, girls are supposed to sweep, cook, and wash dishes while boys are supposed to fetch water and even so, they sometimes go with the girls. There could be virtually nothing for the boy child to do in the urban setting depending on the kind of parental upbringing the individual child receives. This takes a greater percentage of the study time of girls, resulting in low participation and poor performance of girls in Mathematics because they barely make time for continuous practice. The nonperformers also were comforted by the belief that Mathematics is very difficult for girls and society seems comfortable with any little performance of the girl child. There is an

interesting and a popular belief that “as for the woman, her place is just the kitchen” in the African settings.

6.3.6 Effect of Mathematics anxiety and phobia on academic progress

Effects of the decline in Mathematics knowledge result in Mathematics phobia and anxiety influencing people’s academic progress and socioeconomic lives negatively. There are many people who would have loved to be in tertiary institutions but are prevented by poor grades in Mathematics or Science. The researcher’s visit to a remedial centre revealed a woeful majority of the inmates incarcerated as a result of poor grades in Mathematics or Science or both in their West African School Certificate Examination hence they have to keep trying until they pass to be able to achieve their aim of going to a tertiary institution. This is because Mathematics is a requirement for admission to both secondary and tertiary education programmes in Ghana, hence poor grades in Mathematics hinders an individual’s entry into high school or the tertiary institutions.

6.4 RECOMMENDATIONS

Following the research findings summarised above, the study would like to make the following recommendations which are based on the themes which emerged in this study

6.4.1 Gender differences in enrolment into Mathematics programmes

There is the need to revisit entry into tertiary programme which demands a least grade of D7 in Mathematics, English and an additional Core subject plus three elective subjects. Funny enough, after the individual is twenty five (25) years, she/he is allowed to enrol into a tertiary programme with or without Mathematics. The girl child at that age may have started making family and may not be able to even if she desires to continue with her educational ambitions. The study recommend an access programme for such individuals, they could be given extra preparatory tuition to prepare them for their tertiary education. By this, they will not have to wait to be twenty five years before going to school.

This study calls on the government and the good people of Ghana to have a nonpartisan autonomous Education Ministry to work with little or no political interferences. This will facilitate the continuous implementation of educational policies even when there is a change in government. The study further recommends a good political will in enforcing global standards in the Ghanaian schools. By this, the study recommends the abolishment of schools under trees, provision of gender sensitive furniture for all school children in every community in Ghana, provision of relevant teaching learning materials etc. in the Ghanaian schools. These will create a conducive atmosphere for the Ghanaian child most importantly the girl child.

6.4.2 The contribution of the school to the decline in the number of girls in Mathematics Education as they progress academically

The general notion and expectation from the Ghanaian teachers is to improvise the needed teaching learning materials to aid their Mathematics lessons. However, the average Ghanaian teacher may not be able to afford the basic materials needed for this improvisation from his or her meagre salary. The government of Ghana should as a matter of urgency provide the needed teaching-learning materials such as Multi-Base blocks, Cuisenaire rods, Abacus and Pebbles, in Ghanaian schools.

The Free S.H.S policy of the ruling New Patriotic Party under the leadership of His Excellency President Akufo Addo has seen every qualified Secondary School going child into High School in Ghana without having to pay fees, girls will be attracted to study Mathematics if there exists a similar scheme to cater for girls pursuing Mathematics in tertiary institutions. This would have increase the enrollment because every girl desiring to pursuit Mathematics will not have her dream shuttered because of lack of financial support. The study calls for the introduction of scholarship schemes for girls who are desirous of pursuing Mathematics in Ghana.

The study also recommends a restructure of the training of teachers in Ghana. This study is of the view that training of the teacher should be on site and not in lecture rooms. Demonstration of how to teach little ones must be done using the little ones in their classroom settings. The practice has been demonstrating to teacher trainees how they should manage the little ones when they go out

to teach. A review of this form of training will do pre-service teachers lots of good especially those who will teach Mathematics.

