UNIVERSITY OF EDUCATION, WINNEBA

EXPLORATION OF CRITICAL EXPERIENCES INFLUENCING THE PURSUITS OF TECHNOLOGY-RELATED PROGRAMMES BY STUDENTS ON FEMALES IN GHANAIAN UNIVERSITIES: A PHENOMENOLOGICAL STUDY

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A THESIS IN THE DEPARTMENT OF EDUCATIONAL LEADERSHIP, FACULTY OF EDUCATION AND COMMUNICATION SCIENCES, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, KUMASI CAMPUS NOW - AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY (Ph.D.) IN EDUCATIONAL LEADERSHIP

MARCH, 2022

DECLARATION

STUDENT'S DECLARATION

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

SIGNATURE: ………………………………………………

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SUPERVISORS' DECLARATION

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

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ACKNOWLEDGEMENTS

The success of this thesis depends on more than those whose names appear as its creators. It would be gross ingratitude of the highest order if the author of this thesis therefore fails to extend appreciation towards the honourable personnel who rendered encouragement, lent the needed support and their much appreciated professional advice. From the first day of planning and organising to the final editing of this masterpiece, I have been enormously supported by professors and doctoral students of University of Education, Winneba (UEW) and some staff of other universities. The ultimate appreciation goes to the Almighty God for sustaining me and guiding the whole process via these veterans. To them I owe such debt of gratitude that mere "Thank you" does not seem to satisfy. May the Lord richly bless them in all their endeavours.

In particular, without the patience, diligence and readiness of my supervisors: Professor Jophus Anamuah-Mensah - the first Vice Chancellor of the University of Education, Winneba (UEW) and Professor Frederick Kwaku Sarfo – the current and the first Vice-Chancellor of Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), this credential would not have been achieved. Prof. Emeritus Jophus Anamuah-Mensah's contributions have been indispensable. I am overwhelmed with gratitude for his patience and the time which he always readily spent on my work on-line and whenever I went to him.

Similarly, the ease with which Professor Sarfo could be reached even without any appointment was encouraging and very deeply appreciated. Aside his own thesis as a guide, I benefited a lot from his wisdom and great sense of humour. To Professor Akwasi Asabere Ameyaw, former Vice-Chancellor of UEW, thanks for your encouragement and

reference materials. To Nana Kwaku Owusu-Kwarteng of Offinso, Chief, thank you for your encouraging words. By them, you lifted me up when I was down. But for your input, I could not have come this far. Thank you! Again, I say thank you!

To Rev. Fr. Prof. Anthony Afful-Broni and Professor Mawutor Avoke - Immediate Past and current Vice-Chancellors respectively of UEW, I thank you for your great encouragement from the onset and throughout the period of my research. To the two Deans - Professors Martin Amoah (deceased) and Jobson Mitchual, Deans of the Faculty of Technical Education, thank you for the tremendous work done in introducing me to the universities, the faculties and the departments who permitted the sampling in their outfits.

Rev. Fr. Dr. Francis Sam, it was during your tenure of office as the Head of Department (HOD) of Educational Leadership that my proposal was formulated and presented hence, you also deserve my gratitude for the greatest encouragement offered. Father, you are a force to reckon with. Additionally, the lecturing and lecture notes by Rev. Dr. Alexander Edwards during my auditing have been very instrumental. I am so grateful.

I also wish to express my sincerest gratitude to the current Vice Dean of Students' Affairs at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) - Dr Philip Oti-Agyen who edited every written piece: thanks a great deal! I also owe a great debt of gratitude to Dr Abu Yaya and Dr Mrs Peace Amoatey of School of Engineering – Legon, Dr Boateng (HOD), Mrs Vida Naa Lamiley Quao and Mr Kingsley Kwaah Tandoh all of All Nations University; Dr Ohene Boansi Apea of University for Development Studies for selflessly allowing themselves to be observed for the improvement of pedagogical strategies in science-related programmes. To all the Deans, HODs, Faculty Officers of UEW, School of Engineering

(University of Ghana), Central University College in Tema, Valley View University at Dodowa, All Nations University College in Koforidua, University for Development Studies in Navrongo, I say Thank you all! To Dr Aboagye, my doctorate auditing course-mate, thanks for your great support!

Special appreciation also goes to the student-participants on face-to-face and focus-group interviews in all the sampled universities. They were fantastic with deep wealth of ideas and insights. My sincerest appreciation also goes to the departments for the logistical support and physical space which they provided even on short notices.

To my International Women's Forum (IWF) Leadership Foundation Fellows - 2006 course-mates: female giants in academia and Chief Executive Officers in the business sectors - Group-of-sixteen (16), thanks for your encouragement!

To my son – Yaw Asiedu Danso, my computer literacy tutor: you are a son well cherished and deeply appreciated. Again to my daughter Mrs Yaa Takyiwaa Oppong and Dr Kwaku Gyamfi Oppong - my son-in-law, thank you for your motivation. Last but not least, to my beloved cousin in the United States of America (USA); Ing. Kofi Owusu-Ansah - thanks for proof-reading portions of this work. Finally, I am grateful to all those, some of whose names I could not include here, but who in diverse ways contributed to the successful completion of this work. May the Lord continue to bless you.

DEDICATION

To my late father - Mr Samuel Kenneth Kwadwo Agyepong and my children Yaw Asiedu Danso and Yaa Takyiwaa Danso (Mrs Oppong).

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LIST OF ACRONYMS

COLTEK	College of Technology Education, Kumasi
DE	Distance Education
DTE	Design and Technology Education
FIAC	Flanders' Interactive Analysis Categories
HE	Higher Education
HOD	Head of Department
IEDE	Institute of Educational Development and Extension
KNUST	Kwame Nkrumah University of Science and Technology
ME	Mechanical Engineering
OECD	Organisation for Economic Co-operation and Development
S&T	Science and Technology
STEM	Science, Technology, Engineering & Mathematics
SC	Social Constructionism
SCT	Social Constructionist's Theory
TVE	Technical/Vocational Education
UDSM	University of Dar-es Salaam
UEW	University of Education, Winneba

ABSTRACT

This study investigated the experiences of female students pursuing technology-related programmes in Ghanaian universities. It focused on the exploration of key issues causing low enrolment of female students in five universities and the interventions that could be implemented to offset the imbalance. The study was substantively situated in Burr's (2015) Social Constructionist's theoretical framework. The phenomenological qualitative research paradigm was adopted. The main research design was a non-experimental exploratory approach. Fifty-eight (58) participants (comprising 53 students and 5 lecturers) were purposively sampled via snowballing technique. Data were gathered through semi-structured interviews and non-participant observational inductive methods. The data were then thematically analysed and interpreted. The study, inter alia, found that brain laterilization (dichotomy) was not a contributor to females' choices of technology-related programmes. Again, parents were noted to play significant roles in directing their wards towards programme preferences and choices. With regard to cultural influences, a key challenge and new insight gained from this study, not recorded in the literature, was the restriction placed on females in holding and using basic technological tools such as the saw whilst embarking on Community Service. Additionally, stereotypically-adopted domestic chores were found to hinder the studies of female students. Some participants, especially the females, further complained about boarding commercial vehicles with large equipment such as drawing-boards which made them socially embarrassed. In the observation exercise, it emerged that the most frequently used pedagogical strategy by the lecturers was explanation supported with audio-visual aids. Active interaction in the form of practical demonstration with students was minimal. Some participants also complained about the restrictions on the use of instruments by some lecturers and in some laboratories during demonstration lessons. It is recommended that policy-makers take measures to increase funds allocated to universities to improve infrastructural development. Parents must be sensitised to assist their wards to select the most appropriate courses. Adequate boarding facilities must be provided to female-students to insulate them from labourious domestic chores. Such chores keep them exhausted and prevent them from comprehending spatial disciplines such as Mathematics that is placed early on the time-tables. Technological education should also be given a boost with advertisements on the social media.

UNIVERSITY OF EDUCATION, WINNEBA

THE IMPACT OF WORKPLACE ENVIRONMENT ON TEACHERS' PERFORMANCE IN THE PUBLIC BASIC SCHOOLS IN KWADASO MUNICIPALITY

BY

MARGARET OHEMENG

(INDEX NUMBER: 7181770069)

A project in the Department of Educational Leadership, Faculty of Education and Communication Sciences, submitted to the School of Graduate Studies in partial fulfilment of the requirements for the award of the degree of Master of Arts (Educational Leadership) in the University of Education, Winneba

AUGUST 2022

DECLARATION

STUDENT'S DECLARATION

I, **MARGARET OHEMENG**, declare that this Project, with the exception of quotations and references contained in published works which have been all identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for any other degree elsewhere.

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SUPERVISOR'S DECARATION

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

NAME OF SUPERVISOR: DR SAMUEL ADU GYAMFI

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ACKNOWLEDGEMENTS

I will first of all like to extend my deepest appreciation and gratitude to my supervisor, Dr. Samuel Adu Gyamfi, whose expertise and direction were invaluable in the completion of this work. Particularly, his patience and understanding are greatly appreciated. I am also grateful to my husband Mr. Wat Kwame Tweneboah for his prayer, support and encouragement. To him, I will forever be grateful. I will also like to extend my sincere appreciation and indebtedness to Linda and Vero for their patience, support and encouragement. Without them, my dream could not have been realized.

DEDICATION

To my lovely and precious children Eugene, Tony and Michael

ABSTRACT

The purpose of this study was to investigate the impact of workplace environment on teachers' performance in the public basic schools in the Kwadaso municipality. A sample size of 171 was selected through simple random sampling. Descriptive research design was employed with close-ended questionnaire as the instrument for data collection. Data was analyzed using frequencies and percentages. The findings revealed that most of the schools lacked facilities such as staff common room, well ventilated and lighted classes. In addition, most of the schools do not have ICT laboratories. Besides, the size of class and the teacher-to-teacher relationships also affect teacher performance. Finally, better financial incentives and fairness in promotion could help improve the workplace environment for teachers which will impact positively on their work. It is therefore recommended that the Kwadaso Municipal assembly should lease with Government to build more facilities including staff common rooms and well ventilated and lighted classrooms for the various schools within the Municipality. Furthermore, the Ministry of Education should put up more modern ICT facilities for schools. Again, head-teachers and teachers should establish close relation and ensure mutual respect among themselves. The Ghana education Service should motivate teachers financially and ensure open and transparent processes in teacher promotions. These would go a long way to enhance the output of teachers in the Kwadaso Municipality and in Ghana as a whole.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

The first chapter of this research describes a general overview of the study which includes: the background to the study, statement of the problem, purpose of the study, objectives of the study and the research questions. The chapter also spells out the significance, limitations, delimitations and the general layout of the thesis' report.

1.1 Background to the Study

It has been widely agreed that the education of females who form a proportion of over 51 percent in general of the world's population has high returns to schooling than for men. **Dougherty (2005)** assigns a reason based on the data of a Longitudinal Survey of Youth in 1979 that; besides education having a double effect on the earnings of both women and men by increasing their skills and productivity, it additionally appears to reduce the gap in male and female earnings. He explains further that this is attributable to factors such as discrimination, tastes, and circumstances. Again, according to Anamuah-Mensah (2007), the education of women contributes immensely to economic development in Africa through ways such as food production, storage, marketing and household chores. In that vein, issues such as the application of scientific and technological methods for food production, correct and safe preservation methods and sanitized living conditions could be assured. Hannum, Zhang and Wang (2013), using data from the China Urban Labour Survey in 2001 and reported in China Quarterly, also argue that the returns for women are higher than for men because many women trade their own income for spouse income particularly among less educated women. Similarly, Schultz (2001) supports with empirical evidence that a mother's schooling will have a larger beneficial effect on a child's health, schooling, and adult productivity as compared to that of a man. All these could lead to the improvement in the quality of lives of citizens, thereby reducing poverty and diseases significantly. Consequently, females' lack of scientific and technology-related education could lead to costly repercussions including poor health and high mortality rates in children, poor family nutrition and low life expectancy (Anamuah-Mensah, 2007). Women's potentiality however, should not be restricted to issues particularly in food production and child caring alone. It is important that their potential in applied science or technology be harnessed fully for economic, social and technological development and this might be achieved through knowledge, skills and competencies in technology-related disciplines. In the context of this research, technology-related disciplines or subjects refer to Applied Science disciplines such as Mechanical and Computer Engineering.

The under-representation or the enrolment gap of females in technology-related disciplines could be traced back to quite a number of factors. These include socio-cultural, curricula, scientific and other general factors like leadership styles and role modelling as the foregoing enumeration reveals.

1.1.1 Socio-Cultural Underpinnings

Socio-culturally, McWilliams and Kwamena-Poh (1975) describe the home as traditionally the earliest and main educational agency of every child. They point out what a Danish merchant in the mid-1600s observed about the Fante Community; that a boy after following the father could learn a trade and get initiated into the customs and traditions of the family and the society. Such professional training for the males included specialized functions in priesthood, hunting, wood-carving, rope-making and boat-building. The young men of the 'Fetu' tribe were also noted to have attended sessions of law courts to equip themselves with tribal law since there were no alphabets to learn from. On the other hand, McWilliams and Kwamena-Poh (1975 p.3) again state that:

> From age six, the young girl would be taught how to clean the house, make fire, and prepare the various meals. At a later stage she would learn mother-care from the mother or the older women, while the young boy would begin to pick up the father's profession

Through such informal system of training, it could be deduced that the females gained experience towards home-making skills whilst the males were groomed towards acquisition of technological skills. Experience in this context is defined by Merriam Webster dictionary as the process of doing and seeing things and of having things happen to you. It also explains it as the skill or knowledge that one gains by doing something or the length of time that one has spent doing something such as a particular job. The females in this regard, always gained experience in domestic chores. This is the case since as one continuously practices the norms and behaviour of the society, one gets well acquainted with them. Growing up and living within a society can therefore foster the development and observation of social experiences since the knowledge or skills could be acquired through a period of practical experience of an individual especially, ones gained in a particular profession. Development over the years might have, however, transformed the society which could suggest changes in the thought process of societies too but to what extent has it positively affected female technology-related programme participation?

Danso's (1996) dissertation reports how gender differentiation happens to be a major aspect of traditional education that has survived the introduction of formal Western education. Thus, under curricula issues, she highlights that the introduction of formal education through the missionaries, colonial masters and governors has brought about the acquisition of new skills and aptitudes. How these have affected gender roles and choices of subjects is worth reviewing.

1.1.2 Historical analysis of the educational system and Curricula Issues

1.1.2.1 The Castle and Missionary Schools

The acquisition of new skills and aptitudes as illustrated in **Danso (1996)** was achieved after several structures in the educational ladder. Citing from Abosi and Brookman-Amissah (1992) and Mc Williams and Kwamena-Poh **(1975), Danso (1996)** explains that formal education for the Gold Coast (Ghana) commenced in 1529 with the establishment of Castle Schools by the Portuguese at Elmina. The Castle schools were mainly established to teach reading, writing and Arithmetic - the '3Rs' (Boahen, 1989 in **Danso, 1996).** What initiated the establishment of the schools was the urgent need for locally trained personnel to serve as interpreters to help the European merchants in their business transactions with the natives. It was also aimed at filling in the few clerical jobs at the castles such as filing letters and running other errands **(Graham, 1971 in Danso, 1996).** The merchants lived in the castles located along the coast and the schools established were all confined to these castles thus attracting the term 'Castle Schools' (Oti-Agyen, 2007). The schools were taken over by the Dutch in 1644 and operating within the same Elmina Castle premises (the former Portuguese fortress at Elmina), their schools were known as the best known Castle Schools on the Gold Coast. The British school was also operated at Cape Coast Castle and the Danish school at Christiansburg Castle near Accra. In the late eighteenth century and throughout the nineteenth century, in describing the enrolment into the castle schools, Graham (1975 in Danso, 1996) and Oti-Agyen (2007) report that: the pupils were largely sons of European merchants and local women (mulattoes). The enrolment was however supplemented by the admission of children of some wealthier African traders in the urban centres. An example is cited of an Ashanti chief who sent twelve (12) boys and two (2) girls to the schools in the 18th Century' (Goves, 1958 in Danso, 1996 P.10). It could be inferred from the number of girls sent by the chief that girls' education was not given the same or equal attention as that of boys at the inception of formal education. Though the castle school system was not entirely successful, its footprints on contemporary Ghanaian educational system were enormous. The introduction of literacy and numeracy which constitute the foundation of modern educational system paved the way for the beginning of formal Western education with the Christian Missionaries being the bedrock in the spread of education into the interior parts of the country (Oti-Agyen, 2007).

1.1.2.2 Missionary Education

The missionaries (e.g. the Basel Mission or Presbyterians and the Wesleyan Methodists) started running parallel sessions with the castle schools thus; formal education started widening its scope. The main propagators of the missionary schools had the purpose of converting the school pupils and their parents to Christianity. One of the greatest contributions of the missionary schools was that they provided Ghana with leaders who came to assume major responsible positions in building the nation; political leaders like

Dr. Aggrey, Dr Kwame Nkrumah, Dr K. A. Busia and J. B. Danquah were all products of the missionary schools (Oti-Agyen, 2007). Unfortunately, none of them was a woman.

Most of the Basel Missionaries who arrived a little earlier than the Wesleyans did not survive. The survivor Andreas Ris later helped in opening a boy's school at Akropong and a girl's school at Aburi in 1854. Prior to that the first school had been opened for girls in 1821 by a widow of a merchant and it had Sewing and Home Science as the content of the curricula (Danso, 1996). This school could not survive and was closed down seven years later. Another school was again opened in Cape Coast in 1836 for girls tutored by Mrs Wriggley, a Wesleyan's minister's wife. After the death of Mrs Wriggley, Mrs Elizabeth Waldron took over the management and the school had an enrolment of about thirty (30) girls at that time (Oti-Agyen, 2007). It had Reading, Sewing and Catechism on the curriculum (Danso, 1996). Whereas the reading would inculcate literacy skills and the sewing vocational skills, the catechism inculcated moral education - one of the aims of the propagators of the initial education. Nothing of pure technical base was included. By 1840, the enrolment at the school had reached eighty (80) and Oti-Agyen (2007) further reports that another woman Mrs. Barnes started teaching reading and sewing to twenty (20) girls at Anomabu in the central region.

The Basel missionaries also opened schools at Christianborg for industrial training in joinery, carpentry, blacksmithing, shoemaking and book-binding (Mc Williams & Kwamena-Poh, 1975). Although not reported, such trade or industrial schools were opened for boys. Oti-Agyen (2007) describes how the Basel schools were highly interested in industrial, technical and Agricultural education. He reports that by 1890, all Basel schools had small farms and pupils were expected to grow crops such as cocoa, coffee, pineapple and mangoes. A model farm was established at Abokobi by the Basels. The Wesleyan Methodists focused on training teachers and catechists and started a theological seminary in Accra in 1842. This was later transferred to Aburi and then to Wesley College. They also promoted technical/vocational education whereby they divided their schools into lower and upper levels with the latter learning subjects such as technical drawing and elementary science and the lower levels restricted to the 3Rs as already established by the castle schools (Oti-Agyen, 2007). Female education was also central to the activities of the Wesleyan missionaries and Oti-Agyen further expresses that the founder of that mission - Wesley, was noted to believe in equal opportunities being offered to boys and girls in education.

The colonial British Government's interest in educational matters started in the middle of the nineteenth century. That period was therefore noted for the formulation of policies to control and infuse more measures of uniformity into the colonial educational practices in the country. From 1850, the educational activities were largely restricted to the passing of ordinances to regulate the educational practices in the country (Oti-Agyen, 2007).

1.1.3 The Educational Ordinances

The first educational ordinance by the government of Ghana was formulated in 1852. Prior to this period, Lieutenant-Governor H. W. Hill's proposal with the aim of starting a higher education to prevent the high cost of educating African merchants outside the country Ghana was rejected by the colonial office. Two years later, his successor Winniett pleaded for the establishment of technical education, and as put by McWilliams and Kwamena-Poh (1975 p.36), Winniett stated that:

> At present there is no employment for educated boys, except as teachers in schools, and clerks in government and mercantile establishments, and hence the results of education, pleasing as they may be, are not so healthy as they would be if they were associated with various branches of mechanical knowledge.