6.4.3 The teacher's contribution to the decline in the number of girls in Mathematics Education as they progress academically

The study recommends a structured Continuing Professional Development (CPD) for teacher of Mathematics to help shape them into world class teachers who can meet the needs of the 21st century student. By this, teachers will learn from each other and other resource persons how to improvise teaching learning resources. Through the teacher's participation in the CPD, teachers who may have difficulty teaching some specific topics could overcome their challenges. The study recommend frequent supervision of teaching in general especially the teaching of Mathematics.

Elsewhere students are told the importance of every topic and how it relates to their everyday life even before they are thought or introduced to the said topic. Some teachers will also relate every topic to life after delivery. The researcher sat in a Mathematics lesson in Kenya and observed from the teacher in the class that it was mandatory for the teacher to teach students how they have been using the concept under discussion and how they can even use it better going forward. This is not a common phenomenon per the findings of this study in Ghana. It is useful to know the significance of what one learns, how one can make use of it and how one will need knowledge in what they learn for future use. This may help with assimilation. Students may embrace the subject knowing how useful each topic is to them now and in the nearest future. The study therefore recommend a policy in this direction. Teachers of Mathematics should be made to relate every topic they teach to life. Learners are supposed to be encouraged to ask teachers the importance of each topic before or after being taught.

6.4.4 The contribution of the home to the decline of girls in Mathematics Education as they progress academically

The study is of the view that as much as we need the girl child to play home, her spatial abilities must also be catered for. Therefore, girls should be engaged in activities that will help develop their spatial skills. Manipulative games which will set the kids thinking should be parents' choice.

Taking into consideration the statement of Ertekin et.al. that Societies which are aware of the importance of Mathematics, and which base their teaching of new generations on thinking skills and reasoning will be at the forefront in all fields in the future, the study recommends a national education on the importance of Mathematics. If parents, teachers and students are made aware of the importance of Mathematics, they will all work at supporting their kids especially the girl child to survive the study of Mathematics. The girl child, parents, teachers and society must be also educated against all social myths, the girl child must be challenged to live up to her God-given talents. She ought to be told that the woman's place these days is beyond the kitchen.

6.5 IMPLICATIONS OF THE STUDY

The findings of this study have several implications spanning a variety of areas including research, teacher education, societal education, professional development, and education policy.

6.5.1 Implications for practice

The study showed the existence of a gender gap in Mathematics participation in Ghana. This gap keeps widening as the women progress academically. There is, therefore, a decline in Mathematics knowledge among women in Ghana as they progress academically. This has resulted in the creation of the gender gap which keeps broadening as the women progress on the social and academic ladder. There is the need for the government, society, school, opinion leaders and parents to make conscious efforts to increase the number of women who participate in Mathematics and sustain them as they progress academically. If not for anything, for the fact that Mathematics is classified as a "powerful sieve" on the employment market and it remains a essential requirement for access to top-paying or high-status professions (Sells, cited in Mireku et. al. 2015).

6.5.2 Implications for research

The findings of this study may inform researchers the relevant instructional practices related to the transfer of Mathematics phobia and anxiety. Factors contributing towards the phobia and anxiety, as identified by this study, are to prove research in the African context since the African consideration of gender in learning environment is mainly founded on studied conducted in Western Europe and North America (Kitetu, 2004). The study urged teachers of Mathematics, especially the female teachers, to overcome their Mathematics phobia and anxiety and that of their students through professional development, employing the enquiry based approach, relating every topic in Mathematics to everyday life, giving students the significance of each Mathematics topic and using teaching-learning materials in the delivery of Mathematics. Mathematics phobia among teachers has been mentioned as a contributing factor of Mathematics phobia among female learners and students. Teacher strategies and instructional materials have all been mentioned; studies capturing these areas are needed to investigate how these factors affect students' performance in Mathematics over time.

6.5.3 Implications for theory

Findings from this study is in line with the Social Learning Theory. According to the Social Learning Theory, behaviour is learnt or picked from the surroundings or environment through the practise, procedures and processes of learning by observation (Bandura, 1977). Children observe, adopt and develop the stereotypic conceptions of gender from what they see and hear around them. Societal myth and cultural attributes give the girl child consolation even when she fails in Mathematics . Stereotypes affect children starting from their homes. Parents' beliefs about their child's Mathematics aptitude greatly impact the child's achievement. By middle school, carrying through to high school, learners' parents tend to believe that boys have greater Mathematics ability than girls (Beilock,Gunderson, Ramirez &Levine 2010).

The findings also support the sociological theories. Gender in the sociological theories is a societal creation more than a biological given. Sources of gender disparity lie more in institutional and social practices rather than in static characteristics of the person. Finding from various studies, Geis (1993) documented authoritatively, the social structure and perpetuation of stereotypic gender

discrepancies. Gender stereotyping form the evaluation, perception and treatment of the male and female in a discriminatory gendered techniques. It produce the very configurations of conduct which approve the initial stereotypes.

As found by Gunderson *et al.,* (2011), adults' stereotypes regarding Mathematics and gender shape their expectations for boys and girls. This results in varying attitudes and achievements for boys and girls in Mathematics . When their children pick up on this belief held by their parents, the stereotype that girls are poor in Mathematics begins to form.

6.6 SUGGESTIONS FOR FUTURE RESEARCH

This study was inspired by the observed limited research in literature that addressed Mathematics anxiety and phobia among female students and the decline in Mathematics knowledge among females as they progress academically, in the African context. Thus, more African and Ghanaian research needs to explore the Mathematics anxiety and phobia among Ghanaian students especially the girl child as she climbs the social and academic ladder.

A cross-cultural research on Mathematics anxiety and phobia among female students as they progress academically from different countries, may offer more insight on factors that contribute to Mathematics anxiety and phobia among females as they progress academically particularly those that are related to cultural and societal influences. Such research ought to also consider the multi-dimensionality of Mathematics phobia and anxiety as some groups of participants may have a phobia for examinations or tests while others may have numerical task phobia or Mathematics course phobia.

As Kitetu (2004: 6-7) acknowledges from an African view: "Unfortunately, while a lot of gender programmes have been carried out, not much research has been done within the classroom in the continent. Our understanding of gender in classroom practices is most often based on what has been studied in Western Europe and North America. I would like to argue that there is always a cultural angle in studies of social practices". This study identifies Mathematics teacher's phobia in the African context as an area that needs attention adds that the same applies to Mathematics

phobia among female students as they progress academically. More research is needed in the area of Mathematics teachers' phobia and anxiety and how the teachers deal with this challenge in the classroom.

Studies ought to also be conducted to examine the relationship between teachers' level of Mathematics phobia and their students' levels of Mathematics phobia to determine the inter-relationship between the two. The study recommends further studies on the correlation between teachers' pedagogical and content knowledge on the decline of Mathematics knowledge over time. More research should also be conducted to determine whether one's geographical location has any contribution to the decline in Mathematics knowledge over time.

Tatum, Vorster Klingler and Paulson (2006) study did not show an interest in the effect of anxiety reduction on Mathematics achievement. The study mainly focused on the reduction in general anxiety. It is not too clear if the results would lead to a reduction in anxiety and improve performance. As the result may reduce general and Mathematics anxiety, the treatment of Mathematics anxiety as a step towards the mathematical success of a learner, is the goal of many researchers. This study, therefore, recommends more studies to be conducted that will address Mathematics phobia among teachers and learners' Mathematics achievement.

6.7 LIMITATIONS OF THE STUDY

The study represents the perspectives of a group of tertiary institution students in Ghana, hence the findings of the study are not generalisable beyond the participants in the study. However, the study can be adopted in any country with similar socioeconomic status and educational systems.