The writers explained that nothing was done about the plea. It could be inferred from this plea that only boys were educated and therefore any training in mechanical knowledge should focus on them. Though the 1852 ordinance was not successful, Oti-Agyen (2007) expresses that some modest achievements were made at the initial stages. One of the causes for the failure was the death of the wife of the European couple who were appointed to head the schools associated with the ordinance of 1852. By 1874, the government schools had almost collapsed so the government entered into partnership with the mission schools that had been able to establish over one hundred schools. To introduce a more uniform system of educational structure in the West African region, the Gold Coast Legislation Council passed the 1882 Educational ordinance. This ordinance was patterned on the English Education Act of 1870 (Danso, 1996). The Ordinance of 1882 provided for the establishment of a General Board for Education. It also set up rules for opening new schools especially schools that were built in areas where the missionaries had failed to reach during their educational venture because of the tribal disturbances such as those caused by the Ashanti invasions.

A lot of curricular changes were effected in the ordinance of 1882 to include subjects such as Drawing, Industrial Instruction and Physical Exercise. All but Singing (mainly church hymns), were trade-based and singing had the purpose of instilling Christian doctrines into the pupils. Other optional subjects for Grants-in-aid such as Elementary

Science, Book-keeping, Shorthand and Mensuration were also introduced. Grants-in-aid was linked to average attendance of pupils, the general efficiency of the schools and the success of the pupils in the examination based on prescribed syllabuses (Foster, 1965; Graham, 1971 in Danso, 1996). The ordinance also stipulated that the pupils had to sit for annual examinations individually in Reading, Writing and Arithmetic, and girls had to be assessed in Needlework. By 1885, there were a total of 82 schools providing basic education in Ghana with a total enrolment of 4,970 pupils out of which 21.8% were females, that is, about 1,083 (Danso, 1996).

The 1882 ordinance also failed due to a number of reasons including lack of funds and the scope of management because Gold Coast, Lagos and Sierra Leone for instance were managed by Rev M. Sunter, the Principal of Fourah Bay College and the educational board (Oti-Agyen, 2007). Foster (1965) and Graham (1971) as cited in Danso (1996) also attribute the failure to lack of personnel and monitors for the projects (as they required constant supervision by those who had wider experience). Unavailability of machinery for implementing recommendations and general lack of equipment and funds also contributed to the failure. Five years later (in 1887), another ordinance was passed.

In the 1887 Ordinance, the subjects taught were still “Reading and Writing of the English Language, Arithmetic and in case of females, Plain Needlework” (McWilliams & Kwamena-Poh, 1975 p.40). One could however deduce that boys’ exemption from taking Needlework set the pace for subject segregation and this dates as far back as the colonial days. A new board to manage education was set up and a director for education was appointed. Thus, Ghana was granted an educational department of her own from the British West African zone which hitherto comprised Sierra Leone, Gambia and Nigeria.

As a result of this, a Director of Education was appointed in 1890. Sierra Leone followed in 1909. Lagos' education completely got separated from Ghana and Sierra Leone in 1892 (Danso, 1996). The curriculum drawn in the 1887 ordinance was expanded to include technical, vocational and agricultural education. Needlework was still taken solely by girls.

This 1887 ordinance also failed purposely due to what was known as 'payment by results' (Oti-Agyen, 2007 p.86) which was the system of offering grants by the number of children in schools that passed the annual examination conducted by the Inspector. The two ordinances passed in 1882 and in 1887 however, were considered as the stepping stone to colonial education policy in the Gold Coast which helped the process of instruction to go many steps forward (Aissat & Djafri, 2011). Secondary education for instance, started in 1909 and 1910 by the Methodist and Anglican missions respectively at Mfantsipim and Adisadel in Cape Coast. Achimota, a large boarding school was also built in 1930 in Accra (Danso, 1996).

The next governor appointed for the Gold Coast after the 1887 ordinance was Governor Frederick Gordon Guggisberg. Together with Sir John P. Rodger, vocational and agricultural education was introduced in the primary school curriculum. Governor Guggisberg had an outstanding commitment towards education and some historians have recognized his contributions as a critical effort in constructing a firm foundation for the future manpower training of the people of the Gold Coast. A famous Ghanaian historian – F. K. Buah for instance has noted that Guggisberg's eight-year administration from 1919 to 1927 was the most revolutionary in the colonial days (Oti-Agyen, 2007). Under the 1920 Educationist Committee for instance, Guggisberg enunciated his sixteen (16) principles of education to the Legislative Council (Graham, 1971; Oti-Agyen, 2007). Significant to gender and technical education were the fourth and sixteenth principles which are noted by Oti-Agyen, (2007 pp92-93) as:

i. Equal opportunities to those given to boys should be provided for the education of girls.
ii. There should be provision of trade schools with a technical and literary education that will fit young men to become skilled craftsmen and useful citizens

It should however be noted that the trade schools introduced earlier with technical education were solely for young men so in that respect, equal opportunity was not available or realistic. The ordinance however saw an improvement in teacher education. An attempt was made by the 1925 and the 1927 educational Acts to implement the 16 principles to augment the supply of educated technical staff. A number of subjects such as African Traditional Craft in the form of weaving, pottery as well as experimental gardening received considerable attention (Wilson, 1966 in Danso, 1996) within the period. Again, on the issue of equal opportunity, Kwamena-Poh (1959 in Danso, 1996) expresses that the success of the policy was difficult to show. 'There was little change either in methods of teaching or content and whatever change that became apparent was in the form of basket weaving, woodwork and loom weaving' (Antwi, 1990 p.115) particularly, in Northern Ghana. Four government trade schools were opened at Yendi and later transferred to Tamale, Asuansi, Ashanti Mampong and Kibi (Oti-Agyen, 2007). An engineering school run by C. S. Deakin was also opened at Achimota and this is known to have produced Ghana's first engineers (Oti-Agyen, 2007).

Despite these achievements, Guggisberg's governorship was criticized and the most significant of the criticisms to this study was that female's enrolment did not see any appreciable change. The lack of substantive success was also attributed to the fact that teachers who were to teach the craft were not fully prepared for the work. Danso (1996 p.14) cited from Antwi (1990 pp.15-16) that:

> Most of them work in supervisory capacity only. Sometimes the pupils who came from homes where the trades were practiced knew more than the teachers. In gardening and farming lessons, there was not much for the children to learn because they had seen better gardening and farming elsewhere. Clay modelling followed the same process.

Antwi again, attributed the failure to the lower academic qualifications of the technical and vocational subject teachers. Further, Guggisberg expected the products particularly from Achimota to be well integrated into their societies to serve as agents of socio-economic development but many turned out to be too elitists. "Guggisberg [also) failed because he only implemented the British public school philosophy into a society that was basically different" (Oti-Agyen, 2007 p.101).

Other educational reforms followed the Ordinance of 1925 under the Nationalist government of Dr Kwame Nkrumah. These included the Accelerated Development Plan (ADP) from 1951 to 1957, the Educational Act of 1961 and the Kwapong Educational Review / Mills Odoi Education Commission.

In 1951, Ghana attained internal self-government under the Convention People's Party's (CPP) administration. A new constitution was drafted and prominent amongst the content was an Accelerated Development Plan (ADP) for education which was laid before

Parliament, passed in 1951 and implemented in January, 1952. The main objective of the plan was to grant financial support to a large number of non-assisted schools and expand facilities at the primary level with the purpose of laying a foundation for universal primary education in Ghana. Asare-Bediako (2014) therefore reports that a tuition-free elementary education for children between the ages of six (6) to twelve (12) was introduced. The ADP of 1951 therefore resulted in the opening of a number of secondary schools from 1952 when the policy was implemented. Educational facilities rapidly expanded to all parts of the country for instance; 12 to 38 secondary schools had been opened by February 1958 with the enrolment standing at 10,423 students. By 1960, the enrolment had tripled and the number of schools doubled. Despite these number of schools and increase in enrolment, Aboagye (2007) as cited in Asare-Bediako (2014) explains that over the past fifty years, a number of efforts have been made to achieve universal primary school enrolment in Ghana but these efforts have not yielded the intended results. Within the ADP period, only four (4) secondary technical schools were however earmarked to be opened at Tarkwa, Accra, Kumasi and Sekondi-Takoradi.

By 1961, it became necessary to make it possible for the government to introduce free compulsory elementary school nationally. The Educational Act of 1961 was then passed and according to Asare-Bediako (2014), these measures laid the foundation for the greatest revolution in Ghana's history. As a result, there was the introduction of fee-free elementary education, teacher training, and university education. Free textbooks were also provided and university facilities got expanded. In support of Asare-Bediako, all these were manifestation of the high premium Nkrumah placed on education. Teachers turned out within the period as noted by Oti-Agyen (2007), numbered 9,000. Not much is noted about technical education and females in technical education, though.

Quite a number of problems surfaced within the 1961 Act. Asare-Bediako (2014) for instance expresses that a number of internal and external factors including economic, political, social, religious, scientific and technological posed various challenges as noted of every educational system. In the 1961 Act, the numerous schools opened with non-commensurate number of professional teachers to handle the classes led to the lowering of standards in the performance of students. Also, congestion arose due to lack of accommodation and classrooms. There was also divided attention perhaps due to the uncertainties about the common entrance and middle school leaving certificate examinations. Perhaps, stakeholders could not distinguish between the clear outcomes of these categories of education.

After the overthrow of the first President of Ghana – Dr. Kwame Nkrumah on February 1966, the National Liberation Council (NLC) took over the administration of schools and they also set up another committee to review the educational structure chaired by Prof. A. Kwapong (former Vice-Chancellor of University of Ghana). This was an overall review with the aim of eliminating inefficiencies and the waste in the educational system. Known as the Kwapong Commission, they recommended a reorganization of teacher education, strengthening of teacher education and the development of technical education (Oti-Agyen, 2007). Thus, the committee recommended that continuation classes should be set up to provide practical skills to middle school form four (4) leavers who could not enter secondary schools. Before the commission's report, the Mills Odoi Education

Commission was also set up by the NLC mainly to consider the salary structure of public servants.

After the NLC, the Progress Party headed by Dr K. A. Busia took over the administration and had a One-Year Developmental Plan that emphasized increase in secondary schools to cater for the numerous middle school leavers. Due to limited resources, communities had to partner the government in providing resources.

From the foregoing discussion, Ghana transitioned through a lot of educational structural legacies or acts and the system of education after independence from Britain in 1957 was regarded as one of the most highly developed in Africa (Akyeampong, 2008). Prior to 1972 however, the system of education was criticized as being elitist, "too bookish in character and built on a selective system like the grammar type of schools in Britain" (Kadingdi, 2004, p.4). In 1974, under the National Redemption Council's (NRC) government, another committee was set up to review the educational system. Chaired by Dzobo, the duration of pre-university education was reduced from seventeen (17) to twelve (12) years with the aim of reducing cost. The structure was to be 6-year primary, 3-year junior secondary and 3-year senior secondary (6- 3- 3) instead of the existing 6-year primary, 4-year middle, 5-year ordinary level secondary and 2-year advance level education (6- 4- 5- 2). This reduced the duration by five years (Oti-Agyen, 2007). This led to the implementation of the junior secondary school (JSS) system - a major post-independence reform which was piloted with nine experimental JSSs by the Ghana Education Service (GES) in September 1976. This was termed as the New Educational Reform Programme (NERP). By 1980/81, the continuation programme had to be discontinued since many parents preferred the education that led to white-collar careers.

There were also inadequate equipment for the schools (Bishop, 1986). The implementation of the JSS programme nationwide took off in 1987 with the establishment of 4,424 JSSs under the Provisional National Defense Council (PNDC) administration under Rawlings' government (Antwi, 1990). The thrust of the reforms was to place more emphasis on vocational and technical training at pre-university level. It could be deduced that the idea was to make the educational system in Ghana more functional and oriented towards contextual demands and challenges. Technical Skills as a subject was made compulsory at the basic level of education and this implied getting both males and females involved in these areas thus predisposing them to technology-related areas of study at this level. The reform was to promote vocational and technical education in order to give the basic school leavers the opportunity to learn a trade and become self-employed towards rapid socio-economic development (Oti-Agyen, 2007). Antwi (1990) explains that there were a number of challenges since the Ghanaian populace had less respect for those who carried out technical jobs than those who were involved in white-collared jobs. The populace wanted their children to pass examinations set by British standards.

It is worth realising that whilst the numerous educational ordinances were being implemented, after the World War 1, the inevitability of granting self-government to the West African colonies raised the need for higher education. In 1944, two commissions, the Asquith and Elliot Commissions were set up to review the suitability of establishing a university or universities for the colonies. Also there was a need for progression to higher education by the graduates turned out from the secondary schools such as Mfantsipim, Adisadel and Achimota.

1.1.4 Higher Education

Two main personalities noted to have initiated the establishment of university education with the purpose of developing the West African colonies were an African physician Dr Africanus Beale Horton and a scholar Edward Wimot Blyden all from Sierra Leone (Oti-Agyen, 2007). Horton suggested a curriculum that will focus on science and vocation while Blyden suggested humanities, Philosophy, Mathematics, English and African languages. The Fourah Bay College in Sierra Leone affiliated to Durham University had then been established since 1876 and had started offering courses at university level for arts and theological students.

The Asquith and the Elliot Commissions set up as noted earlier, released their reports in 1945 (Oti-Agyen, 2007). Whereas the Asquith suggested general problems of higher education in West Africa and other colonies in other parts of the world, the Elliot Commission presented two reports (majority and minority) which concentrated on West Africa in detail. The Asquith commission recommended that universities should be developed in the colonies so that as far as possible, students could receive their university education locally rather than in the United Kingdom. Also, it recommended that most of the universities should be university colleges rather than full universities for an inter-university council to be set up in London to safeguard standards in the new university colleges (Danso, 1996).

The Elliot Commission produced two reports (the majority and minority). Eight (8) out of the thirteen (13) issues raised by the Commission recommended that university colleges should be established at Badagry in Nigeria, Achimota (Accra) in Ghana and the existing Fourah Bay College in Sierra Leone (Foster, 1966 in Danso, 1996). The curriculum proposed was that ordinary academic subjects should be developed separately in each university college but due to the high cost involved in providing a teaching hospital for medical students, medical studies were to be confined to Ibadan in Nigeria. Advanced teacher training and research in education were to be concentrated at the Institute of Education at Achimota (Danso, 1996). Initially, these recommendations falling under the Majority report of the Elliot Commission were rejected. The minority's report preferring one university and a number of feeder institutions was rather endorsed by the British colonial government. The minority report inferred that there were not enough students of the required calibre to justify separate university colleges. Again, there were insufficient qualified staff members hence they suggested that a single university should be built at Ibadan.

The decision of the colonial office to adopt the minority's report raised a storm of indignation in Ghana so the Ghanaian populace decided to finance their own university college. This then led to the opening of University College of Gold Coast by Governor Allan Burns in October 1948 under the principalship of Mr. David Mowbray Balme (Oti-Agyen, 2007). He therefore reports further that the founding of Achimota during Governor Guggisberg's regime prepared the way for the establishment of University of Ghana-Legon in 1948 after the Second World War. Recruitment and supervision of staff and undergraduate degree examinations were carried out by University of London until the attainment of autonomy with the Act in 1961. By the late 1970s and early 1980s, the university had mounted programmes within seven (7) faculties namely; arts, social studies, law, science, agriculture, medicine and school of administration. None of these offered pure technical or technology-related programme as defined in this study.

The second university established was the Kumasi College of Technology in October 1951 with 200 resident teacher-training students transferred from Achimota College. Later in 1952, a school of engineering and a department of commerce were established. With a decision that the college becomes a pure science and technology institution, all the teacher training courses apart from courses in arts were transferred to Winneba Training College in 1957. In 1958, commerce was also transferred to Achimota to form the nucleus of the School of Administration of the University of Ghana. In 1962, the college attained full university status and the department of Arts was also transferred to the University College of Cape Coast in 1962. By the early 1980s, the University of Science and Technology had created seven faculties namely: agriculture, architecture, arts, engineering, pharmacy, science and social sciences.

It is therefore worth noting that the University of Ghana, Kwame Nkrumah University of Science and Technology, and University of Cape Coast were the three main public universities in Ghana before 1992 (Poku, Aawaar, Adomah & Worae, June, 2013). The thrust of Dzobo's 1987 educational reforms as narrated earlier too, was to place more emphasis on vocational and technical training at pre-university level. In view of this, the Dzobo's Committee recommended a post-basic education amongst which Technical and Vocational Education and Training (TVET) at formal, informal and Tertiary level education were paramount (Poku, Aawaar, Adomah and Worae, 2013). A reduction in the educational pre-tertiary level from seventeen (17) years to twelve (12) years was recommended and effected.

In January, 2002, President Kuffour under the government of the New Patriotic Party, inaugurated a Committee towards a general review of the educational structure chaired by

Prof Anamuah-Mensah, Vice Chancellor of University of Education Winneba (Eshun, 2013). The purpose of the review was to make education responsive to current challenges by addressing the inadequacies and shortcomings in the previous reforms (Eshun, 2013). Amongst the recommendations made was the need to upgrade tertiary institutions to make them more relevant to the needs and expectations of the people of Ghana.

The University College of Education (UCEW) was therefore established in 1992 by the amalgamation of seven diploma awarding institutions by the PNDC government to produce professional teachers for basic, secondary and teacher training colleges (Poku, Aawaar, Adomah and Worae, 2013), cited from the Republic of Ghana (2002), UCEW (2002) and Manuh, Gariba and Badu (2006). UCEW was upgraded to full university status in the year 2004 with the core mandate of producing professional teachers for basic, secondary and teacher training colleges (Republic of Ghana, 2002; UCEW, 2002; Manuh et al., 2006). The College of Technology Education, Kumasi (COLTEK) as a satellite campus of UEW had the core mandate of educating students to cater for the technical and vocational education at pre-tertiary levels in Ghana.

The University for Development Studies was also established in 1992 following reforms in the tertiary education system in 1991 (Acheampong, 2008; Oti-Agyen, 2007). Other private tertiary universities such as Valley View and Ashesi were also established towards various specializations. Currently, according to the National Accreditation Board's website www.nab.gov.gh2018, there are a total of ten (10) public universities and over fifty (50) private tertiary institutions offering degrees as noted at Appendix 1.

To confirm the problem of low participation by females in STEM, a previous study conducted by Danso (1996) to compare male-female enrolment in two universities in Ghana is worth reporting.

1.1.5 Statistical Analysis of Male-Female Enrolment Pattern of Two Departments

The two universities in question were College of Technology Education, Kumasi (COLTEK) of the University of Education, Winneba (UEW) and Kwame Nkrumah University of Science and Technology (KNUST). The two departments sampled as case studies were the erstwhile Design and Technology Education (DTE) of COLTEK and the Mechanical Engineering (ME) Department of KNUST**.** The pattern of enrolment as shown in Table 1.1 indicates a dwindling and stagnating enrolment of females in the DTE and Mechanical Engineering (ME) respectively. The enrolment in DTE decreased from 17.5% in the 2002 / 2003 academic year to 2.5% in 2008 / 2009 academic year whilst that of KNUST decreased slightly from 6.7% to 6.5% within the same period for the ME programme.

Table 1.1: Enrolment pattern of First Year DTE students at COLTEK and First Year Mechanical Engineering students at KNUST by sex from 2002-2008

Academic year	C O L T E K				K N U S T			
	MALE (M)	FEMALE (F)	TOTAL	**% F**	MALE	FEMALE	TOTAL	**% F**
2002/03	75	16	91	**17.6**	84	6	90	**6.7**
2003/04	85	7	92	**8.2**	110	10	120	**9.1**
2004/05	106	16	122	**13.1**	120	10	130	**7.7**
2005/06	177	15	192	**7.8**	129	11	140	**7.9**
2006/07	191	14	205	**6.8**	441	36	477	**7.5**
2007/08	154	07	161	**4.3**	405	36	441	**8.1**

2008/09	154	4	158	**2.5**	430	30	460	**6.5**

Statistical Source - Vice-Chancellor's Annual Report on Admission list for COLTEK: 2002-2009
Statistics from HOD of Mechanical Engineering (ME) Department at KNUST: 2008-2009

The statistical data resulted from a case study conducted by this researcher in 2009 to explore the trend of enrolment of females pursuing DTE courses at COLTEK and those pursuing Mechanical Engineering at KNUST also in Kumasi. The trend from both departments is similar to other departments in most Ghanaian Universities pursuing science and technology-related programmes and therefore constitutes a social problem defined by Ritzer (1986 p.5) as a condition of which a 'significant population is aware ... and sees [a] need for collective remedial action'. These statistics have also been represented graphically in Figure 1.1.