The research did not cover the Colleges of Education and the Technical Universities, though both are tertiary institutions in Ghana. There are some teacher trainees who specialise in Mathematics and will graduate with a diploma in Mathematics education. These trainees may have contributed significantly to the study; unfortunately they were not a part of it. This is because the study targeted students who were to graduate with a minimum of a first degree in Mathematics. The teacher

trainees in the Colleges of Education and Technical University students at the time of this research were awarded a diploma at the end of their training.

6.8 CONCLUSION

There exists a gender gap in Mathematics participation in favour of the male in Ghana. This gap broadens as the female progresses academically. By the time they get to the Ph.D level, the number of women in Mathematics declines. Many factors contribute to the creation and widening of this gender gap in Mathematics participation. Examples include games and activities children are introduced to at the early stages of their lives. Unavailability of incentives and scholarships for girls who study Mathematics is a contributing factor to the decline in Mathematics knowledge among female students. Teachers' inability to relate the topics they teach in Mathematics to everyday life makes it difficult for students to value the subject. Topics are not related to what students are familiar with and what they will encounter in their lives. Students, therefore, have difficulty situating Mathematics in their everyday activities. Mathematics is taught abstractly without teaching-learningmaterials. Teachers barely employ relevant teaching resources in their lessons due to their scarcity. Drawing three-dimensional objects on a blackboard (2 dimensional) makes it difficult for students to have the correct mental image of the shapes under discussion. Mathematics, therefore, becomes abstract and very problematic for learners to understand. The teaching strategies of Mathematics teachers also contribute greatly to the decline in Mathematics knowledge, among girls in particular. Some teachers teach mathematical concepts by mere provision of formulas and substituting those formulas. Anxious Mathematics teachers transfer their anxiety onto their students and the anxious female Mathematics teacher has an adverse effect on the female learner. Societal myths contribute greatly to the decline in Mathematics knowledge among girls. Girls are made to believe it is okay to fail Mathematics since it is presumed a very difficult subject sorely meant for boys. The majority seems to be comfortable with the non-performance from girls. The decline in Mathematics knowledge has an effect on the academic promotion of an individual. It is evident that are not enough women heading the Mathematics departments in the tertiary institutions in Ghana.

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APPENDICES

APPENDIX A - QUESTIONNAIRE FOR CROSS-SECTIONAL SURVEY

This is an academic research being carried out on the topic: **Assessing Mathematics Phobia and its Impact among Female Students** in partial fulfillment of the requirements for the award of a Doctor of Philosophy degree in **Curriculum Studies**. The researcher is currently a student of UNISA. Your views are being solicited to make this study a success. I assure you that any information given will be treated with the utmost confidentiality.

SECTION A: DEMOGRAPHIC DATA (PLEASE TICK WHERE APPLICABLE)

1. Name of institution

01.Legon ( ) 02. KNUST ( ) 03. UEW ( ) 04. Valley View ( )

05. UCC ( ) 06. AIT ( ) 07.Central Uni. ( ) 08. UPSA

2. Sex

01. Male ( ) 02. Female ( )

3. Age

01. 15-20 ( ) 02. 21-30 ( ) 03. 31- 40 () 04. Above 40( )

4. Highest level of education attained

01. Under graduate student ( ) 02. First Degree holder ( )

03 Graduate student ( ) 04. Master's Degree Holder ( )

04 Ph.D student ( ) 05. Ph.D Holder ( )

5. What degree are you pursuing?

01. First degree ( ) 02. Masters ( ) 03. Ph.D ( )

SECTION B:THEORETICAL AND CONCEPTUAL RELATIONSHIP BETWEEN MATHEMATICS KNOWLEDGE AMONG BOYS AND GIRLS.

Do boys and girls learn Mathematics under the same conditions?

Use a four-point scale ranging from Strongly Agree (SA) 4, Agree (A) 3, Disagree (DA) 2, and Strongly Disagree (SD) 1.