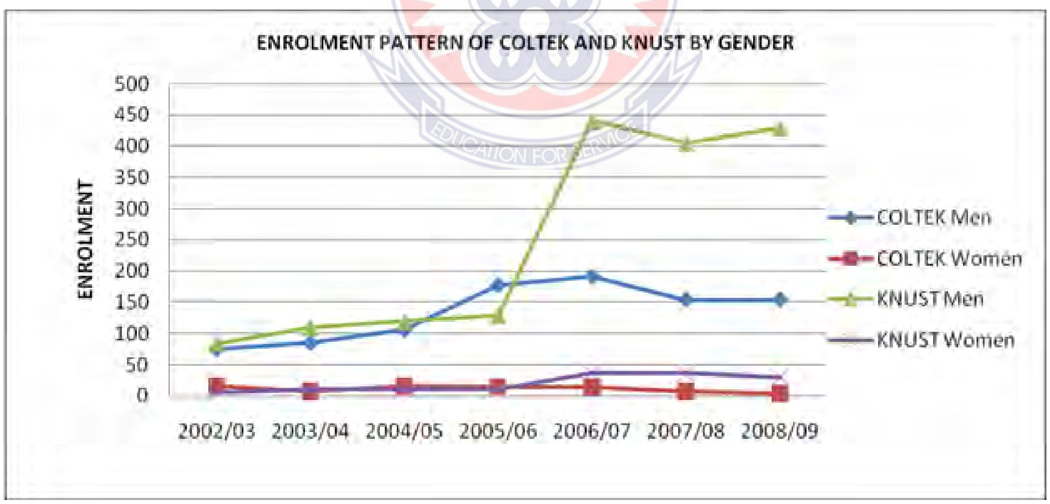

Fig 1.1: Enrolment Graph of First Year DTE students at COLTEK and Mechanical Engineering students at KNUST from 2002 to 2008

It has been realised that the situation ten years down the educational ladder, has not improved as analysed with current statistics under the Statement of the Problem later. As analysed earlier, Ghana has gone through a number of educational reviews but, the position of technical or technology-related education seems to be discouraging in terms of enrolment or participation hence, some researchers including Boateng (2012), Bakar and Mahmood (2014) are of the view that leadership's influences governing some higher educational institutions could be a contributory factor.

1.1.6 Leadership and Female Technology-related Education

Boateng (2012) reports that a number of reforms (such as those described earlier) have been put in place but it seems the impact has not been significant in terms of female technical or technology education. The concentration has not been on female technical or technology-related programmes. She affirms that the restructuring programmes are "in place to improve the quality of provision and learning outcomes to make it more accessible and attractive to all, and to ensure it is relevant and connected to the world of work" (p.108). Her article does not concentrate on subject disparities but rather educational re-structuring so she emphasises that the success of policies on reforms towards the restructuring of technical vocational education and training (TVET) especially in Ghana, depends largely on leaders' responsibilities for generating ideas, formulating policies as well as transforming these policies into practice. Her article suggests the need for Ghana to pay attention to providing leadership programmes and guiding current leaders, administrators and managers towards transformed technical vocational education (TVE). Such developmental programmes, she emphasizes, should aim at cultivating in individuals' vital attributes and characteristics that will encourage participation in TVE programmes. Boateng's (2012) quote at page 108 of her article as noted earlier emphasizes her point of educational reforms intending to make the technical and vocational sectors attractive to all and this connotes the inclusiveness of the two sexes (males and females). Although she did not specifically stress a restructuring in gender, her inputs on leadership insightfully raise pertinent issues worth looking into. These issues could promote active participation by females in technology-related programmes through leadership styles or influences on programmes adopted especially by institutional heads. Perhaps her paper could have elaborated a bit on how leadership could enhance participation by females in the technical sector of education which is overtly dominated by males.

In addition to Boateng's (2012) input, Owusu-Mensah, Bampo and Jabialu (2014) report in a journal article the extent to which female and male leadership promotes effective and efficient leadership towards achievement of goals. This was part of the findings revealed during the conduct of a research into 'Leadership' at Manhyia sub-Metropolis in Kumasi. The researchers affirmed that "the survival of educational institutions is dependent on leadership" (p.106). From these last two analyses, it could perhaps be adduced that female technical education could be influenced by the form or style of leadership adopted by heads of institutions or departments. Regarding such influences, Kouzes and Posner (2007) suggest five practices of exemplary leadership that leaders should engage in. The five components do not necessarily describe the personality of leaders but behaviours that are exhibited by anyone through committed practices. Within the five practices outlined are ten commitments of leadership trends that showcase real-life success stories of leaders in applying each practice and/or commitment. The five practices are: Modelling the Way, Inspiring a Shared Vision, Challenging the Process, Enabling Others to Act and Encouraging the Heart.

They explain the first of their five practices as ‘Modelling the Way by committing to clarifying values’ and ‘setting the example’. To clarify values, Kouzes and Posner suggest that leaders must find their voices and affirm shared values. If a leader is unable to find his/her voice, the leadership researchers explain that they will end up ‘mimicking others and never gaining the integrity to lead’ (p.49). By modelling the way, leaders should use their own voices to share their values in order to promote loyalty, teamwork, and a strong sense of the goal at hand. Thus, to set the example, leaders need to personify the shared values and teach others to model the team’s values.

Relating these practices to the educational structure particularly that recommended by Dzobo to introduce practical skills at the basic level for all-inclusive practical education, it looks as if the leaders in the educational ministry in Ghana have not emphasized female education in technical. The weight or value placed on female technical education seems to be lesser than the general secondary schools. The general secondary schools have been uplifted with careers that are more attractive to the stakeholders as compared to technical education. The next leadership practices and commitments (Inspiring a Shared Vision and others) discussed by Kouzes and Posner (2007) have been reviewed in the literature (next chapter) to examine how these could have an impact on female technology-related studies.

Bakar and Mahmood (2014) also support the leadership input for they discuss that a style of leadership could transform quite a number of situations in higher institutions. They researched into the significant relationship between transformational leadership and performance of academic leaders in higher institutions. Although the aim of their study was to explore the relationships between transformational leadership style, corporate entrepreneurship and the performance of academic leaders in the public higher education institutions (HEIs) in Malaysia, it is worth taking a cue from the research because one of the commonly accepted tasks of transforming HEIs to higher performance is effective leadership. Bakar and Mahmood (2014) explain that leaders are in the positions of power and they influence and manage human, physical, financial and other resources. These managerial elements further supported by Bento (2011), Yukl (2010), Gappa, Austin and Trice (2007). provide crucial support towards higher achievement and success in higher institutions. Leadership has therefore been accepted as a significant influence on the success of many organizations and therefore, can assist to enhance the enrolment of females in technology-related programmes. More recently, researchers have focused on transformational leadership and how this style of leadership can help transform the enrolment situation of females in technology-related programmes is worth studying. There are additional issues worth looking at.

1.1.7.1 Other Concerns in Ghana

Apart from the statistics of the two departments at UEW and KNUST discussed earlier, further observation on the under-representation of females is exhibited in a survey carried out to find out the views of pupils, teachers and parents on the usefulness of the educational curricula. This was designed in terms of content, methodology and extra-curricular activities by Anamuah-Mensah, Asabere-Ameyaw and Dennis (2007). The survey was aimed at preparing pupils for future employment and amongst the subjects noted to be least preferred by the respondents were Pre-Technical Skills. The researchers assumed that these subjects may probably be considered difficult, uninteresting and lack job relevance. In that study, no female teacher was found to have qualified in Pre-technical skills or Mathematics.

Also, in the final draft report of the Ministry of Education's (2014) committee set up by the Ghana Education Service (GES) to investigate Science and Mathematics education in Ghana, amongst the major conclusions highlighted were teacher preparation and pedagogy. It was as a result, recommended for teachers to use inquiry and gender-friendly approach to teaching by making their teaching practical and inclusive. The committee stated that: "The acquisition of appropriate pedagogical skills is needed to inspire and excite pupils in Science and Mathematics learning" (Ministry of Education, 2014 p.30). In that same report, the committee highlighted the need for the Ghanaian government to ensure that all citizens in Ghana irrespective of variables such as age and gender receive quality education in Science, Technology, Engineering and Mathematics (STEM). Furthermore, the Ghana Statistical Service (February, 2011) reports subject disparities in the National Population Census carried out in September-2010 in Ghana. Amongst the main factors recorded about the lopsidedness that emerged included: Girls' limited encouragement to study the STEM or Technical Vocational courses except Nursing and Home Economics.

It therefore behooves on the government as well as other stakeholders to encourage females into TVET as the Sustainable Development Goals (SDGs) established by the United Nations advocate. The SDGs are the new framework for sustainable development after the millennium developmental goals (MDGs) (www.sdg4education2030.org/the-goal).

1.1.7.2 Sustainable Development Goals (SDGs) four (4) and five (5)

SDG four (4) is the educational goal that aims to ensure inclusive and equitable quality education in order to promote lifelong learning opportunities for all. This goal therefore advocates equal access to education for all females at every stage of education. equal access to quality pre-primary education; affordable technical, vocational and higher education would be attained if both males and females are given equal access to the subjects. Where girls are made to take up domestic chores at the expense of concentrating on the subjects early enough, they would be denied equal access in terms of time and devotion. There would be no universality in the achievement of the goals if females are continuously discriminated at indirectly.

The SDG five (5) is also aimed at reducing poverty, achieving gender equality and reducing inequality. In effect, the goals seek to ensure gender equality and a reduction in inequality (UNESCO, 2015). Relating to the SDGs, the Global Education Monitoring (GEM) Team (2018), reports how only four (4) percent of countries have achieved gender parity in tertiary education. The head of office and representative of UNESCO to Ghana Mr. Abdourahamane Diallo expressed the need for enhanced strategies of teaching to encourage more females into STEM. He called for a concerted effort by all stakeholders to address the long-standing biases and gender stereotypes that discourage females from pursuing the STEM disciplines. It is therefore encouraging to note that a second cycle school such as Mamfe Methodist Girls' (MEGHIS) in the Eastern Region of Ghana has set up Robotics Club. It was within such formation that the school was adjudged as World Champions consecutively in 2019 and 2020 in Michigan and New York respectively (Larnyoh, 2021). This is a laudable feat but would be meaningful if such creative and problem solving technological skills could be replicated in many schools. What is the situation of STEM enrolment in Africa?

1.1.8 Enrolment Pattern of Tertiary Education Students in some African Countries

Within the African context, the phenomenon is not different. Statistics reveal that women account for fewer than 15% of the enrolment in Vocational, Technical Education (VTE) in Niger, Ethiopia, Uganda, Eritrea, Malawi and Namibia (Morley, Gunawardena, Kwesiga, Lihamba, Odejide, Shackleton & Sorhaindo, 2006). In Nigeria, it is reported by Ogunjuyigbe, Ojofeitimi and Akinlo (2006) and Bolarin (1987) that females are underrepresented in science education. Discussing the Summary of 21 Nations' United Nations Educational, Scientific and Cultural Organisation's (SUNESCO's) Medium-term Strategy in a study in Africa, Hoffman-Barthes et al. (n.d) point out that the area of science and technology (S&T) has the highest shortfall of national human resources. The SUNESCO further reveals that the developing countries of Africa need at least an estimated figure of 200 scientists per one million individuals for effective industrial development. By the year 2000, it was estimated that Ghana and Nigeria would respectively require about 12,000 and 230,000 engineers, as well as 48,000 and 920,600 technicians for science and technological development to take off. The question that should be answered again is: What percentage of these figures should be females and how could this be achieved?

Despite the general low enrolment pattern just enumerated, in some African countries such as Tanzania, the situation seems to be encouraging. Affirmative action (AA) programmes instituted by the University of Dar-es-Salaam (UDSM) in Tanzania and

Makerere University in Uganda for instance have been yielding positive impact. In Tanzania, Mkude, Cooksey and Levey (2003).

point out how a number of policies have been formulated such as the National Higher Education Policy (NHEP) in 1999 which have the aim of expanding its public facilities and encouraging private sector participation towards the promotion of science, engineering and technology (SET). Access and intensive remedial courses together with similar affirmative action (AA) programmes have been taken to promote the STEM studies in females who failed their matriculation examination in Tanzanian Universities (World Bank, 2002;

Lihamba, Mwaipopo & Shule, 2006).

On the part of Uganda, a Department of Women and Gender Studies at Makerere University has been instituted with the sole aim of intensifying research and developmental agenda of the study of STEM disciplines by females in Uganda (Kwesiga, 2002; Kwesiga & Ssendiwala, 2006). The curricula of Ugandan's universities in general have been noted to be gender sensitive and one Ugandan academic for instance saw gender mainstreaming (GM) as a positive representation of females leading to a remark in Morley (2007 p.615) that:

> The courses should be gender mainstreamed. For us, we teach people to write to develop materials, so we also talk about that when we are developing materials; that writers should not always put down women, we tell the writers to give the women a positive representation, take women as people who can be doctors and not only people who can peel ''matooke'' and whatever.

This quote demonstrates that most Ugandans did not consider the kitchen for that matter cooking or domestic chores as the prerogative of women. How they factored gender issues into their material development clearly substantiated the staunch co-operation and interest attached to gender issues by Ugandans. Available data on the percentage ratio of women in 'Engineering and Agricultural Sciences at Universities [before the year 2008], indicate that with the exception of Uganda (17%) all the other countries show less than 10% participation of women in Engineering' (Hoffmann-Barthes, Nair & Malpede, n.d p.21).

UNESCO's (2010) science report statistics further reports that between the year 2000 and 2008, Uganda was enlisted amongst the seven (7) countries in sub-Saharan Africa who produced more than 100 scientific publications. She topped female Science and Engineering (S&E) publication with 20.5% out of a total S&E publication of 10.5%. UNESCO (2015) recorded figures for twenty-seven African countries with varied years for the sub-Saharan African countries. Ten (10) sub-Saharan African countries recorded have been shown in Table 1.2.

Table 1.2: Women researchers in Sub-Saharan Africa in 2013 or closest year (%)

Year	Country	Percentage of women publishers
2010	Namibia	43.7
2012	South Africa	43.7
2010	Kenya	25.7
2010	Tanzania	25.4
2010	Zimbabwe	25.3

2010	Uganda	24.3
2007	Nigeria	23.3
2010	Ghana	18.3
2011	Mali	16.0
2012	Togo	10.2

Source: Extract from Fig 19.3 of UNESCO (2015 p.532)

In Table 1.2, South Africa and Namibia top the list with 43.7 percentage publications. Both Uganda and Tanzania have dropped their position as best scientific researchers because UNESCO (2010) enlisted Tanzania amongst the top seven research publishers in the sub-Saharan Africa.

The enrolment patterns in Tanzania indicated by Hoffmann-Barthes et al. (n.d p.21) revealed a higher concentration of girls in "soft" trades, although some have taken advantage of increasing diversification to take up new trades. Girls form a large majority of trainees in tailoring (95%), Catering (95%), Secretarial / Computer Training (94%) and Office Trades with a very low percentage of girls in Foundry (0%), Panel Beating (0%), Truck Driving (0%), Pattern making (0%), Shoe Making (2%) and Carpentry (3%). Having been enlisted amongst the top seven countries with scientific publications and also involved in the promotion of other affirmative actions described earlier by Lihamba et al (2006) in engineering, Tanzania becomes a force to reckon with in higher education and scientific gender issues.

South Africa has continuously dominated scientific publication in the Sub-Saharan African countries (UNESCO, 2010 & 2015). In 1990, Hoffmann-Barthes et al. (n.d) reported that for every one female engineer, there were 78 male engineers in South Africa. Ghana had 267 publications with no records for female S&E recordings (UNESCO, 2010). The areas of science researched into and recorded were Biology, Biomedical research, Chemistry, Clinical medicine, Earth and Space Engineering and Technology, Mathematics and Physics. Table 1.3 shows the top seven (7) countries with their scientific publications and adult literacy rate by UNESCO (2010).

Table 1.3: Top seven (7) countries in terms of productivity in scientific publications in sub-Sahara Africa from 2000-2008 in tertiary education

Top seven (7) countries that produced more than 100 publications	Number of publications by major field of science	%age of Total enrolment in science and engineering fields.	%age of Female students in S&E fields against total enrollment of students in S&E fields	Adult literacy rate for country
South Africa	5,248	-	-	95.1
Nigeria	1,869	-	-	60.1
Kenya	763	29.1%	18.3%	86.5
Cameroon	463	21.8%	-	75.9
Tanzania	376	Not indicated	Not indicated	-
Ethiopia	364	14.4%	18.9%	35.9
Uganda	354	10.5%	20.5%	74.6

Source: Extract from UNESCO (2010: pp.283 - 288)

Report by UNESCO (2010) again indicates that in 2008, most African countries could not produce one hundred (100) publications in the natural sciences. Such low figures are noted to be well below the theoretical threshold that would trigger a virtuous interaction between science and technology (S&T). UNESCO (2010) further reports that institutions responsible for policy-making and development are weak in many African countries, especially the smaller ones.

Beside the foregoing background details, Hoffman-Barthes et al. (n.d) again report of some interventions that have been implemented in other African countries to ensure females' active participation in technology-related programmes. They include science camps set up in Botswana, Kenya, Zimbabwe and Ghana to attract girls into science education and technical careers. Zambia, Zimbabwe and Malawi have also adopted a general strategy of making science compulsory for boys and girls at secondary level. In Ghana, science, technology, mathematics education (STME) programme dubbed 'STME clinics' was incepted into the educational sector in 1987 with the aim of encouraging females into science based programmes. Evaluations made in 1997 according to Hoffman-Barthes (n.d) showed an increase of 75% in girls wanting to venture into fields of Science and Technology at the end of the programme. There is however, no significant enhancement in the enrolment of females pursuing applied science programmes in the universities two decades after this evaluation as revealed in the research. This researcher happened to be a regular resource person for the STME programme hence its impact on female technology education at higher level is significantly a concern to her.

The Ghana government has showed concern in her policy framework towards female technological and engineering development. In the concluding paragraph of a report by the Ghana National Education Campaign Coalition (GNECC -2021), the government's attention was drawn towards any implementation programme to allocate resources that would ensure delivery of high quality education to every child as a basic human right irrespective of their "location, gender and disability" (GNECC 2021, p.11).

1.1.9 Policy Framework on Strategic Development Goal Four (SDG4)

According to a report compiled by the GNECC, in the implementation of Education 2030 agenda, the government is to ensure the right to free, quality public education and lifelong learning at the forefront, irrespective of other elements such as gender. The Government of Ghana has also adopted an Inclusive Education Policy with minimum standards and rolled-out new curriculum for the basic level to ensure that the quality of education outcomes improve. The Ministry of Education in effect has developed an Education Strategic Plan (ESP) for the period 2018 to 2030 with a financing framework. The government is in the process of finalizing and approving the five year Technical, Vocational Education and Training (TVET) strategic plan. The implementation is however facing challenges because, in interrogating the Sustainable Development Goal (SDG) Four (4) further, the Ministry of Education - 2018-2030 reports that the TVET sector receives "less than 3 percent of the overall educational expenditure" (p.23). Beside this, the Ministry emphasises that access to TVET institutions increased both in secondary and technical education steadily but due to the perception held that TVET is for students of weaker brains or underperforming students, there is real constraints about its development. With these efforts being made to check the lopsidedness of female participation in the sciences and technical education within the sub-Saharan African region, it is worth reviewing the background at international level too.

1.1.10 Enrolment in the Technology-Related Programmes: International Dimension

Nguyen and Pudlowski (2012) describe the low enrolment in technology-related programmes internationally by arguing that females' disinterest could be due to poor preparation in Science and Mathematics. This in turn, limits the appeal of Engineering to females. These researchers analysed statistical data in Australia and pointed out that although Australian universities have managed to retain 15% enrolment rate for women in Engineering courses between 2005 and 2009, such a rate is regarded unsatisfactory since women form approximately 50% of the general population. Their data again revealed that some science-based disciplines such as Chemical Engineering (e.g. Process and Resources Engineering) are appealing to females in Australia unlike females in most countries of the European Union. Disciplines such as Automotive, Mechanical and Industrial Engineering have on the other hand been noted to least attract female students in Australia (about 10% of the overall female are studying engineering-based disciplines). In view of this, the writers further stress that: "more work is required on the part of the universities to encourage more women to enroll in Engineering and Technology" (p.21).

Nguyen and Pudlowski (2012) again continue the description of low enrolment in the technology-related programmes by arguing that females' disinterest could be due to poor preparation in Science and Mathematics which limits the appeal of Engineering to females. Brunner (1997), Rosser (1985), Zuga (1999) cited in Weber and Custer (2005) also highlight pedagogical considerations as critical to sound gender-balanced curriculum design. According to them, there are instructional methods and learning styles that can be classified distinctively as female. Zuga (1999) therefore points out further that curriculum material must connect in meaningful ways with students' prior experiences and the world in which they live. Teachers are therefore intuited to construct knowledge from students' experiences (Belenky, Clinchy, Goldberger & Tarule (1986); Jacobs & Becker, 1997 in Weber & Custer, 2005). This is further supported by this quote: "While this is important for all students, it is particularly important that teachers and curriculum designers in the SMET disciplines attend to the experience base of female students" (Weber & Custer, 2005 p.56). Again, the encouragement that must be put in place to ensure participation by females in this industrial development must be addressed.

Stating some of the reasons for the phenomenon of least attraction by females to the technological or scientific fields of study, Nguyen and Pudlowski (2012) explain further that the curricula of engineering contain more hard components. These hard components were unexplained but it could be presumed from their line of description that they are the areas with very difficult mathematical elements or concepts because, earlier, in the foregoing discussion, girls in Tanzania were noted to form a large majority of 'soft' trade trainees in areas such as Tailoring (95%), Catering (95%), Secretarial and Computer Training (94%). Aside the hardness of components, The writers untiringly, further argue that females might least prefer engineering and technology courses perhaps due to lack of exposure to engineering-based subjects in secondary education. Physics and Mathematics as pointed out by them, typically attract male students and these offer the males greater opportunity or leverage to pursue engineering whose curricula have been noted to contain more hard components. Females have been noted to choose science subjects such as Biology and Chemistry and one wonders why females cannot cope with the hard components. Does it mean males are exposed to the hard-component subjects earlier than females or is a different methodology of teaching employed for either sex or what? If this is based on the exposure, then it is worth examining how differently males are exposed to the subjects since experience reveals that equal opportunity is offered both males and females at secondary level regarding subject choices in most countries particularly Ghana. Nguyen and Pudlowski (2012) in effect suggest that these subjects must be structured differently with greater balance between the hard and soft components which include the non-technical and technical subjects. They supported their statistical data with graphical representation as shown in Figure 1.2.

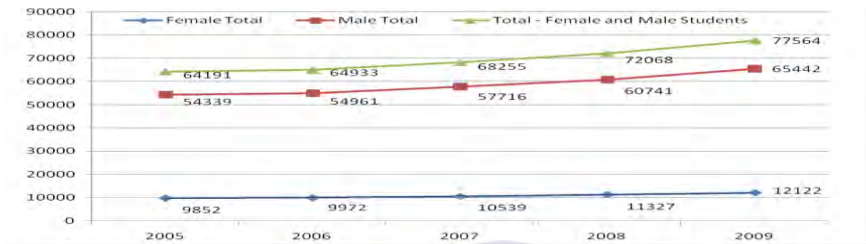

Figure 1.2: A chart showing the national enrolment in Engineering and Technology Disciplines in Australia from 2005-2009. Courtesy: Nguyen and Pudlowski (2012 p.22)

In Figure 1.2, the enrolment from 2005 to 2009 shows a huge gap between male and female

participation in Engineering and Technology disciplines as tabulated in Tables 1.4a and b.

Table 1.4a: Analysis of Enrolment Chart at Figure 1.2 of Engineering and Technology disciplines in Australia from 2005 to 2009

Year/ Statistics	2005	2006	2007	2008	2009
Males (M)	54,339	54,961	57,716	60,741	65,442
Females (F)	9,852	9,972	10,539	11,327	12,122
Difference between M & F	**44,487**	**44,989**	**47,177**	**49,414**	**53,320**
%age difference of females to total	15.35	15.36	15.4	15.7	15.6

Researcher’s Construct from the Chart at Figure 1.2.

Table 1.4b: Further Analysis of Enrolment Chart at Figure 1.2

Exponential increase	2005 – 2006	2006 – 2007	2007 – 2008	2008 – 2009
Males	622	2755	3025	4701
Females	120	567	788	795

Researcher's Construct from the chart at Figure 1.2

From Figure 1.2 and Tables 1.3a and 1.3b, Nguyen and Pudlowski (2012 p.22), show that:

- There is exponential growth in the overall enrolment in Engineering and Technology courses in 2005-2009.
- The rate of participation of females in Engineering and Technology courses from 2005-2009 has improved slightly but it is still very low when compared to the male enrolments.
- The enrolment of females reached its peak of 15.7% in 2008.
- There is a huge disparity in the distribution between the gender groups in Engineering and Technology education.
- Engineering and Technology is predominantly a male-dominated discipline.

Arguing from the statistical data, Nguyen and Pudlowski (2012) encourage educators to map out strategies to increase the size of the initial Science and Mathematics pool of minorities in order to reduce the attrition along the educational pipeline. Such strategies should include innovative ways to enhance the appeal of Mathematics and Physics for female students, they suggested. Again, confirming the problem of under-representation of women in these technology-related programmes, Spelke (2005) details that males dominate the academic faculties of science, engineering and mathematics programmes in the United States' (US) universities. Hanson, Schaub and Baker (1996), Abouchedid and

Nasser (2000) also indicate that females in the US are underrepresented in mathematics and science programmes in the high schools and university education. In Canada, Anderson and Straka (2004) reveal that in the 1998/99 academic year, though 55% of students who enrolled in Canadian universities were women, only 19.5% were females who enrolled in Engineering programmes. Also, only 9.5% of Engineering graduates in Japan in 2004 were women. Similarly, in Latin America, females constitute only 36% of students in STEM disciplines though they form about 60% of tertiary education graduates (Castillo, Grazzi & Tacsir, 2014)

This unending concern about the low attraction by females in the sciences has also been expressed by Weber and Custer (2005) in their report. They researched into the content of curriculum, activities related to the study of technology and instructional methods most preferred by males and females at the middle and high school levels in the United States. Their findings revealed that females rated design activities more interesting than did males, while males preferred activities involved in manipulation. They summarised that females' preference for *design* and males' preference for utilizing or manipulation is consistent with gender stereotypes. The literature reviewed by them described what writers such as Sanders et al (1997) have expressed about the content of technology education curricula. To these writers, one key problem confronting educators in the Science, Mathematics, Engineering, and Technology (SMET) disciplines is the disproportionate lack of involvement of females which was attributed to the content of curriculum being biased toward males' interests

Welty (1996) and Zuga (1999) intuit that "curriculum developers in technology education need to be informed by research and theory designed to comprehend 'women's ways of knowing' if they hope to effectively recruit and retain women and girls into the study of technology" (Weber & Custer, 2005 p.56). They again consider pedagogical issues as critical to sound gender-balanced curriculum design. The only critique found about their 2005's research report was a lack of in-depth study since a descriptive design was employed using two surveys. Such descriptive surveys are usually associated with the conduct of quantitative research (Patton, 2002). Weber and Custer (2005) could have reinforced their research by conducting interviews as well to find out the real reasons for the behavioural pattern in terms of the curricula from the male and female participants sampled for their research. Brunner (1997) and Zuga (1999) on pedagogical skills, point out that the best way of addressing the abysmal participation is by investigating and acquiring knowledge in the differences between males and females' choice of studies. Aside the formal curricula issues, there are other barriers in the form of 'non-traditional' or social issues which have been discussed by researchers such as Morley et al (2006).

1.1.11 Some Social Barriers / Role Modelling

Socially, some of the examples cited by Morley et al (2006) as barriers to females' entry into technology-related studies include limited career advice, negative attitudes from families, fear of Mathematics (already touched on) and fear of visibility as a minority. Additionally, Hall and Sandler (1982) describe the classroom climate for females as being 'chilly' with overt and subtle ways for the treatment of the two sexes. Varghese (2004) also frames that courses such as humanities have been noted to attract more females since the level of fees is usually lower than other courses like engineering. Welde, Laursen and Thiry (n.d) pivot the reason for the underrepresentation of females' studies in STME to dearth of role models and this has been detailed at the next chapter of the literature review. Other schools of thought have scientifically discussed the underrepresentation under a dichotomy of female and male brain popularly known as 'brain lateralization'. Role models per se, as discussed in an IFAC (Information for a Choice) project and reported by Dimitriadi (2013), do not necessarily assist directly in career choices. Thus, seeing or meeting a successful bioengineer for example does not mean that the girl will also choose to pursue a bioengineering degree. The girl might however realize that she can pursue a career path in another science-oriented profession of her preference, which has been inspired by the story and success of the role model presented to her. Increased exposure to role models in a variety of engineering professions could therefore assist female students in making career choices. Other assumptions and theories such as the Social Constructionist's and socio-cultural formulations by writers including Burr (2007, 2015), Cleswell and Campbell (2002) for low participation by females in S&T have been critically debated in the next chapter.

From the undergoing background review, there seems to be a number of issues worthy of consideration to enhance females' participation in the technology-related programmes which may include educational curricula, pedagogical strategies, scientific and socio-cultural factors. Some of the arguments raised however, go contrary to the Social Constructionist's (SC) theory (Andrews, 2012; Burr, 2007, 2015; Owen, 1995; Young & Colin, 2004) whilst others favour the Social Constructivist's Theory about knowledge construction and these have been discussed in the Literature Review (Chapter Two).

1.2 Statement of the Problem

The main problem identified especially in Ghanaian universities is the declining and low representation of females in the technology-related studies which culminates in their marginal representation in technology-based professions. The development of every nation, depends on the combined efforts of all its members and thus it is doubtless to say that any rapid development would depend on the effective participation of females and males in the developmental process. One area very vital to such participation is education particularly in technology-related disciplines.

From the background analyses, enrolment in Australia from 2005-2009 for instance, shows a huge gap between male and female participation in Engineering and Technology disciplines. In Africa, due to similar marginalization, University of Dar-es Salaam in Tanzania and Makerere in Uganda have instituted quota systems as interventions implemented to ensure females' active participation in technology-related programmes. Other interventions include science camps set up in Botswana and Kenya to attract girls into science education and technical careers. Ghana is no exception when it comes to the implementation of such camps because, since 1987, there has been an inception of Science, Technology, Mathematics and Engineering (STME) Clinics to attract girls into science education and technical careers. Notwithstanding, according to Danso (1996), the informal sector has become the most important area of employment for most females in Ghana. Females have been and are still mostly involved in small-scale cottage industries and other traditional trades such as, dressmaking and hairdressing. Although the study further reported that women had made strides in various fields and produced high calibre of professionals providing great service to the people in hospitals, the primary schools, the Bar and on the Bench, their absence is noticeable in the critical contemporary areas of technical or technological education. Over two decades beyond the study by Danso (1996), with the population of females in Ghana (51%; 2010 Census) still outnumbering males, there seems to be certain lack of serious concern over the study of technical or technology-related programmes by females in Ghana. There seems to be a degree of fait accompli that all is well so long as a certain number of females, albeit small, take up technology-related courses and progress to take up technology related professions.

A cursory look at the basic schools in Ghana, that is, from age 6 to 15, shows appreciably very good enrolment statistics of boys and girls and in a number of cases, girls outnumber the boys. At the second-cycle level, the enrolment for females in Science starts declining as compared to General Arts for instance. This is confirmed by Akinsola, Ogunkola and O'Neale (2013) that: "by the final year of secondary school, males had significantly higher scientific literacy than females in all countries" p. 547.

The situation gets so discouraging at the tertiary level. An instance is the enrolment ratio of students in two Faculties of the University of Education Winneba -Technical and Vocational Education at COLTEK for the 2017/2018 Academic Year shown in Table 1.5.

Table 1.5 Enrolment Statistics of Students of Faculty of Technical and Vocational Education at University of Education, Winneba (UEW) (2017/2018 Academic Year)

Faculty/ Programme	**Dept./ Gender**	**Regular**			**Sandwich/Evening**			**Overall Total**			**%**
		M	F	**T**	M	F	**T**	M	F	**T**	
Vocational Education	C&H	21	276	**297**	31	975	**1,006**	52	1251	**1,303**	**96**
	F&T	38	113	**151**	30	384	**414**	68	497	**565**	**88**
Technical	BCT	437	12	**449**	827	11	**838**	1,264	23	**1287**	**1.8**
	ETE	90	02	**92**	153	13	**166**	03	15	**258**	**5.8**

Education	ITE	1,250	262	**1,512**	350	33	**383**	1,600	295	**1,895**	**15.6**
	MTE	94	03	**97**	144	06	**150**	238	09	**247**	**3.6**
	WTE	62	01	**63**	121	01	**122**	183	02	**185**	**1.1**

Key

M ---- Male F ----- Female T ---- Total

C & H. --- Catering & Hospitality Education

F&T --- Fashion & Textiles Education

BCT --- Building Construction Tech. Education

ETE --- Electrical Tech. Education

ITE --- Information Tech. Education

MTE --- Mechanical Tech. Education

WTE --- Wood Tech. Education

1.2.1 Enrolment Statistics of Students of Faculty of Technical and Vocational Education at UEW

As realised from the Table 1.5 and Figure 1.3, the enrolment in the Faculty of Vocational Education for females as compared to that of the Technical Education shows extreme deviation for the female enrolment. The female enrolment for Catering & Hospitality is 96 percent whilst it is 88 percent for Fashion & Textiles. As noted from the graph at Figure 1.3, at the Faculty of Technical Education, the situation of enrolment reverses. An instance is the Building Construction Technology Education Department having a total enrolment of students at 1287 with 23 females (representing 1.8% of the total). What a sharp deviation for female population in the two programmes!

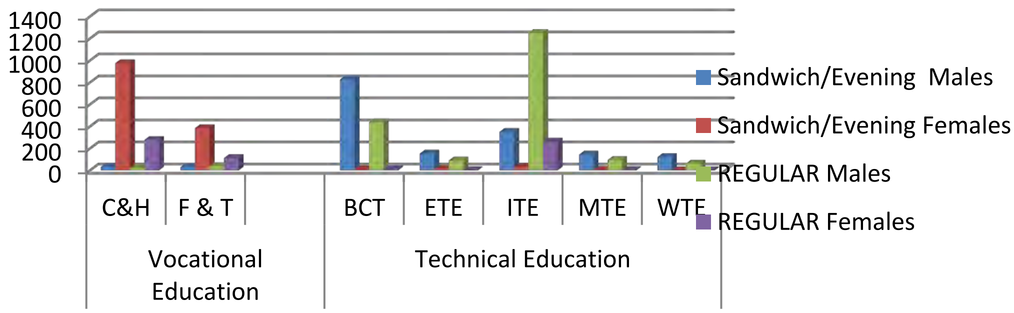

Fig 1.3: **Enrolment Chart of Students in the Faculty of Vocational and Technical Education of the University of Education Winneba (2017/2018 Academic Year)**

One really wonders why these enrolment perceptions about the TVET still persist, thereby, leading to abysmal disparities prevailing in the 21st century. Some years ago, females' absence in technological developmental activities was considered somehow normal as an adage in Akan the largest ethnic group in Ghana states that: "*obaa ton nyadowa na onton atuduro*" literally translated as "*a woman sells garden-eggs but not gunpowder"*. Garden-eggs could also be botanically referred to as egg-plants or Solanum melongena. Quite a number of females might have imbibed this adage and therefore considering themselves weak or vulnerable thereby restricting themselves to menial domestic chores, petty trading and vocations which prevent them from taking the practical technological-oriented jobs requiring activities such as lifting of planks and sawing of metallic bars and rods. In this technological era however, fork-lifters and power-hacksaws get such tasking jobs performed respectively under the instructions of the operator. Their operations are not beyond the capabilities of females.

There is a need to check this enrolment pattern since a lot of gaps need to be filled as raised in the Background Statement especially on the number of scientists, technologists, technicians and engineers required to move any nation forward. Aguele and Agwagah

(2007) describe the significance of Science, Technology and Mathematics (STM) and emphasise that:

> STM is very central to the development of any nation. It is considered as the vehicle for rapid development and economic transformation of any nation. Today, women constitute more than half of the world's population. Hence, we cannot afford to ignore them if we must attain meaningful development in our nation. Their general education and in particular their education in STM is very vital to any nation. The need to involve women equitably in national development needs no further emphasis. (Aguele and Agwagah, 2007 p.124)

Specifically, research into the reasons why females are not enrolling in technology and engineering seems not to have been both qualitatively and quantitatively done. The literature seems to be silent on an in-depth investigation into the phenomenon especially under Ghanaian context even though this is a major concern in the country. There is limited statistical evidence from research conducted inside and outside Ghana regarding the study of technology-related programmes by females. Whether scientific, cultural or traditional inhibitions lead to the disinterest by females in technology-related programmes, it requires intensive research.

Beside the statistics on enrolment detailed earlier in the Background Statement, further declining and low pattern of enrolment have been recorded in the sampled Universities for this research. For the past decade, this low enrolment has persisted. Statistical data at Winneba Campus of UEW from 2006/07 to 2009/10 Academic Years as revealed at Appendix 4 shows abysmal trends of low average percentages of females in Science (29.75%), Mathematics (13%), compared to appreciable or enrolment parity in the Languages especially English (53.25%), Ga-Dangwe (49.5%) and Ewe (46%). When the second chart at Appendix 4 is examined closely, with the exception of Institute of Educational Development and Extension (IEDE), females' enrolments in all the other faculties were disparagingly very low. IEDE is a faculty which has mounted a programme for Distance Education which is noted to favour females.

From the foregoing analyses, comprehensive studies to investigate the pertinent issues that influence females' decision to enrol in technology-related disciplines need to be carried out. It must be realized that the development of every nation depends on the combined efforts of all its members and this goes without saying that any rapid development of Ghana would depend on the effective participation of females and males. One such area worth participating actively by both sexes in education is technology-related programmes. Kwesiga (2002) supports this reasoning and cites the Late Dr Aggrey of Ghana as claiming that: "If skilled trainees are only men, the people will be half free" (p.43). Such studies are also needed to add to existing policies based on females' experiences (Zuga, 1999) to improve female technology-related education in Ghana. There is little doubt that other persons have at one time or the other raised their voices and warned against the fact that the potential of female is perhaps under-utilized. Perhaps one or two more in-depth research findings and suggestions could be enough to tilt the scales and awaken minds as to how crucial the further contribution by females would be to national development. Tapping the experiences of females in this study area might be of great advantage to the development of females and the nation in these technology-related disciplines. By examining various literature sources and interacting with females who have gone through the system, problems associated with the severe under-representation, root causes that hinder females' participation in the STEM and how they have been dealt with could be unearthed

It is against these background analyses that this research is being conducted to find out the issues that encourage or discourage the study of the technology-related disciplines by females in the context of Ghana and it is also based on participants' retrospective educational experiences. If the low participation is left unattended to, it gives the impression of the insignificance of the inclusion of women in the technology-related study area.

1.3 Purpose of the Study

The main purpose of this study is to ascertain the main issues that influence enrolment of females in science and technology-related disciplines and recommend practical measures to improve their enrolment in this technology-related sector of academic disciplines in Ghanaian Universities. This is important since all students of both genders need to acquire the skills necessary to become consumers capable of critically assessing the technologies they use. This would result in the ability to make more informed decisions (Bybee, 2003; Colaianne, 2000; Greenspan, 1997). The underutilization of females' potentials leads to a loss not only for the females but for the economy and the society in general. Why female enrolment seems to be far lower than that of males in technology-related studies in this contemporary 21st century era despite the numerous educational restructuring revealed in the background is also worth looking into.

1.3.1 The Specific Objectives of the Study are to:

1. Find out the biological characteristics that influence choices of subjects for female and male students.
2. Find out about who/what influenced the participants in the society towards their choices of technology-related disciplines.
3. Examine the major pedagogical strategies that appeal to females studying technology-related disciplines in the sampled universities in Ghana.
4. Find out about how leadership influences female-participation in the study of technology-related programmes in the sampled universities.
5. Find out some of the policies formulated and implemented at national (macro) and institutional (meso, micro) levels for access and participation of females in / into technology-related studies.
6. Analyse the prevailing interventions or measures that could be put in place to boost enrolment of females in technology-related programmes in the universities sampled for this study.

1.4 Research Questions

In line with the purpose and the objectives outlined above, the following are the major guiding questions for this research.