Construct

6. Mathematics is a very difficult subject and must be reserved for only brilliant boys.

   1 2 3 4

7. Girls are given the same motivation and support as boys in the home, school and society to study Mathematics

   1 2 3 4

8. Textbooks examples give the impression that Mathematics is boys thing.

   1 2 3 4

Concept

9. Boys usually explore, lay bricks etc., activities that facilitates the development of their spatial skills giving them an upper hand when it comes to performance in Mathematics .

   1 2 3 4

10. Incentives and special packages such as scholarships for girls who decide to pursue higher study of Mathematics will increase the number of women in the field.

    1 2 3 4

Dimension

11. In sociological theories, gender is a social construction rather than a biological given. The sources of gender differentiation lie more in social and institutional practices than in fixed properties of the individual. In your opinion, would you say the same theory support Mathematics learning among boys and girls?

    1 2 3 4

12. Classroom practices, such as pedagogy, classroom setting and teaching learning materials give both boys and girls equal opportunity to excel in Mathematics .

    1 2 3 4

SECTION C: SOCIETAL FACTORS THAT CONTRIBUTE TO WOMEN FALLING OUT IN THE FIELD OF MATHEMATICS

Use a four-point scale ranging from Strongly Agree (SA) 4, Agree (A) 3, Disagree (DA) 2, and Strongly Disagree (SD) 1.

Construct

13. Social environment (influences of teachers/parents/friends/media/ culture /other) contribute to women falling out in the field of Mathematics

    1 2 3 4

14. Girls are given more chores at home. They barely make time to study in the house while boys have little to do and have more time to learn Mathematics and other subjects.

    1 2 3 4

15. Lack of role models (Women mathematicians) is a story that simply says Mathematics is a no go area for girls

    1 2 3 4

Factors

16. Societal myth affects performance of girls in Mathematics .

    1 2 3 4

17. Students from less privileged homes cannot do well in Mathematics .

    1 2 3 4

18. Mother's attitude has influence on her daughter's mathematical performance.

    1 2 3 4

Concept

19. People conceive the notion Mathematics is difficult even before they are introduced to it.

    1 2 3 4

20. Girls are often discouraged to stay off Mathematics with the view that it is difficult.

    1 2 3 4

21. Everybody sees nothing wrong with the non-performance of the girl-child in Mathematics .

1 2 3 4

SECTION D:THE ROLE OF THE SCHOOL, THE HOME AND THE TEACHER IN THE DECLINE OF GIRLS IN MATHEMATICS EDUCATION

Use a four-point scale ranging from Strongly Agree (SA) 4, Agree (A) 3, Disagree (DA) 2, and Strongly Disagree (SD) 1.

Constructs

22. Too strict of Mathematics teachers affect my performance in Mathematics .

1 2 3 4

23. Mathematics teachers usually do not teach the application aspect of the topics they teach hence girls do not see how related their everyday life is to the Mathematics they learn.

1 2 3 4

24. Societal believe that Mathematics is not girls thing to a large extent contribute to the fall out of women in Mathematics .

1 2 3 4

Concept

25. The teaching strategies of Mathematics instructors contribute largely to the lack of interest in the subject.

1 2 3 4

26. Female Mathematics teachers are a source of motivation to girls in Mathematics learning.

1 2 3 4

27. Teaching Mathematics without Teaching Learning Materials make Mathematics lessons abstract and boring for girls.

1 2 3 4

Dimension

28. The Mathematics topics in the syllabus are not applicable in our everyday life. This is likely to affect the performance of girls.

1 2 3 4

29. Forcing pupils to learn Mathematics and applying punishment for avoidance will promote Mathematics among girls.

1 2 3 4

30. Incentives such as special handshake for girls who do well in Mathematics could promote Mathematics development among females.

1 2 3 4

SECTION E:EFFECT OF THE DECLINE OF MATHEMATICS KNOWLEDGE ON THE WOMAN.