1. What are the biological characteristics that influence subject choices for female and male students?
2. Who / What influenced you in the society towards your choice of technology-related disciplines?
3. How do identified pedagogical strategies influence the interest and choice of technology-related disciplines by females?

4. How does leadership influence female-participation in the study of technology-related programmes in the sampled universities?
5. What are some of the policies formulated at national (macro) and institutional (meso, micro) levels for access, entry and retention towards participation of females in technology-related studies?
6. What are the prevailing interventions that have been put in place to boost enrolment of females in technology-related disciplines at higher levels of education in Ghana?

1.5 Significance of the Study

The major driving force for this study is the need for increased access for females to participate in higher education (HE) in the technological disciplines. This research might also contribute to knowledge that will highlight the nature of the problem (Patton, 2002) existing within the technological programmes or gender positions in the sampled universities regarding science and technological choices by females. Such knowledge could be relevant to the universities in re-examining their policies to make them gender-sensitive.

The contribution of women to national development too is expected to be higher when more females are enrolled in technology-related disciplines and subsequently adding to the core of technology-related professionals. According to the European Commission (2008), gender balance in science education ensures the recruitment of most talented people thereby leading to the use of unexploited resources (especially in women). This could also enhance policy-formulation in gender issues at the national and sub-national levels.

Again, educating more women in the sciences enhances more innovative and productive development than marginalizing them (National Academy of Sciences, 2006). In this respect, providing equal opportunities to science and technology (S&T) education for both males and females ensures a better use of scientific and technological resources. This would also lead to the achievement of scientific and technological excellence (genSET, 2011) thereby improving practice. This would again contribute towards the achievement of SDGs four (4) and five (5) as discussed earlier.

The knowledge and skills gained in this research would also enhance supervisory competencies of undergraduate and post-graduate students' projects in general and in researching into gender issues in particular. This would be achieved by the theoretical knowledge attained through a broader literature research as well as the interaction with the participants through the qualitative methodology employed. Seminars and conferences could be organized in gender issues related to technology-related programmes. Again, this study has the potential aim of generating information on how gender inequity and inequality manifest, how they are intervened in terms of enrolment within the sampled and other institutions for the generation of concern by females in technology-related programmes. This could also enhance policy-formulation in gender issues at the national and sub-national levels. In effect, this would enhance career guidance and counselling services in the universities.

Furthermore, apart from the fact that females enrolled in higher education in S&T encouraging role modelling, it is also noted to improve health, nutrition and maternal health which ensures low mortality rates (Anamuah-Mensah, 2007; Kabeer, 2004). Thus, there are compelling reasons to promote females' active participation in the application of scientific-based development or careers since technology pervades every aspect of life vis-à-vis food security and production, health care and others. Additionally, writers including Akabue (2001), Forje (2006), and Morley (2007) in addressing policy issues that will enhance the role of women's contribution to technological improvement, highlight that the cumulative result of capacity building for women in decision-making might lead to technological skills' acquisition capable of reducing poverty.

Again, the nature of the job market in this contemporary period is changing hence, females should not rely on the traditional, limited range of occupations and cottage industries. With the increased numbers of technical occupations, females should be guided to broaden their horizon in order to enhance their potential in technology-related careers and also reduce the suffering from unemployment. Weber and Custer's (2005) research findings describe the arguments made by prominent U.S. economists and educational leaders on the limited technological literacy amongst females that: "all students of both genders need to acquire the skills necessary to become consumers capable of critically assessing the technologies they use, resulting in the ability to make more informed decisions" (p.55).

1.6 Delimitations of the Study

This study was conducted in two (2) selected public and three (3) private Universities (Appendix 3) in Ghana with a focus on Level 100 to 300 females in technology-related programmes. Although the focus was on females, for broader divergent perspective of issues, views and comparative purposes and to prevent lopsidedness in potential gender issues and implications, sampling was extended to males in the same sampling units.

Sample Population Delimitation: The sampling units comprised two (2) out of a total of the ten (10) public and three (3) out of over fifty (50) private Universities and University Colleges (Appendix 1) in Ghana (www.nab.gov.gh). Although the private universities far outnumber the public, most of them do not offer science-based disciplines. The piloting was carried out at the Kumasi Campus of the University of Education Winneba (UEW). This is also known as the College of Technology Education, Kumasi (COLTEK) or most currently called Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED). Purposive sampling technique was adopted in sampling fifty-eight (58) participants made up of (5) lecturers and fifty-three (53) students. The rationale for the sample-size has been clearly discussed within the third chapter (methodology) and it is in line with the conduct of phenomenological qualitative studies suggested by researchers such as Leedy and Ormrod (2005).

Conceptual Delimitation: Falling under feminist research, gender issues happened to be the core for this research. Quite a number of concepts abound in this domain but the research considered some concepts under; 'how sex or gender affect subject choice in terms of brain lateralization', 'leadership such as transactional and transformational styles', and 'impact of social, cultural / traditional roles on the study of technology-related programmes'. These were argued along the theories in which the study was based. Also, since the study of applied sciences or technology falls under higher education (HE), issues influencing access and participation by females in HE in the technology-related disciplines and the reasons for these were considered. The import was on accessibility by both sexes of students but the focus was on females and access to University education in pursuance of technology-related programmes.

Theoretical delimitation**:** This study was situated substantively in the Social Constructionist Theory (Burr, 2015) though other subsidiaries such as the Constructivist and Essentialist Theories were reviewed. The study also explored biological issues like Brain Lateralization by sources such as Diamond (2003) and Sabbatini (2007) and this was argued as scientific determinant of subject choices that opposed social/cultural issues.

1.7 Limitations to the Study

The limitations are considered from the following perspectives: the conduct of interview, participant solicitation, literature in terms of availability of right secondary data.

Conduct of interview: Setting intelligible questions to unveil participants' epistemological experiences could not only be challenging but as Mason (2002) writes, it could be practically, socially and ethically difficult since there is that fear of not posing the appropriate questions, going beyond what is expected and also, offending respondents in the manner the questions may be reacted to. Again, intellectually, respondents might think that the researcher has the aim of challenging their mental abilities thereby feeling irritated. This was addressed by ensuring that all the questions were well scrutinized, vetted by my supervisors and also piloted.

Also, although focus group discussion for instance demanded only one sitting for a group (six sittings in this research), retrieving emerging themes, coding, analysing and interpreting all respondents' raw data was very tasking. Despite these limitations, conscious effort was made to offer the opportunity for each member to contribute during the focus group discussions whilst being conscious of the time frame. Also, all views were morally and ethically reckoned, and in most cases, though participants were asked to give their names before responding to the items, it was still very challenging, distinguishing between the intermingling tones of different dialects.

Participant limitation: Though access to participants as an insider researcher at UEW-K-COLTEK during the piloting was less challenging since informants could be reached easily and promptly without coercion, getting interviewees willingly in other universities demanded professional and mature approach. In view of this, initial telephone conversation inviting lecturers and student-participants helped to establish rapport and distinct statement of the purpose for the research made. Subsequent telephone calls however proved difficult since in some cases, participants could not be reached easily. Furthermore, a major limitation for the data gathering session of the research was that females upon whom the research was pivoted were quite often not available especially with the observation of lecturing or teaching

Literature and appropriate secondary materials: Apart from the constraints encountered on the availability of right secondary data, philosophically, reading and digesting the literature broadly in order to make meaningful judgements of the data generated became brain-boggling. Sometimes too, purchasing materials on-line without the necessary on-line purchasing access became tasking but again, others with such facilities were contacted for a compromise. UEW and other Universities' libraries however, have intellectual holdings that proved very useful towards the substantive, theoretical and methodological stances of this study. A lot of reference sources were also accessed on the internet based on my Supervisors' recommendation. The use of computer on-line sites like the Google and Science Direct became great assets to the retrieval of secondary data.

1.8 Organisation of the Study

The study has been organized under six chapters. The first chapter provides the introductory section which includes the historical perspective of the general educational background in Ghana (informal and formal) and the main statement of the problem for investigation. The chapter also touches on the purpose and objectives of the study, formulation of the research questions, significance of the study, limitations and delimitations of the study, followed by a statement of the general organisation of the research. The second chapter discusses the related literature reviewed in which is woven Burr's (2015) Social Constructionist's theoretical framework, conceptual framework with topics on gender and sexuality, nature of human (male and female) identity, feminist's theories propounded by researchers such as Zuga (1999), cultural and scientific underpinnings related to female participation in technology-related disciplines. Other concepts discussed are: socio/cultural stereotypical and attitudinal influences on subject choice, gender and sexuality, the role of leadership and social change.

The third chapter discusses the philosophical underpinnings, methodological choices, and justification with ethical considerations woven in. In that regard, the research design adopted for the study, the contextual description of the study area or site, the population, sampling, procedure for sampling and data collection techniques are all clearly discussed. The fourth chapter presents the results or findings of the study in line with the objectives and questions guiding the research. Under the chapter, meaningful patterns are determined from the data that emerged. Thus, common, conflicting or contradicting patterns of issues are categorized based on the objectives framed and the research instruments developed.

The fifth chapter discusses the findings and further interprets the data in relation to the entire literature, theoretical, conceptual frameworks and the methodological paradigms. In that line, common themes and patterns as well as the conflicting ones are interpreted by synthesizing and arguing with the researcher's opinion. The final chapter (six) summarizes the study, draws conclusions and provides a reflection on the study by making recommendations for improving female technology-related education in Ghanaian higher education. It also makes suggestions for further research into the area under study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The low enrolment of females in technology-related programmes which largely restricts access to technology-related professions or careers has raised several concerns among researchers and scholars of gender issues. Foremost among these concerns is what Weber and Custer (2005) express about the need for students of both sexes to acquire the skills necessary to become consumers who would be able to critically assess the technologies they use, thereby resulting in their ability to make more informed decisions. Lack of participation by females has also been attributed to the content of the curriculum that is considered by some to be biased towards males' interests (Sanders, Koch, & Urso, 1997). Others like Shroyer, Backe and Powell (1995) also attribute females' lack of interest to pedagogical approaches and not the inherent nature of the subject. The main objective of the research is therefore to explore the motivative and de-motivative academic and socio-cultural experiences of female students pursuing technology-related education particularly mechanical technology or engineering.

The sequence of events in pre-independence, independence and post-independence periods of education in Ghana were raised in the background study of the first chapter. It revealed that various issues (including curriculum content and pedagogical approaches) accounted for the low participation by females in technology-related programmes in the Ghanaian and international circles. Prominent among the issues under the educational reform was the fact that technical education as compared to general secondary education was not given the required attention and promotion by the governments of Ghana (Ghana Education Service, 2004). This might have made technical education unappealing to females.

This section therefore aims at reviewing the related literature regarding major gender and technology-related issues in line with the objectives of the research. The review set off with the main theoretical framework in which the research is situated. Other relevant philosophical theories related to gender education and the methodological underpinnings girding the practical fieldwork were also reviewed. As an overview, the chapter looks at the following:

a. Social constructionist and other philosophical paradigms
b. Dynamics of social cultural interaction, general activities in schools in terms of gendered teacher-student interactions (stereotypes).
c. Pedagogical strategies and female technology-related studies.
d. Leadership's influences on female-enrolment levels in technology-related education
e. Interventions for female technology-related education: mentoring and role modelling
f. Barriers to females' participation in technology-related studies.
g. Conceptual framework of Gender issues: characteristics, spatial skills etc.

2.1 Theoretical Framework

2.1.1 Social Constructionist's Theory (SCT)

Historically, social constructionism (SC) cannot be traced to a single source. Burr (2015), explains that it emerged as philosophical developments about two to three hundred years ago from the combined influences of a number of North American and British writers. In psychology, SC dates from Gergen's (1973) Social Psychology as a history which argues that "knowledge is historically and culturally specific" (Burr, 2015 p.15). From this SC's ideology, "all knowledge is derived from looking at the world from some perspective or other and it is in the service of some interests rather than others" (p.9). Thus, to indicate that an event, an issue or something is socially constructed is to explain that the issue would not have existed if the society had not built it. In the building aspect, various considerations are made based on the societal interests and other considerations such as values, norms, needs and beliefs. SC also shows that the construct could have been considered differently had a different society built it. What might be considered by a developing country such as Ghana for instance would be different from that to be considered by a developed world such as Britain. Thus, in support of Burr (2007, 2015), Andrews (2012) writes that SC originated as an attempt to come to terms with the nature of reality. Hammersley (1992) refers to this social reality as the subjective experience of everyday life and not the objective reality of the natural world. Societies construct stable realities and experiences based on the ways in which the prevailing sexual and cultural systems seem natural to them.

Owen (1995) also explains that SC regards individuals as integral beings who culturally, politically and historically evolved in specific times from specific places and therefore, are situated psychologically and cross-culturally in social and temporal contexts. Thus, apart from the inherited and developmental aspects of human beings, SC emphasises that all other aspects of humanity are created, maintained and destroyed in their interactions with others and through time.

The social practices of all life therefore begin and are recreated in the present and eventually end. To the social constructionist, race, sex, gender and sexuality are produced through discourses and practices in historically and culturally specific ways. In a sense, females and males were either categorized as feminine or masculine based on what the society considered as a reality and what occurred in history. Concepts are constructed and correspond to something real in the world (Hammersley, 1992). Gender roles for instance, are significantly formulated by the society but do not necessarily exist naturally.

Certain beliefs could be adopted through science but not created or constructed. An instance is the belief that the sea was naturally in existence and not constructed by any human being. Human beings however assigned the name (sea) to it.

Other cultures adopted different names based on culture or historical discourse. Beliefs and social values seem to be intertwined. Believing in a particular thing or issue therefore has some social factors attached.

Berger and Luckmann (1991) view society as existing in terms of objective and subjective reality. The objective reality is achieved through the interaction of people with the social world, and with the social world in turn influencing people subjectively. Burr (2015) in effect cites examples as how human beings assign names to animals and other objects such as dog or stone which are adopted and accepted by all those living in that society or culture. This could explain how individuals or groups of individuals define reality. Thus, descriptions of statements are driven by different concerns. Science for instance is considered factual and unbiased by most people. People produce ideas and methods for science based on their senses of what is needed and found important for their society. None of these ideas is neutral. Such categories that science create are often seen as truths that cannot be challenged (Kaplan & Grewal, 2006). In that case, SC theory shows that society has more influence on the construction of these categories.

The theories and explanations of mainstream psychology in effect, become time and culturally-bound. Issues pertaining at certain periods of time cannot therefore be accepted as final description of the nature of human beings. In comparing the dynamics of social interactions in the social world under the SC's ideology, "knowledge is therefore seen not as something that a person has or doesn't have, but as something that people create and enact together" (Burr, 2015 pp.11-12). Burr's (2007) version on the same title of Gergen's psychology paper, states that: "Knowledge is not seen as what someone has or has not but something that people do together" (p.9). Comparing the 2015 and 2007 editions of Burr's theory, creation becomes synonymous to construction. Creation in most dictionaries is defined as the production of something or giving rise to something. Construction also means to build or make something physical like a bridge or to create something such as a theory by organising ideas, words and so on. The two terms could therefore be considered synonymous and they could be differentiated from biologically produced entities like human beings, plants or other animals. Thus, to be born a male with the male organ in reality cannot be considered as socially constructed but biological. Being male or female is associated with certain characteristics largely similar in all human cultures and every historical period. Such characteristics (male or female) are significantly influenced by biological factors or are natural.

Quite recently in the 21st century, there have been debates and some confusion about the differences between sexuality, identity and sexual orientation. The article titled 'Center' (2021) reports that some men and women adopt different sexual orientation referred to as lesbian, gay, bisexual, transgender, queer (LGBTQ). LGBTQ is used to describe a person's adopted sexual orientation or assumed gender identity other than the natural genetic orientation. Whereas Gay or homosexual is the term assigned to a male for physical, romantic, and/or emotional attractions towards another male counterpart, females who engage in same sex partnership are referred to as lesbians. Although Browne (2008) explains that identity formation is considered to be a significant part of an individual's socialization, such transgender development is not a subject for discussion within the females who enroll in STEM disciplines. It is not yet legalized in the Ghanaian society. A male who undergoes surgery to transform to a female, unless undetected, would not be admitted or enrolled as a female in any institution in Ghana. Mostly, the hormonal features characterized of the male sex like deep voice and facial hair would be recognized or detected.

Burr (2015) explains that in the way of understanding the world, the categories and the concepts used are historically and culturally specific. The SC framework explains that there is no essential, universally distinct character that is attributed to males (masculine) or to females (feminine). In effect, behaviours are influenced by a range of factors which may include: class, culture, ability, religion, age, body shape and sexual preference. Thus, until the 21st century, although homosexuality was practiced mainly in second cycle schools, it never degenerated to a spate where same-sex marriage was anticipated as found in the LGBT agenda.

Burr (2015) therefore analyses the agenda of mainstream psychology in attempting to discover universal principles of psychological functioning, particularly how attitudes are formed. The theories and explanations of mainstream psychology become time and culturally-bound. Issues pertaining at certain periods of time cannot therefore be accepted as final description of the nature of human beings. Relating this further to subject choices in schools, perhaps the trend of females choosing the domestic courses or social skills, might have become a routine or habit passed on from generation to generation necessitating the need to find out mechanisms of reversing the trend.

In relation to the classroom or academic experiences, Rob and Rob (2018) clearly distinguish between the two philosophical terms - Social constructionism and constructivism as explained especially by Piaget and Papert.

2.1.2 Differentiating between Constructivism and Constructionism

Piaget (1968) an educational philosopher cited in Rob and Rob (2018) and Cornu and Peters (2005), explains constructivism as a theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their experiences and ideas. Such knowledge is not simply transmitted from teacher to student, but actively constructed by the mind of the student or learner. Central to constructivism is the notion that learners play an active role in "constructing" their own meaning (Peters, Thate & Craig, 2003). Connolly and Begg (2006) support this by explaining that cognitive constructivism views learning as an active process in which learners construct new ideas or concepts based upon their current/past knowledge. Knowledge is not seen as fixed and existing independently outside of the learner, but rather learning is a process of accommodation or adaptation based on new experiences or ideas (Cornu & Peters, 2005).

Piaget and Dewey have been noted to have developed the theories of childhood development and education which later became known as Progressive Education which evolved into social constructivism (Brooks, 1999 in WNET Education, 2004). Piaget also differentiated children's thinking from adults hence constructivism is sometimes referred to as Piagetian theory (Ibid). Dewey's theory of learning concentrated on the sustenance of inquiry learning. Other educators, philosophers, psychologists and sociologists such as Lev Vygotsky, David Ausubel and Jerome Bruner added new dimensions or perspectives to constructivist learning theory. Vygotsky introduced the social aspect of constructivism by defining the “zone of proximal learning”. In that zone he explains that although students solve problems within their level of potential development, they go beyond their actual developmental level (Ibid).

Bruner is known to have initiated curriculum change based on the fact that learning should be active and a social process in which students ought to construct new ideas or concepts based on their current knowledge. Thus, constructivism is associated with the theory of perception by Bruner (Burr, 2015). Constructivism, again, claims that people learn more effectively when they are engaged in constructing personally meaningful artifacts. A person is therefore seen as engaged in the creation of his/her own phenomenal world (Raskin, 2016). Constructivist psychologists further “argue that each person perceives the world differently and actively create their own meanings from events” (Burr, 2015 p.21).

Thus, in the opinion of the constructivist, individuals have got the power or capability to construct the world and therefore create new possibilities for their own action. In constructivism, each individual mentally constructs the world of experience through cognitive processes (Andrews, 2012; Charmaz, 2000; 2006; Schwandt, 2003; Young & Colin, 2004). A constructivist teacher therefore sets up the environment that fosters individual learning for students and presents a problem to be solved, while the students go on their own way to produce a personally meaningful solution without any further teacher’s intervention. In effect, the teacher guides students in the classroom through activities that will build on their pre-existing conceptions. Such activities with adequate tools or resources and a well-planned environment ensure that students learn appropriately. The learning environment can be termed as teacher initiated. In a way, it is synonymous to student-centred learning as compared to the teacher-centred learning. The teacher helps the student to construct knowledge in the constructivist classroom but does not necessarily expect a reproduction of facts. Constructivism ensures that the student is very active but not necessarily ingesting knowledge from the teacher or pouring out notes in the textbook. Students learn to hypothesize how to test and draw conclusions from the findings. The teacher only facilitates the learning process through prompts in the form of mainly questioning. The teacher should therefore be skilful at questioning technique.

Burr (2015) acknowledges that this situation is very challenging. WNET/Education (2004) however explains constructivism as a theory about how people learn and thus, people reflect on their experience as they construct their own understanding of the world. There is thus a need for either reconciling a new experience with a previous idea or changing what one believes in. Perhaps, this is what Burr (2015) considers as challenging – thus, judging from the maturity level of most students, creating new possibilities could be a bit mind ranking and challenging.

The two theories - constructivism and constructionism lead to the understanding of how people learn and grow (Ackermann, n.d). In the growth process, Piaget suggests that children have very good reasons not to abandon their worldviews just because someone else such as an expert tells them they are wrong. This means that children should take responsibility for their own learning leading to individuals creating their own phenomenal world (Raskin, 2006). Constructivist psychologists therefore state that “each person perceives the world differently and actively create their own meanings from events" (Burr, 2015 p.21). Constructivist strategy is associated with how children and adults perceive issues. Piaget differentiated children's thinking from adults' hence constructivism is sometimes referred to as Piagetian Theory. In constructivism, individuals create their own phenomenal world (Raskin, 2006). Constructivist psychologists therefore state that "each person perceives the world differently and actively create their own meanings from events" (Burr, 2015 p.21). This is in contrast to social constructionism that places great emphasis on everyday interactions between people for acquisition of knowledge.

Seymour Papert's Brooks -1999 in WNET Education (2004) describes the initiative in using computers to teach children which led to the use of computer and information technology in constructivist's environments. Papert was also interested in how learners engage in a conversation with their own or other people's artifacts and how these conversations boost self-directed learning (Rob & Rob, 2018). Both Piaget and Papert are therefore noted to be constructivists in that they view children as the builders of their own cognitive tools (Ackermann, n.d; Rob and Rob, 2018).

In addition to constructivism however, Papert emphasises the theory of constructionism and he initiated the learning theory of constructionism in the classroom. He thus, advocated that learning is most effective when the learner designs or constructs a tangible or meaningful product as part of an educational activity (Papert, 1980 in Rob & Rob, 2018). Constructionism asserts that it is not only the process involved in constructing something that learning becomes truly meaningful for the learner, but that the creation or on-going process and the end product must be shared with others to get the full benefit of learning (Amineh & Asl, 2015). In a research, Rob and Rob (2018) developed a questionnaire to find out about students' perceptions of knowledge creation that relate to the learning dimensions of constructivism and constructionism. Majority of the students agreed that developing a real-world product in a collaborative manner provided a better learning opportunity over personal cognition.

To most philosophers, researchers and educationists, knowledge and the world are both constructed and reconstructed through personal experience. Thus, knowledge is not merely a commodity to be transmitted, encoded, retained, and then reapplied, but based on a personal experience to be constructed. Again, they consider the world as not just sitting somewhere and waiting to be uncovered, but it is progressively shaped and transformed through the child's or the scientist's personal experience as well as social interaction.

From the foregoing analyses, the child is least directed by the teacher in the cognitive activities in the constructivism theory as compared to the constructionist's theory. Students discover what they learn for themselves in constructivist's theory but in the social constructionism, students learn or adopt what is in existence in the society. The student is noted to reflect on the learning in the teaching process in the constructivism whereas in the constructionism, learning could be considered as somehow learnt from people within the society such as parents, peers, teachers, pastors. Thus, by interacting with each other, the students pick ideas. In the constructivist's theory the teacher's attention is focused on children's need rather than the style considered appropriate to the teacher whereas in the constructionist's theory people seem to adopt what the teacher or society practices. Social constructionism might not necessarily be considered as a learning style but rather, the way the ideas of an existing society shape the perception of students.

The constructivist style of learning might be limited to only a few students since the teacher's task would be impossible with the adoption of individual differences in a large class size. Nonetheless, the constructivist learning style could attract more students into skill-related, applied-skill or technology programmes since students will have the opportunity to create their own knowledge based on their unique potentials. This study is predominantly situated in the constructionist's theory to find out whether females' interests in the pursuance of technology-related programmes is mainly constructionist's propelled or a mix of the two main discussed. Both constructivism and constructionism seem to be implemented in the technology class. In teaching Design and Realization for instance, students are guided to identity problems within certain contexts like school, libraries, workshops, hospitals and recreational grounds individually or sometimes in groups. They then have to analyse various possible solutions to solve the problem and come out with specifications in terms of elements such as appearance, stability, aesthetic appeal, social and environmental effect. The students then choose the appropriate materials, tools and equipment to be employed in making the real object or artefact. In the end, the student compiles the stages involved in the learning into building a detailed portfolio. By this, students use inquiry methods as pointed out by Papert (Ackermann, n.d). to reflect on what has been learnt and how it was learnt through the teacher's guidance. Thus, whilst social constructionism has more of a social dimension, constructivism seems to have an individual dimension or focus.

In summarizing the two theoretical views, the discussions of Rob and Rob (2018) intuitively may guide instructors who might be contemplating in implementing the educational philosophies of constructivism or constructionism, or intermixing the two in their classrooms. To promote female-participation in technology-related programmes, practically, teachers should use constructionist approach to guide their students throughout the course time. Such students could work collaboratively on a project to learn the important concepts to be developed. As carried out in Design and Realization – a course in Mechanical Technology, students are collaboratively guided to use tools and equipment appropriately with the selection of the right materials and processes to plan for a project under the guidance of a teacher or a facilitator. Socially, students especially females develop their knowledge positively through interaction with others. Weber and Custer (2005) found out in their research that females prefer collaborative learning as against individual highly competitive learning. A collaborative environment produces knowledgeable people in the society with better understanding and respect toward each other (Rob & Rob, 2018).

Another contrasting theory to constructionism is termed Essentialism. This is next to be discussed in order to establish the connections between them.

2.1.3 The Contrast between Essentialism and Social Constructionism

Some qualities of living things are inherent and this means such living beings are born with such qualities or characteristics. If someone is female, it is because she is born with a female's external features of distinct shape from that of the male. The social constructionist views knowledge of the world (epistemology) and the way of knowing or understanding it as psychologically not derived from the biologically inherent nature of the world. Essentialism or biological determinism is the belief by most people that there are some essential biological differences in the brain structures, learning styles, and interests between males and females. Thus, males inherently, possess particular masculine character traits such as aggressiveness and competitiveness; and thus, they are naturally more active than females. Essentialism as a theory holds a belief that gender is mainly caused by biological factors while social constructionist's theory shows that society has more influence on these qualities of gender than biology. Essentialism therefore is an ideology which tends to trap people inside personalities and identities thereby limiting them to possible future change (Burr, 2007, 2015). This exhumes that a person's world is pre-given and fixed. SC strongly opposes this 'essentialistic' view because people are not inherently born with character traits or behaviours. Again, it could be deduced that if essentialist views are upheld, the differences could justify inequality in the social system. This is because in that ideology, females and males would be classified under natural and innate characteristics and therefore it becomes acceptable to treat them differently in subject choices for instance. It means the brain dichotomy of females and males would be accepted and thus based on spatial ability, all engineering and mathematical-related programmes for instance would be reserved for males who are considered spatially skilful. Careers or jobs for the two sexes would thus become lopsided. Kwesiga (2002) for instance considers females as naturally endowed with catering for children hence domestic chores should be relegated to them. Categories to the social constructionism seem to be already created by society and different people fit into these different categories.

In debating the social constructionist and essentialist theories, Vance (2006) also points out that in essentialism, human behaviour is 'natural,' and predetermined by genetic, biological and physiological mechanisms which makes it impossible to change. Social construction theory therefore aims at "denaturalizing" this essentialist view thereby showing how SC theory may be of use to feminists. Baumgardner and Richards (2012) explain that feminism's goal is to change the perceptions of the opportunities available to females hence social constructionist theory is of a great benefit to feminists. Holding on to essentialism will perpetuate inequalities thus leading to unequal treatment meted out to the sexes regardless of ability or potentiality. Other underpinnings worth reviewing are the main philosophical assumptions or theories underpinning the methodology of the research.

2.1.4 Epistemological and Ontological Assumptions

Researchers generally classify theories or research strategies as paradigms. A paradigm is a worldview, a general perspective, a way of breaking down the complexity of the real world (Patton, 1990, 2002). Guba (1990) describes a paradigm as an interpretative framework which is guided by a set of beliefs and feelings about the world and how it should be understood and studied. Denzin and Lincoln (2005) also explain two paradigms or philosophical terms that influence the nature of research namely; epistemology and ontology. These are categorized as beliefs or assumptions that guide and influence the nature of research.

One of the main reasons for the conduct of research is the acquisition of knowledge and epistemology is a key social research paradigm used to depict knowledge. Epistemology, coined from two Greek words 'episteme' meaning knowledge and 'logos' meaning word or speech concerns the question of what could be regarded as an acceptable knowledge in a discipline (Bryman, 2008). It is a branch of philosophy that deals with the nature, origin and scope of knowledge (Gall, Borg & Gall, 1996). Somekh and Lewin (2007) describe it as “what counts as knowledge and ways of knowing” (p.66). Guba (1990), cited in Fazlıoğulları (2012, p.42), explains that epistemology examines the relationship between the one who knows, what is known and what can be deemed as knowledge. It is also concerned about the relationship between the researcher and what is known. This relationship assumes an objective or subjective posture (Billings & Jennings, 2000) and it is about what can be known (Kalof, Dan, & Dietz, 2008) cited in Fazlıoğulları, 2012). Epistemology therefore focuses on looking at what makes knowledge true or justified, the characteristics, sources and limitations of knowledge. This fits in well with this study which seeks to identify the in-depth knowledge of students pursuing technology-based programmes in the universities.

Ontology, noted by Denzin and Lincoln (2005) as another belief or assumption deals with the nature of social entities thus, dealing with the question about what is real. In this research, it was important to research into the kind of ontological knowledge held by the participants in the sampled institutions - whether they still hold on to internalized beliefs and values of their culture or whether their choices of disciplines are pre-empted by social interactions or constructionism. Bryman (2008) describes how social entities must be considered as either objective entities that have realities external to social actors or as social constructions built up from the perception and actions of social actors. If the reality is built up as an objective entity, the position is referred to as objectivism. If the reality is perceived by social actors, then the position is known as constructionism. Bryman (2008) therefore relates objectivist and constructionist ontological assumptions with organization and culture of a society. An organization he explains, has standard rules and procedures for carrying out its activities while culturally, it has shared values and customs for socialization to ensure good citizenry. People therefore are known to internalize the beliefs and values of the culture.

Constructionism considers social actors as external realities to entities like organization and culture. Thus, social actors produce various phenomena through social interactions with such social phenomena changing through revision by the social actors. Ontology is considered as “one’s worldview and how this shapes what can be known about the world and indeed what it means to be a full human being” (Somekh & Lewin, 2007 p.66).

2.1.5 Feminism, Marxism and Critical Theory

This research could be classified under feminist’s perspective since it sought a change in enrolment pattern of females pursuing programmes in technology-related applied science disciplines. Feminism as a paradigm has the aim to emancipate human beings (Lather, 2006; Hatch, 2002). The ultimate goal of feminism is to offer rich insight into the ways in which females’ voices and life stories could inform research. Thus, such insight might shape the ways of seeing the world and how knowledge is viewed. Regarding this, some of the questions asked during data-gathering were aimed at checking whether females have their voices and if indeed they are keen in ensuring a change in subject choices for a balance in the ‘male-dominated’ fields of study. Most of the questions sought insight into the causes of low enrolment because feminists’ theories seek insights into the causes of concepts such as inequalities and gendered oppressions in research. Somekh and Lewin (2007) explain that feminism concentrates on femaleness as the central focus of research questions but point out that there are no methods which are specific to feminists' research. Feminists therefore make use of both quantitative and qualitative data and adopt various methodologies like ethnography, surveys, interviews and observation designs based on research principles that would lead to the production of knowledge and dissemination of findings. Feminism also aims at developing equitable professional and personal practices. It again aims at creating social change especially on the unexamined assumptions about women and dominant forms of knowing and doing (Weiner, 1994; in Somekh & Lewin, 2007).

Karl Marx according to Livesey (n.d), classifies society into the Capitalist or "bourgeoisie" class and the proletariat". The former includes those who own and control the means of economic production whilst the latter are considered as the working class who sell their labour power in their ability to work in return for wages. An attempt was made to find how such classes affect subject choices in second cycle schools in this research. No stratification was however found out.

2.1.6 Positivism and Post-positivism

The paradigm of the positivist asserts that real events can be observed empirically and explained with logical analysis. Collins Spanish dictionary describes positivism as a form of empiricism that bases all knowledge on perceptual experience (not on intuition or revelation). Positivistic knowledge is based on natural phenomena and their properties and relations are verified by the empirical sciences. It is known to have been used for the first time in 1847 (19^{th} century) by the philosopher Auguste Comte who was interested in the application of natural laws to the society. Thus, Comte viewed the natural sciences such as biology as a necessary step in the development of the social sciences. A positivist dealing with complex social problems such as unemployment and crime for instance, would be concerned with their visible manifestations. Another instance would be an individual or criminal who could be seen or perceived as having committed the crime rather than the underlying causal mechanisms that are invisible. In view of this, Miles and Huberman (1994) believe in the use of the senses to generate knowledge about reality (i.e., scientific method). They think that philosophical and logical reasoning could lead to seeing non-existing links between events occurring simultaneously.

In this research, having adopted qualitative research methodology, positivist methodology was considered inappropriate in the sense that peoples' feelings, motives and emotions are mental states that exist in the people's own consciousness hence, they cannot be measured statistically by positivistic methods. Positivist research methodology emphasizes experimentation in a laboratory environment that eliminates the complexity of the external social world and the economic linkages (Fazlıoğulları, 2012). While the results obtained using experimental methods provide valuable insights into the nature of reality, those results may lack external validity. This is the case because the relations observed in the laboratory may not be the same in the more complicated external world where much greater number of factors interact. The criterion for evaluating the validity of a scientific theory is whether the claims of knowledge (i.e., theory-based predictions) are consistent with the information obtained using the natural senses. Kaboub (2008) expresses that positivism exerts an important influence on scientific practice in the social natural science methodology where laboratory experiments can closely approximate the real world environment, thus allowing for accurate predictions. Positivist's prescriptions tend to treat the symptoms rather than the root cause of the problem (Kaboub, 2008). One cannot conduct an experiment to detect people's emotions or beliefs and essences for particular choice or behaviour. In view of this, in this research, measurement was not carried out mainly by pure scientific techniques that are likely to produce quantified conclusions. Such a report would have been narrated scientifically with the appropriate scientific packages like the Scientific Package for Social Sciences (SPSS). Rather, responses were qualitatively sought through interaction with respondents via interviewing and observation.

Furthermore, some feminist researchers such as Ryan (n.d) oppose positivist epistemologies with some key claims that all events and phenomena are inter-connected and that divisions between objectivity and subjectivity or scientific and emotional knowledge (dualist) have been socially constructed. Ryan (n.d) describes further, how critics opposed the positivist's epistemologies for asserting that such knowledge is regarded as separate from the person who constructs it. Mathematics, science and technical knowledge are for instance given high premium because they are regarded as objective, separated from the person and the private world. Knowledge is construed as something discovered and not produced by humans and that contrasts the social constructionist's theory in which this research is substantively situated.

2.1.7 Interpretivism

The interpretivist approach was employed in collecting and analysing data in this research, because interpretivism emphasis the meaning that participants attach to phenomena. By interacting and sharing experiences and knowledge with the participants, the varying perspectives in responses that emerged were treated without bias. This interaction underpins the fact that interpretive research assumes that; reality is socially constructed hence, the researcher becomes the vehicle by which this reality is revealed (Cavana, Delahaye, & Sekaran, 2001); Walsham, 1995). The items constructed for data-gathering (interviews and observation) encouraged diverse approaches thereby limiting the objectivist's view that meaning resides within the world independently of consciousness (Saunders, Lewis & Thornhill, 2012). In interpretive research, the researcher's interpretations of response play a key role and usually bring "subjectivity to the fore, backed with quality discussions rather than statistical exactness" (Garcia & Quek, 1997 p.459; cited in Werner & Keutel, 2011). If a researcher has to understand the meaning of the responses by the participants, it requires grasping the subjective consciousness of the participants internally. All the actions must be interpreted in a particular way that would be meaningful to the social world – not understated nor exaggerated. Interpretation must not be prejudiced by the researcher's own preconceived ideas.

From different philosophical standpoints, Chowdhury (2014) therefore explains interpretivism as a philosophical approach that helps people to understand the social world by meaningful interpretations of the world they inhabit. He however added that these prejudgments and prejudices are changing in the course of history. In effect, he states that: "However, what things [they say] will be different in light of the changing research horizons and the different questions researchers learn to ask" (p.436). The interpretations cannot therefore be considered entirely distortive based on subjectivity because interpretivist researchers always aim at a correct understanding of what their respondents say. Additionally, Chowdhury (2014, p.436).) cites a quote by Gadamer (1970, p.87) that: "To understand is always to understand differently" It could therefore be deduced that interpretations may differ slightly based on different researchers' perspectives but not deviated entirely from the informants' submissions or what may solve the problems in the societies.

By resorting to data collection through interviews and observations too, the feature of interpretivist's approach as a naturalistic approach was brought to bear on this research. Thus, knowledge of reality was gained through language as a social construction entity. With these natural settings of methodology in terms of the research design and active fieldwork, the issues that emerged from the academic and socio/cultural experiences of the participants led to suitable interventions that may enhance enrolment of females in scientific studies. This may lead to appreciably recruitment in technology-related careers in future. Attitudes according to the interpretivists (Saunders et al, 2012), could change as a result of various interventions, situations or pragmatic policies especially those formulated to empower females. Knowledge could also be said to have been gained if there is a change of attitude in the choices of disciplines. Neuman (2007, p.2) defines social research as:

> a process in which people combine a set of principles, outlooks, and ideas (ie. Methodology) with a collection of specific practices, techniques, and strategies (ie., a method of inquiry) to produce knowledge.

In the conduct of this research, quite a lot of linguistic terminologies had to be explained. This is in tune with Neuman (2007) who explains that in qualitative research, there is a need for persistence, tolerance for ambiguity during data-collection strategies and interaction with the participants if good or quality work has to be done amidst integrity and pride. By tolerance of ambiguity, Erten and Topkaya (2009) refer to a psychological construct of process that involves processing unfamiliar linguistic and cultural input especially in reading. If an effort is not made to get clearer meaning of each terminology or word, one may be discouraged and pull away from the research. They again explain that an awareness of how this tolerance for ambiguity influences learners may alter the way teachers plan and execute their lessons. This would in turn help learners overcome their psychological barriers in learning especially science-related programmes. In one of their research projects, Erten and Topkaya (2009) again found out that statistical analysis on the average indicated that female students have lower tolerance of ambiguity in the process of learning than the males. Interest in STEM subjects could be sustained if females improve their tolerance of ambiguities hence, this was checked in the language used by this researcher during data-gathering. In the introduction of the interviews for instance, key words such as qualitative and quantitative research were explained to the student-participants since quite a number of them were accustomed to the administration of questionnaire in research projects instead of interviews. Specific questions asked to solicit information from the participants during the interviews (Appendix 9) were critically checked and key terms explained to exclude ambiguities. In the primary data-gathering process, an attempt was also made to curb four main errors that could affect research discussed by Neuman (2007) namely: premature closure, overgeneralization, selective observation and halo effect. All these errors could be summed up as the inability to complete a particular research project by especially not covering the sample-size yet, concluding and reporting based on one's own biases. It is worthy of note that in carrying out a study of this nature, which is basically about interpretivism (rendition of respondents views of social reality in their own linguistic forms and styles), direct quotations from respondents were profusely used to provide some illuminations on their personal experiences, values, tastes, reactions and passions. Fortunately, all of them could use the medium of expression (English) utilized by the researcher. Walsham (2006) explains that a reporter of empirical data in interpretive research ought to "use plenty of quotes from respondents, as they can often make a point really sharply and vividly" (p.327). He however cautions that the point being made in the quotations must be introduced first "rather than making the quote 'do the work" (p.327)

In line with the first objective of this research, besides the theoretical framework, the concepts underpinning the study such as gender and sexuality were also found worthy of reviewing.