Use a four-point scale ranging from Strongly Agree (SA) 4, Agree (A) 3, Disagree (DA) 2, and Strongly Disagree (SD) 1.

Constructs

31. The feelings of Mathematics anxiety affect people's progress academically.

1 2 3 4

32. My mates who couldn't further their education couldn't do so as a result of bad grade in Mathematics .

1 2 3 4

33. Most of my mates who were female ended their education along the way as a result of failure in Mathematics .

1 2 3 4

Concept

34. Knowledge in Mathematics facilitates your promotion in academia.

1 2 3 4

35. There are few women Heading departments in the Physical Science Faculty especially Mathematics due to their non-availability in the field.

1 2 3 4

36. The number of times women taught me Mathematics , the girls in my class did slightly better than when men taught us.

1 2 3 4

Dimensions

37. Less than 5% of the teaching staff in our Mathematics department are women.

    1 2 3 4

38. My female Mathematics teacher was very patient with the weak students in class.

    1 2 3 4

39. My Mathematics teacher who was a male was very patient with the weak students in class.

    1 2 3 4

40. The Head of Mathematics Department in my institution is a woman.

    1 2 3 4

Thank you very much for your co-operation.

APPENDIX B - ENROLLMENT DATA

ENROLMENT OF STUDENTS BY PROGRAM AND YEARS 2012-2016

No.	Program_Name	Year	Male	Female	Total
1	M.PHIL (MATHS)	2014	2	1	3
2	M.PHIL (MATHS) -TOP UP	2015	2	2	4
3	M.PHIL (MATHS) -TOP UP	2016	1	0	1
4	M.PHIL (STATS)	2013	1	0	1
5	M.PHIL (STATS)	2015	2	1	3
6	M.PHIL (STATS)	2016	5	0	5
7	M.PHIL (STATS) -TOP UP	2016	1	0	1
8	MSC (MATHS)-SW	2014	5	0	5
9	MSC (MATHS)-SW	2015	8	0	8
10	MSC (MATHS)-SW	2016	7	2	9
11	MSC (STATS)-SW	2013	18	1	19
12	MSC (STATS)-SW	2014	14	1	15
13	MSC (STATS)-SW	2015	8	2	10
14	MSC (STATS)-SW	2016	7	3	10
15	PH. D. (MATHS)	2012	1	1	2
16	PH. D. (MATHS)	2014	4	1	5
17	PH. D. (MATHS)	2016	1	0	1
18	PH. D. (STATS)	2014	2	0	2
19	PH. D. (STATS)	2015	4	0	4
20	PH. D. (STATS)	2016	1	0	1
21	PH. D. (COMPUTER SCIENCE)	2014	2	1	3
22	PH. D. (COMPUTER SCIENCE)	2013	7	1	8
23	PH. D. (COMPUTER SCIENCE)	2015	1	0	1
24	PH. D. (COMPUTER SCIENCE)	2016	2	0	2