2.1.8.1 Conceptual Framework

This section focused on some of the main concepts upon which the study is based on. Some concepts (that influence subject-choices), bearing significant relationship with the review and the study in its entirety may include but not limited to the following: Gender differences/ sexuality; spatial ability and brain lateralization, as illustrated on the conceptual chart below at Fig 2.1.

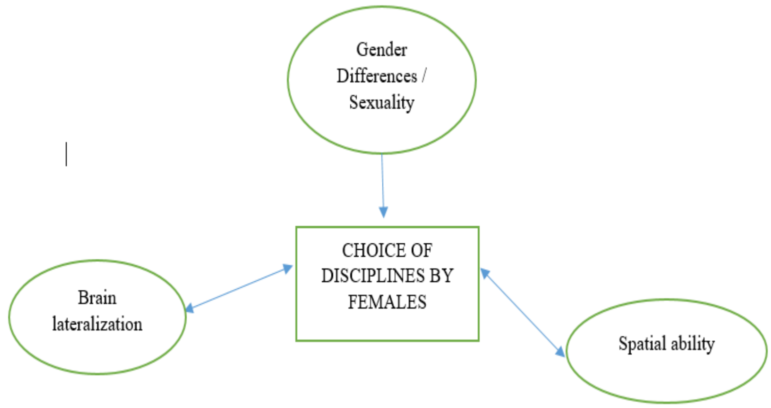

Fig 2.1: **Conceptual chart for choice of engineering disciplines by females**

2.1.8.2 Gender Differences and Sexuality

Gender refers to the socially constructed roles, behaviours, expressions and identities of human beings including girls, women, boys and men. Newman (February, 2018) explains the term "gender" as the role of a male or female in society, or an individual's concept of themselves or gender identity. Gender therefore refers to the attitudes, feelings, and behaviors that a given culture associates with a person's biological sex. Behaviour that is compatible with cultural expectations is referred to as gender-normative and those that are viewed as incompatible with these expectations are said to be gender non-conformity (American Psychological Association (APA, 2011). APA (2011) describes how gender originates from the Latin word "genus" which means 'a class or group with common attributes'. Gender again, refers to group(s) of species that are structurally similar and related biologically. Thus, gender refers to socially-constructed roles of relationship between females and males. In that sense gender refers to the attribute, opportunity and socialization process which are changeable by time and context. Gender therefore, influences how people perceive themselves and each other, how they act and interact, Nobelius (2004) further explains that the term 'gender' was originally borrowed from linguistics anthropologists to discuss the social roles occupied by males and females in society. The roles engendered in society were assumed to be 'natural' results of one's sex. Cross cultural studies on the contrary have shown that sex is a universal condition of humans whilst gender roles vary across culture. To Nobellius (2004), it is important to study the extent to which gender roles are as a result of biology, the result of social conditioning or enculturation. Pederson (2001, p.4) also refers to:

> Gender at any given point in time, in a given culture, to be a "woman" or a "man." The specific content of gender varies historically and culturally; gender norms and values differ from place to place and time to time. Gender also involves cultural identity and generational position, as these are elements that may lead to variations in the content of gender.

Thus, from this quote, whereas sex (discussed later) that is being female or male cannot be changed unless under specially agreed-upon circumstances and surgery, 'gender' can change. In that vein, gender is dynamic so what existed within the 20th century could change within the 21st and subsequent future centuries based on societal epistemological and ontological insights.

Under sexuality, sex is commonly understood to refer to biological characteristics or status that vary and yield distinctly male or female persons with differences in anatomy and physiology (Pederson, 2001). Smith (2016) also describes sex as a typical combination of features that usually distinguish male from female. She further highlights that women are still under-represented across all fields of science, making up just 14.4% of the science, tech, engineering and mathematics (STEM) workforce in the UK but there is a need to achieve STEM diversity for equal opportunities. One wonders if this disparity is due to the chromosomal distinctions.

Pederson (2001) explains genetic morphology as every human being possessing genes arranged in 23 pairs of chromosomes and the biological association of these genes determine the sex of a particular person. A gene is generally defined as a 'unit of heredity composed of deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) which is self-replicating material in all living organisms. Sex chromosomes explained further by Pederson (2001) happen to be one of the pairs of genes and the geneticists have adopted X and Y for them. Females usually have two Xs (XX) whilst males have X and Y. Each egg produced by a female therefore contains one egg and males usually have one X and one Y-chromosomes. Each individual sperm as continuously shared by Pederson (2001), can have an X or Y chromosome. This means it is the sperm's sex *chromosomes* (X or Y) that determine what sex chromosomes the resulting child will possess. Females and males are endowed with certain physiological characteristics based on the replication of the genes acquired from both parents. If the foetus has a Y chromosome, then testes would develop. If there is no Y released by the male, then ovaries would develop. Testes produce higher levels of certain hormones such as androgens produced by the adrenal glands. Adrenal glands secrete adrenalin which affects circulation and muscular action. If the level of secretion of androgen (containing adrenalin) is very high as normally found in the formation of testis, then a penis and scrotum would be found. If the adrenalin is low (i.e. that found with the formation of ovaries rather than testis), then labia and a clitoris will develop.

The high secretion of androgens or adrenalin as found in males gives males' dominance in muscular or practical activities. It could be reasoned that this practical dominance has led to males' dominance in technical activities but it could be argued again, since modern trends of events have led to less reliance on physical strength for the conduct of practical activities. In the replication phenomenon of genes, occasionally, the individual may be born with neither XX nor XY according to Abir-Arm and Outram (1987) in Kirkup and Keller (1992). Such a genetic disorder is not an issue very pertinent to this study but the acquired inherent traits that have been subject for arguments under female/male acquisition of spatial skills would be discussed later.

It is important that contemporary societies make effort to ensure that there is a balance of male and female technologically-literate workforce to man industries that produce competitively priced products. This could be achieved by providing equal educational opportunities for both males and females. Various reasons (e.g. biological, social, cultural) have been ascribed to the apparent lopsided gender differences in schools regarding the study of science and technology-related programmes by males and females. Researchers such as Haralambos, Holborn and Heald (2004), Weber and Custer (2005), Boateng (2012), Amponsah, Mensah & Mensah (2014) and Owusu-Mensah et al (2014) have attempted to explain the problem through psychological, socio/cultural differences and leadership practices adopted in institutions as discussed already.

A number of researches also point to gender and sexual differences between males and females. In view of this, scholars such as Seward and Seward (1980) suggest that the differences between the sexes regarding interest in science and mathematics is a factor of socialization. These scholars argue that the conviction of belonging to one sex rather than the other appears early and is deeply imprinted on the child. Sex-roles are foisted on children by parents through socialization. “From the moment the new baby is placed in a pink or blue blanket, society lays its imprint upon it and begins to shape its gender” (p.90). This leads to accepted spontaneous differentiation like aggression in the boy-child and submissiveness in the girl. In mixed group interactions for instance, analysis has shown that not only do males monopolize tools and equipment in workshop lessons but they frequently take far more their share of another major resource -the teachers’ time and attention. This was evident in an analysis of 37 separate observations during one of the activities by Girls in Science and Technology (GIST) projects led by Whyte (1986). In that project, the teachers were noted to spend time with the girls differently. Whereas they guided the boys to work independently, they were found to be patronizing and sometimes got the girls’ work done for them. Probably the teachers thought they were assisting the girls or perhaps the girls were considered too slow for them. The aggressions with which boys pursue their practical activities in the sciences perhaps lead to why they are often considered as very good in spatial skills known to be instrumental in the adeptness of females and males’ mathematical and scientific skills.

2.1.8.3 Gender and Spatial Ability

Based on the foregoing analyses, in discussing gender, a concentration is placed on specific context in which power relations would be experienced. Appiah and Cusack (1999) for instance, point out clearly that in Ghana, violence meted out to women such as sexual harassment are all practices erupted out of power relations within ‘gender’. In that stance, gender expression refers to the:

> Way in which a person acts to communicate gender within a given culture; for example, in terms of clothing, communication patterns and interests. “A person’s gender expression may or may not be consistent with socially prescribed gender roles, and may or may not reflect his or her gender identity” (APA, 2008 p.28).

Such sexual differences and gender expressions might have accounted for perceptions in spatial abilities attributed to females’ low participation in the sciences. According to the American Association for University Women (AAUW, 2010), one of the largest gender gaps in cognitive ability is seen in the area of spatial skills. From 1940 to 1960, AAUW (2010) reports how researchers focused on defining the term ‘spatial ability’ but with some difficulty. From 1960 to1980, several divergent approaches to spatial ability research emerged and the term has therefore been defined in numerous ways thereby creating various methods for measuring it (Mohler, 2008). Staffaroni (2021) explains it as the ability to “generate, retain, retrieve, and transform well-structured visual images’. He thus, categorized it under reasoning skills that refer to the capacity to think about objects in three dimensions and to draw conclusions from limited information.

Regarding this, Danso (1996) cited Maccoby and Jacklin (1974) pointing to apparent psychological differences between males and females and explained that males are more aggressive and therefore excel in visual-spatial ability. Girls are also known to possess greater verbal ability than boys and thus, outperforming boys on tests relying on verbal skills such as writing, memorization and perceptual speed (AAUW, 2010; Kimura, 2002; Halpern et al, 2007). Other research-projects conducted in North America and in a host of European countries have established males’ advantage over females in their ability to generate and mentally manipulate spatial representations of geometric and other figures

(Geary & DeSoto, 2001). Boys and girls therefore tend to have different cognitive strengths and weaknesses. Jernagan (n.d) however explains that there are some disagreements amongst those who find significant gender differences especially on the timing of the research.

Hoffman, Gneezy and John (2011), also show men outscoring women in spatial ability test in patrilineal societies where the males were. Their study suggested that patriarchal cultures could be the reason for the gap in spatial ability. It was found out that those women in cultures where men are in charge score lower than males but in communities where women are at the forefront and being equally educated as the males, the gender gap disappears. The experiment, carried out in India could not offer concrete qualitative reasons as to how cultures influence spatial ability. The studies further revealed that in the patrilineal tribe (Karbi), men received about 3.5 years more education than women and they completed the task or puzzle on spatial ability 36 percent faster than the women. Men and women in the matrilineal tribes (Khasi) are known to be equally educated so both sexes were equally good at the task during the experiment. A generalised conclusion reached was that gender-gap widens in the patrilineal education but not in the matrilineal society within the two tribes researched. The researchers concluded that a reduction in the gender gap in spatial abilities may reduce the gender gap in STEM's workforce. The main findings of their research were published in the journal of National Academy of Science (NAS -2006). Findings by Geary and DeSoto (2001) who conducted their research in China and the United States (US) also showed that the male superiority in Three-dimensional spatial cognition is dependent upon culture.

Studies on undergraduates by Wright, Othman, Khalof and Zeilani (2008), also revealed that although at baseline, males were better at spatial skills, with training ranging from few hours to few weeks, both sexes improve and the gender gap closes. Linn and Petersen (1985) cited in Boateng (2012) also found that "spatial perception can be measured reliably in 4-year-olds," but, "differences favoring males are first detected around age [seven] 7 and accelerate to adult levels by age [eleven] 11" (p.12).

Developmental studies by Piaget and Inhelder (1971) but also cited in Marmor (1975) and Mohler (2008) examined how spatial ability develops through childhood to adulthood. It was found out that educational toys contribute significantly to the cultivation of spatial intelligence at a young age. Other researchers focused on areas of difference in spatial ability, particularly as it relates to differences across gender. Rilea, Roskos-Ewoldsen and Boles cited in Mohler (2008) researched into brain physiology and its relationship to spatial ability. Their findings showed that spatial ability affects many fields and disciplines and is a predictor for success in many areas of life. It is known to predict a young person's achievement in STEM. To be successful in mathematics and science careers, one should possess higher visual-spatial abilities (Lord & Holland, 1997). Using engineering as an example, the writers explain that one must 'visualize' how all of the components in the system work and fit together. Such skills are additionally crucial for architecture, sculpture and surgery.

Research projects conducted and conclusions drawn indicate that people can improve their spatial skills with training. Children could be introduced to language that describes the spatial world. Thus, words like circle, triangle, octagon, curvy introduced could have tremendous effect on children at early stages in life. In effect, one could practice spatial thinking by motivating children to think spatially through questioning on shapes and sizes. Tests by Pruden, Levine and Huttenlocher (2011) reported that toddlers and babies who heard and used a lot of spatial words scored higher on spatial skills when they were pre-schoolers. Meanwhile, Jones, Braithwaite and Healy (2003) express that although visual spatial ability research is as broad as it is deep, there is still much work to be done in this area since quite a lot of the measures used in experimenting were flawed and others too relied on very small sample size. Spatial abilities in terms of the dichotomy of the brain structure termed 'brain lateralization' have also been extensively argued

2.1.9 Brain Lateralization / Stereotypical Gender Activities

Brain lateralization has been argued from varying perspectives. Biologically, hormones have been explored to have direct and indirect effect on the development of the brain of males and females (Nicholson, 1993; Fausto-Sterling, 2000 & Sabbatini, 2007). Nicholson (1993) asserts that about 95% of the left hemisphere of the human brain specialises in verbal and linguistic skills after age two. Those with right-brain dominance (males alleged) are asserted to perform better at spatial tasks thus, having highly developed spatial abilities (McGlone, 1980 cited in Mohler, 2008). Gray and Buffery (1971) cited in Haralambos et al (2004) add that the left hemisphere has been noted to be dominant for the verbal and linguistic skills in females after age two. Fausto-Sterling (2000) also explains that scientific analysis of the size of male/female cognitive abilities or corpus callosum began in 1982 and that there are possible gender differences in the degree of lateralization for mental abilities of males and females.

Sabbatini (2007) a neurophysiologist from the Faculty of Medicine of the University of São Paulo at Ribeirão Preto in Brazil also analysed the external anatomical, sexual differences of humans. He found out that there are differences in the way the female and male brains process elements such as language, cognition, mathematical calculations and visualization of objects in three dimensional forms. This might account for the reasons why male airplane-pilots and mechanical engineers abound. He however did not expand the distinctive differences in the processes for instance how mathematical calculations are done by females: whether fast, wrong or so. Balliet, Li, Macfarlan and Vugt (2011), further explain that males outperform females and therefore known to possess the aggressive gene inherent with struggles in occupational life more fitting into prehistoric hunting and the use of tools. Males perform better in manipulative skills in the S&T. In linguistic abilities such as verbal fluency, perceptual speed and memory skills, females are known to outperform males (Kimura, 2002 cited in Mohler, 2008). These gender inequalities are attributed to biological differentiation and are therefore considered genetically acquired. This phenomenon is termed as "*brain lateralization*" by Haralambos et al (2004 p.95). Harris (1978 cited in Mohler, 2008) also supports this with an explanation of why males have superior visuo-spatial abilities over females.

This brain dichotomy was further analysed in a lecture delivery at Wisconsin University in the United States by Diamond (2003) by comparing the human brain with that of the rat's pelican brain which scientifically has been proved to possess similar features or basic components similar to the human brain. Diamond, the scientific analyst upholds the analysis of brain lateralization but points out that up to date, no live human beings have donated brain tissues to be used in conducting an experiment on the differences. Delivering the lecture, she reported that: "Furthermore, wresting meaning from the multiplicity of similarities and differences between male and female brains presents a considerable challenge in the decades ahead" (Diamond, 2003 p.6). Oakley in Haralambos and Holborn (2004) also points out that: "if there are biological tendencies for men and women to behave in different ways, these can be overridden by cultural factors" (p.100).

With regard to this, a typical cultural issue affecting females' studies in technology-related programmes is the high value placed on marriage and catering for children in most African countries. Writing about Nigerians on African Feminism for instance, Mikell (1997, p.278) emphasis that 'in Nigeria, women's responsibilities include cooking, farming, and taking care of the house as well as the children'. Stereotypes, social norms, values and cultural practices lead to the segregation of females into certain fields of study outside science and technology (Weber & Custer, 2005; Suter, 2006; Zubieta 2006; Amponsah et al., 2014; Castillo, 2014). With respect to these, Hoffmann-Barthes et al. (n.d) point out the need for education to challenge the stereotypes about male and female roles so as to offer alternative ideas to equip young women to pursue a range of possibilities. Since gender impacts on education and other social systems, the writers explain that the school is more likely to echo and reinforce prevailing attitudes. In line with these, others such as Martin, Eisenbud, and Rose (1995) as cited in Weber and Custer (2005), add that the media, peers and adults have been noted to communicate and reinforce gender-based stereotypes. How do these cultural issues manifest themselves in Ghana thereby having influence on subject choices?

Issues bordering on spatial ability or brain lateralization are of great concern to this research because those who hold on to biological endorsement of spatial ability may think that people cannot change. As realized from the analyses of sex however, unless one determines the type of sexual orientation through surgery, it is impossible to change from male to female. Being male or female cannot change across cultures but behaviours erupted from societal gender influences or identities could change. If subject-choices are for instance influenced by gender issues, female students' orientation can change to tow the interests of the society but not necessarily that of their own potential interests. Opposing views about these brain dichotomies in terms of gender, societal interactions and stereotypical attitudes as the main construction of these differences abound.

The review moves to cultural practices - the next substantive issue in line with the set objectives.

2.2.1 Dynamics of Social Cultural Interaction

Culture is defined by Byram (2008) in Olga (2017, p.1) as "shared beliefs, values and behaviours of a social group". As was noted particularly of Ghana in the background analyses of the first chapter, males for instance usually took up the trades or interacted with their fathers to learn the occupational skills whilst females adopted the domestic chores.

Balliet, Li, Macfarlan and Vugt (2011) in a hypothesis of a gender co-operation research predicted that compared to females, males are more cooperative during same sex (example son and father) interactions because cooperation with other men has had important consequences for their survival and reproductive success typically regarding ancestral periods. The writers noted that a number of researchers including Costrich, Feinstein, Kidder, Marecek and Pascale (1975) in Balliet et al (2011) have reported that males and females may conform to the gender stereotypes to avoid being negatively evaluated by others. Balliet et al (2011 p.896) state that:

> Because women (and men) are evaluated negatively when they engage in counter-stereotypical [attitudes], they may be motivated to conform to their stereotypes. Furthermore, such gender stereotypical beliefs are likely to be stronger in interactions with the opposite sex because such situations activate the gender roles

From the quote, it is when the two sexes come together that gender roles are manifested culturally. This however contrasts what was noted about boys' co-operation with their fathers (same sex) in the background review earlier. Culture defines acceptable behaviours for men and women and Schalkwyk (2000) expresses that cultural influences play a large part in people's behaviour. Vance (2011) adds that many cultures portray male superiority by expecting men to be more masculine and women more feminine. Men considered less masculine are seen as being less manly, while women who seem less feminine are assumed to be trying to take over the man's role in society. In both cases, Vance considers the reaction to be negative

Biologically, as males produce more of the androgens, so do females produce more of oestrogen and progestin (hormones produced by the same adrenal glands). Kirkup and Keller (1992) explain that the hormonal variance leads to typical sexual characteristics such as pronounced breasts in women and moustache in men. A lot of varying physiological differences such as men sweating more than women during exercises, men's speed in athletics race being faster than women and many others could be the reason why sports for instance are generally organized under sexual identity basis. Such segregation of hormonal differences might have affected the choices of the 'non-technical subjects' by females. Some schools for instance make practical work such as Metalwork optional to Home Economics thereby leaving most females nothing but the choice of Home Economics on stereotypical ground. Lifting of planks by woodworkers for the preparation of furniture and other cabinets in traditional setup which requires physical strength might still be ingrained in females with relatively limited physical strength than men.

In a Ghanaian newspaper article in the 21st January edition of the Weekly Spectator, the regional manager (Mr. Isaac Osei Mensah) of Hyundai-KOICA Technical Institute in Koforidua, the Eastern Regional capital explained how the enrolment of the female students of their Institute has increased. The manager explained that the advent of modern machines has enabled the operations such as lifting of objects with ease thereby ensuring easy-operation especially by women; thus, without physical force (Ampadu-Nyarko, 2017, p.23). He further explained that since the Institute's establishment in the year 2012, out of the ninety (90) students admitted, thirty (30) had been females. In 2017 alone, forty (40) females enrolled though the number of males was unreported. Some of the students who enrolled upon passing their examinations organized by the Council for Technical and Vocational Education and Training (COTVET) are admitted into the Technical Universities for upgrading. This is encouraging and should this continue in other mechanical engineering outfits, there is a glimmer of hope for increase in female-enrolment.