ENROLMENT OF STUDENTS BY PROGRAM AND YEARS 2012/2016

No.	Program_Name	Year	Male	Female	Total
1	BSC (MATHEMATICS)	2012	11	1	12
2	BSC (MATHEMATICS)	2013	14	0	14
3	BSC (MATHEMATICS)	2014	11	4	15
4	BSC (MATHEMATICS)	2015	11	2	13
5	BSC (MATHEMATICS)	2016	4	0	4
6	BSC (MATHS AND STATISTICS.)	2012	22	3	25
7	BSC (MATHS AND STATISTICS.)	2013	18	4	22
8	BSC (MATHS AND STATISTICS.)	2014	30	6	36
9	BSC (MATHS AND STATISTICS.)	2015	9	3	12
10	BSC (MATHS AND STATISTICS.)	2016	6	1	7
11	BSC (MATHS WITH BUS.)	2012	34	14	48
12	BSC (MATHS WITH BUS.)	2013	51	18	69
13	BSC (MATHS WITH BUS.)	2014	50	16	66
14	BSC (MATHS WITH BUS.)	2015	17	5	22
15	BSC (MATHS WITH BUS.)	2016	11	1	12
16	BSC (MATHS WITH ECONS.)	2012	31	7	38
17	BSC (MATHS WITH ECONS.)	2013	68	10	78
18	BSC (MATHS WITH ECONS.)	2014	65	4	69
19	BSC (MATHS WITH ECONS.)	2015	39	2	41
20	BSC (MATHS WITH ECONS.)	2016	36	6	42
21	BSC (STATISTICS.)	2013	42	5	47
22	BSC (STATISTICS.)	2015	36	6	42
23	BSC (STATISTICS.)	2012	46	10	56
24	BSC (STATISTICS.)	2014	43	4	47
25	BSC (STATISTICS.)	2016	19	2	21
26	BSC. (ACTUARIAL SCI.)	2012	29	9	38
27	BSC. (ACTUARIAL SCI.)	2013	45	19	64
28	BSC. (ACTUARIAL SCI.)	2014	28	5	33
29	BSC. (ACTUARIAL SCI.)	2015	23	5	28
30	BSC. (ACTUARIAL SCI.)	2016	37	14	51

APPENDIX C – PERMISSION LETTERS

Accra College of Education
P. O. Box LG221
Legon Accra

The Head of Mathematic Department
University of Ghana
Legon
19th June, 2017.

Dear Sir.

PERMISSION TO CONDUCT A RESEARCH STUDY

My name is Mireku Dora Animwaa and I am a Ph.D student from University of South Africa (UNISA). I am conducting a research with the title "Factors that Hamper the Acquisition of Mathematics Knowledge by Females in Ghana" This project is being conducted under the supervision of Dr. Nkonyane Vussy(Curriculum and Instructional Studies) UNISA.

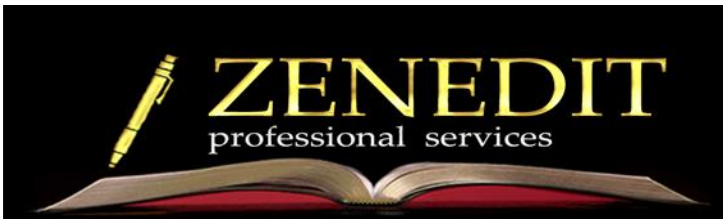
I am hereby seeking your consent to take the enrollment data of students to Mathematics Department from 2012 to 2016 and to distribute questionnaire to some of your members who would be randomly selected to help complete the questionnaire of the study.

Upon completion of the study, I will provide the Department of Mathematics with a bound copy of the full research report. If you require any further information, please do not hesitate to contact me on animbadee2@yahoo.com or 0200248588/0244671228. Thank you for your time and consideration in this matter.

Yours sincerely,

Mireku Dora Animwaa
University of South Africa UNISA

APPENDIX D: LANGUAGE EDITING CERTIFICATE



5 Gwai Place; 10 Kudu Heights
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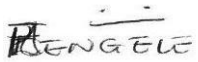
26 June 2021

DECLARATION OF PROFESSIONAL EDIT

I declare that I have edited and proofread the PhD Thesis entitled**: ASSESSING MATHEMATICS PHOBIA AND ITS IMPACT ON FEMALE STUDENTS by DORA ANIMWAA MIREKU.**

My involvement was restricted to language editing: contextual spelling, grammar, punctuation, sentence structure and style, proofreading, sentence completeness, sentence rewriting, consistency, referencing style, editing of headings and captions. I did not do structural re-writing of the content. Kindly note that the manuscript was not formatted as per agreement with the client. No responsibility is taken for any occurrences of plagiarism, which may not be obvious to the editor. The client is responsible for ensuring that all sources are listed in the reference list/bibliography. The client is responsible for the quality and accuracy of the final submission.

Sincerely,



Pholile Zengele

Associate Member, Professional Editors Group