Another social issue affecting female-enrolment in science-related programmes is that because women biologically bear the costs of pregnancy and childcare, females acquire culturally different sets of skills to fulfill the duties of their social roles and this affects the expectations associated with their gender. Thus, assumption of domestic roles usually involves a great deal of interpersonal relationship skills. Accordingly, females are perceived as more communal in orientation, more caring, friendly, and emotionally expressive (Eagly, 2009). On the other hand, males assume social roles of high status and power and so are perceived as more independent, ambitious, and dominant. These socialization and biological experiences have implications on the social set-up and lead to varying identities. Identity is defined by most dictionaries as who someone is or the qualities and beliefs that make a particular person or a group different from others. Thus, some people are addressed as old women, old men, criminals, peacemakers. Names are passed on from generation to generation and in the Ghanaian culture, tribally, most children are named after their ancestors in order not to lose their identities. Hardly would parents name their wards after criminals in their ancestral lineage.

In the cultural identity, it is expected that people within the same culture may hold similar beliefs, values and ideas. In that sense, identities would differ from one culture to the other. People within a particular society having similar cultures assign names to identify individuals, objects and events. People's identities may change based on their positions at various times which could lead to a corresponding change in gender roles but being male or female cannot change unless under surgery as explained earlier. Two potential stereotypical change agents are the parents at home and the teachers in the school environment.

2.2.2 The Home: Gender Issues and Challenges in Africa

Discussing issues on gender about Ugandans, Kwesiga (2002) explains how parental attitudes limit females' advancement through higher education which includes pursuance of technology-related programmes. With customs and traditions being very well upheld in Africa in general, she expresses that parents generally have been noted to be apprehensive about the status quo of their female children getting altered thereby changing the female's traditional practices and roles within society. Under the cultural norms especially in Ghana, girls are mainly associated with the domestic chores as reviewed earlier. Mothers therefore feel that they might lose 'assisters' (helping hands) in the house leaving them (mothers) to take charge of all the domestic chores single-handedly if they overlook traditional norms.

It was also explored that the Sub-Saharan African (SSA) society expected all females to marry and play roles expected of wives. In view of this, most societies reasoned that women needed just enough education to see them through marriage successfully. As a result, when given the option and under limited resources, the fees of a boy in the family would be paid first. This was revealed in a research conducted by Kwesiga (2002) in Uganda. In that research, a student from Makerere University remarked that his father ordered that his sister constantly stay home and assist the mother with the farm-work until there was enough money to cater for her later. Statistically, in that survey by Kwesiga, whereas 34% of parents opted for payment for sons' schooling, 11% opted for girls, whilst the rest (55%) had no preference. Thus, Kwesiga (2002 p.167) states that: "parental attitudes are the biggest determinant, very distinct from other obstacles which might include division of labour, customary practices and unavailability of institutions".

In a similar project by Female Education in Mathematics and Science in Africa (FEMSA), recorded by Hari (n.d), the findings from four countries in Africa including Ghana showed that parental attitude and support has a great deal of influence on females' participation and success in the study of science, mathematics and technology (SMT) subjects. How does this manifest? With interviews and discussion conducted by FEMSA, marriage was considered a great issue. Parents were found to have discouraged their sons from marrying female science graduates as they felt that such females would not respect their sons especially those who were non-scientists. Again, the parents and community members also considered the duration of scientific studies too long thereby reducing the chances of their daughters getting husbands and making it difficult for child bearing. Most communities and the parents thought that the prolonged duration of females' education in the sciences was considered as a waste of time and money since females would eventually be married off and their education benefitting only their husbands and the families they would be married to. Many of the parents in that research expressed that the males would take care of them during their old age thus, providing them with a sense of security. Females, they further enumerated are likely to get pregnant without completing their education therefore wasting the money spent on them. The FEMSA researchers also found out that domestic chores piled up unto females led to lateness and tiredness in class. Meanwhile, Science and Mathematics were noted to be time-tabled in the morning and most girls were severely punished for lateness. The girls also miss vital portions of these important foundational subjects of technology-related programmes due to lateness. Furthermore, another issue that emerged in schools particularly in Ghana was how those females who performed well in the STEM disciplines were regarded as witches.

2.2.3 Gender and School Culture

The school and the classroom is the one place where females are expected to obtain maximum encouragement and motivation to pursue their academic interests to the full. However, too often the school has remained another wall against female attempt to catch up with the males in the study of the STEM disciplines with respect to classroom-practice and attitudes of teachers. Various reasons have been ascribed to the apparent gender differences in the schools in the study of science-related or technology-related programmes. It is therefore important to review how the attitudinal and cultural differences in schools create gender roles.

Writing under school's culture within the context of America, Clarke, Hall, Jefferson and Roberts (1975) identify culture as one of the reasons for females' low participation and low performance in STM in schools. Skelton, Francis and Smulyan (2006 p.425) quote Clarke et al's (1975 p.10) definition of culture as:

> The peculiar and distinctive way of life of a group or class, the 'meanings', values and ideas embodied in institutions, in social relations, in systems of belief, in mores and customs, in the uses of objects and material life ... the map of meanings that make things intelligible to its members

Explaining the word 'meanings' in the above quotation, Skelton et al (2006) highlight the classroom as a microculture of an overall gendered school culture. The culture of the school is to be understood as the broad culture resulting from interactions and interpretations of individuals and groups of the society as active agents. This is so because schools do not exist in vacuum and so cannot be considered as enclaves operating separate entities from that outside their walls. Thus, to ensure maximum participation and successful development of more participatory policies and practices, there is a need for a shift in school cultures (Black-Hawkins, 2014). It is very important to understand the relationship between values and beliefs supporting classroom learning and also valuing diversity (Prosser, 1999). Each school was claimed to have its own culture which might definitely reflect a gendered atmosphere referred to as 'gender regime' by Kessler, Ashenden, Connell and Dowsett (1985) in Skelton et al (2006). Such a regime found in every institution defined aspects like the organisational management, relationships, disciplinary schemes and curricula issues. Mac an Ghaill (1994 p.4) cited in Skelton et al (2006) refers to the inhabitants of institutions such as teachers and students as the "key 'infrastructural mechanisms' through which masculinity and femininity are mediated and lived out as they actively negotiate and reproduce gender identities for themselves and others" (p.426).

The writers explain that the words 'negotiate' and 'reproduce' quoted in the passage above took two main forms of the school culture to carve the identities of students. These were segregation and gendered-teacher-student interactions. Right from the kindergarten through elementary school to secondary education, Skelton et al (2006) analyse how the play items such as airplanes, guns, home making equipment, different sports and rules of games depicted 'invisible' but real boundaries of segregation on the school environs. Thus, all over the world, gender-appropriate behaviours were portrayed at school and in the classrooms. The writers further explain how segregation is exhibited almost everywhere vis-à-vis, arrangement of names in the register, seating in the classroom usually with girls taking the front role irrespective of height and many others. Play patterns and prayer sessions usually take similar format and in most classrooms boys and girls were not to be seen chatting amongst themselves. Christine Skelton confirmed this by disclosing how in her school days, boys and girls of her class were hardly on speaking terms. One cannot however conclude without research whether this might have detrimental effect on students' future scientific and technological endeavours especially where collaborative work in practical work may be involved. Again, it is inconclusive that those with mixed seating arrangements in schools at the basic level for instance may disregard stereotypical attitudes in their future activities. The writers explain further that mixed seating arrangement was similar to Chinese norms where teachers and parents' concerns were on their female children's likelihood of getting attracted to the opposite sex thereby diverting their attention from schoolwork at puberty.

The patterns of task assignments given by teachers were also found to differ. Whereas girls were usually assigned responsibilities related to domestic or clerical tasks like sweeping the classrooms or picking the garbage, boys were often assigned more authoritarian and leadership roles like monitoring the class during teacher's absence or taking message to the head of the school. Skelton et al (2006) emphasise that these have serious consequences on students' evolving identities and subjectivities which might lead to their adult lives. Teachers' gendered-interactions with the students noted to cut across all levels of education including universities were also critically observed by the researchers.

2.2.4 Stereotypical Gendered Teacher-Student Interactions

Women are noted to contribute significantly to the world of science. Marking the 3rd international Day of Women and Girls in Science, the UN Climate Change Executive Secretary Patricia Espinosa noted that women have made significant contribution to the world of science. as an instance, she cited a number of women who had risen above the glass ceiling amongst which included Tu Youyou of China as the discoverer of the anti-malaria drug artemisinin (UNESCO, 2018). Women are however totally under-represented in scientific disciplines and estimates suggest that around 35 percent of all students enrolled in the STEM-related fields are female (UNESCO, 2018). A study conducted in fourteen (14) countries revealed that the possibility for female–students graduating with Bachelor's, Master's and Doctorate degrees respectively in the science-related fields are 18%, 8% and 2% whilst the percentage of male-students are 37%, 18% and 6% respectively. The US Secretary General Antonio Guterres stressed the importance of making efforts and taking concerted, concrete measures to overcome stereotypes and biases that prevent women from realizing their optimum potential. Closing the gap is considered crucial for achieving the UN's sustainable developmental goals and meeting the promise of the 2030 Agenda to "leave no one behind".

Stereotypical issues and biases take diverse forms. Skelton et al's (2006) research findings in Australia, UK and USA were categorised into quantitative and qualitative differences of teachers' interaction with students. On the quantitative difference, boys were found to receive more attention than girls in both teacher and student-initiated interactions at all ages up to 20 years. Teachers were more interactive with boys on more academic topics which might have been classified masculine and more with girls when the topic was classified traditionally as feminine.

Qualitatively, teachers' remarks portrayed boys as intelligent and therefore able to think analytically. The teachers' expectations for boys were high therefore rewarding them with complimentary expressions such as 'brilliant', 'sparkle' and 'unique' (Skelton et al, 2006 p.15). These are believed to be high performance compliments that boosted male students' confidence at the expense of females who received little. Teachers' praises to girls were observed by to be less enthusiastic and less meaningful. The writers did not specify the sex of teachers attributed to the variation in remarks but this attitude was also confirmed by the research findings by VanBelle-Prouty (1991) from Francophone Central Africa which revealed that some teachers normally called the least capable female student to the board in front of the class to solve mathematical problems. When completed unsuccessfully, the teachers called the most able-male student to assist. By this the teachers confirmed the supremacy of male students to females in mathematics.

In a research on barriers to females' studies in higher education, Kwesiga (2002) also reported that teachers' attitude was ranked least though found to be a major factor to students' education be it low or high level. This has also been emphasised by Skelton et al (2006), Harding (1996), Warrington and Younger (2000). In tune with most Chinese teachers, parents perceived innately around the world that girls were unlikely to succeed in mathematics and science but rather talented in languages and other arts subjects. These stereotypical practices and notions found in most institutions condoning the social constructionist's ideology, seem to be greatly internalised or ingrained therefore becoming very difficult to erase. Whenever an opportunity crops up to find myself in male-dominated institutions particularly the polytechnics, inquiries made as to why females are absent from courses such as Plant and Refrigeration, the usual response is, *'it's a man's course'*. The pertinent question is: Are women gender-activists progressing in the area of science-related disciplines or are they fighting a losing battle nationally? One would have contemplated that with the contemporary advancement in technology over the 21st century, such stereotypical issues would have been relegated or minimised completely.

In analysing the experiences of women executives in Nigeria who have risen above the glass ceiling, Chovwen (2003) expresses that the 20th century has witnessed an increasing number of women in management positions. Chovwen, however, stated that though the increase has afforded the opportunity for most women to realise their potential, the fact remained that traditional beliefs about the roles for women and men exerted much influence on employment opportunities and experiences of women. Chovwen (2003) admitted that although changes in women's hierarchical position in management have begun to erode the stereotype of cooperate women referred to as low-in-status, due to the relegation to supporting or clerical positions, the stereotypical change has not been profound as expected. This was acclaimed to prevail in male-dominated areas like engineering.

Oyewumi (2003) explains that gender issues were imported from Western culture to Yorubaland and imbibed gradually so the stereotypical change might also take a while. Oyewumi however, might be referring to the theoretical documentation of gender issues since women's subordination and inferiority positions acclaimed by various societies in Sub Saharan Africa (SSA) have lived with Africans over generations as the literature portrays. Definitely, gender views cannot be changed overnight as expressed by Appiah and Cusack (1999) in concluding their book of readings on violence against women in Ghana. To these researchers, to get around obstacles presented by prejudices, biases and stereotypical attitudes, one must set up some procedural strategies to formalise the *'right way'* (p.176) in dealing with issues. Protocols and policies formulated which become management tools could be used to directly challenge individual's behaviour for not honouring duties. Appiah and Cusack (1999) recommend formal and informal agencies as supporting protocols in resolving violence but then point out a limitation to that approach due to time required to train both staff and personnel associated with the informal systems. Kwesiga (2002) in contrast to what Chovwen (2003) earlier raised, doubts if females' statuses could ever be eroded and for that matter, perhaps stereotypes getting extinct at all. She views under Ugandan's perspective that women's under-participation in the sciences is due to the low status placed on females' access to education and other resources. She assumes this based on the inaction taken to address the gender issues despite stakeholders' awareness of the low participation. It is however gratifying to note that some African universities are motivating their female students into engineering. This has been explained later under 'Interventions'. This might have culminated in appreciable research pattern by females internationally as noted in Table 2.1.

An extract comprising five countries in each continent reported by UNESCO (2020) has been tabulated to show the performance of women in scientific research and publication currently in Table 2.1

. Table 2.1: Women in Science's Percentage Statistics in Research and Publication

America				**Europe**		
Country	**Year**	**Percentage**		**Country**	**Year**	**Percentage**
Trinidad and Tobago	2017	55.9		Latvia	2017	52.2
Argentina	2017	54.1		Croatia	2017	48.4
El Salvador	2017	38.6		Sweden	2017	32.6
Columbia	2017	37.4		Germany	2017	27.9
Chile	2017	34.4		Netherlands	2017	26.4
Africa				**Asia / Pacific**		
Country	**Year**	**Percentage**		**Country**	**Year**	**Percentage**
S. Africa	2017	44.9		Myanmar	2017	75.6
Uganda	2014	29.8		Thailand	2017	49.7
Tanzania	2013	29.8		Kyrgyzstan	2017	46.5
Ghana	2015	26.1		Pakistan	2017	37.5
Ethiopia	2017	11.5		Iran Islamic Republic	2017	31.2

Source: UNESCO (June, 2020) Report on Women in Science; UIS Statistical Fact Sheet No 60

2.2.5 Women in Scientific Research and Publication

According to Table 2.1, America leads the statistics of women's scientific researchers. Though not necessarily applicable to women, Bardi (2017) explains why so many Americans win the Nobel prize followed by Europe. According to him, there is strong historic investment in basic science research and academic freedom for researchers in

America. The government also does not always seek immediate results thus; she is patient to see results. On the part of South Africa excelling in publications throughout African history, Wild (2017) explains that although more than 80% of South African's population is black, its academic sector has remained disproportionately white and this is a legacy of the apartheid era. Over the past decade however, a study has shown that the proportion of black South African researchers has risen steadily from 26% in 2005 to 35% in 2015. The study, which was published in Higher Education last stated that the proportion of white academics decreased by more than 10 percentage points over the same period, to 49% in 2015. The inference from this is that it is not only the white populace producing the enhanced statistics in research. South Africa has maintained a lead in Africa falling by just fractions from the figure recorded in 2015 (UNESCO, 2018) as 45.0% as compared to the recording of 44.9% by UNESCO (2020).

As adduced from Bardi (2017), transformation could take place in all countries with increased investment as noted of the American government earlier. This might have consequential positive effect on females in STEM in Ghana. Ghanaian women have also enhanced their research and publication status from 18.3 percent (UNESCO, 2018) to 26.1 percent as shown in Table 2.1 with a percentage increment of 7.8.

Bebbington (2002) on participation by women under UK's context however expresses that there might be a problem with the scientific culture (SCu) in general. Mbarga (2007) also explains this SCu from an African's point of view.

2.2.6 Scientific Culture (SCu) in Africa

From Cameroons, Mbarga (2007) expounds SCu as the science which takes a stance towards a melding of folklores and customs with modern science. Mbarga describes a range of meanings in modern science with the application of these sciences to people's ways of life. He explains that SCu has newly emerged in Africa and acquisition of its knowledge in a school system has been noted to be ambiguous. This is so because the associations of science with folklores and customs were normally linked with pre-colonial African societies. Mbarga continues to explain that Africans in general place priorities in the development of other areas such as the economic and political fields of interests at the expense of science. He enumerates what has been circulating in intellectual circles of Africa being classified as "one vast museum" (Mbarga, 2007 p.390) without giving any reason. Actually, according to the Oxford Advanced Dictionary, a museum could be defined as a "building in which objects of artistic, cultural, historical or scientific importance and interest are displayed" or an "out of date or obsolete thing or person". The inference could therefore connote that Africa is considered crippled and deficient in scientific initiatives, creativity and innovation. The continent could therefore be viewed as a displayed, static piece of ornament.

Mbarga's reference-free article, highlights the absence of policy of scientific culture in Africa, the worrisome and deplorable conditions of tools, instruments, facilities such as libraries, documentation centres and lack of subscriptions to specialised magazines. He also bemoans the lack of scientific cultural camps and radio clubs emphasising that the few radio stations were likely to discuss issues which did not manifest scientific interests. This cannot be wholly true as gold-mining, pottery, architectural designs for instance have improved in their aesthetic appeals over the years in Africa. The extent to which females are involved in these is worth questioning though.

Apart from governments' initiatives as deduced from Mbarga's contribution, it seems most traditional beliefs draw individuals back from SCu but the submission of Mbarga could be debated since some individuals in Africa manufacture vehicles and other machinery. In Ghana for instance, Kantanka's manufacturing company where vehicles are assembled proves the ingeniousness of a Ghanaian scientist or technologist.

2.2.7 The Role of Language and Social Change

In the interactive processes, language is noted to form a major element in the societal construction of issues. Language is explained by Kramsch (2009) as a tool used for exchange of information and has the power to create and shape symbolic realities like values and perceptions. Language, as further elaborated by Kramsch (ibid) creates socially shared realities or cultures. Edwards and Potter (1992) cited in Burr (2015) as well as Harré and Stearns (1995) term language and social change as Discursive Psychology (DP). DP is the study of psychological issues from a participant's perspective. It investigates how people practically manage psychological themes and concepts such as emotion, intent or agency within talk and text. DP shares anti-essentialist or natural view of a person and therefore "denies that language is a representation of, or route to, internal mental states or cognitions such as attitudes, beliefs, emotions and memories" (Burr, 2007 p.13). Some Discursive Psychologists (Harré & Gillett, 1994; Harré, 1995a) debate the existence or nature of things and their particular concern is to study how people use language as their daily 'discourse' with each other. Another concern is to reveal how people are adept at using their linguistic skills in building specific accounts of events, which may have implications on those interacted with.

Language is explained by Burr (2015) as a way of expressing the internal states such as thoughts and feelings to other people. Language is thus, used to express existing and non-existing things in nature. Language is therefore not a physical entity but an invention from the mind. There is a relationship between language and thought as well as language and action. Human beings' experiences and consciousness are structurally determined by the way that language is structured. The meaning of words and the use of words are bound up with social practices that interact with each other. Words have got their own social meanings in the context in which they are used. Such social constructionists' view of language has been influenced by one Austrian-British philosopher known as Ludwig Josef Johann Wittgenstein who was noted to coin the term 'language game' for the use of various words in different contexts: thus, the language and the action to which it is woven (Burr, 2015). Wittgenstein maintained that mathematicians are inventors and not discoverers and that the power of language to bring about change in the thought process lies in the hands of those who want to effect change. Citing an example with 'disabled persons', Burr (2015) explains that one is considered disabled if one has no means of ascending a staircase for instance. If an elevator or any other provision is made to enable the disabled person gets to the destined floor, then the language would cease to be 'disability' since the objective of getting to the floor has been achieved. Thus, the term 'disabled people' signals that people's disabilities are socially constructed through the values and practices of their societies. By using language, action could be taken to address every issue. That means, language has a performative function. It brings about changes for example, pronouncing someone as the winner of a particular competition. From this analysis, it could be deduced that in academia, language through policies formulated could segregate courses to be pursued under female and male options and this is sometimes done in a subtle and optional manner.

In another vein, Potter and Wetherell (1987) in Burr (2015) explain language in terms of interpretative repertoire. They describe this term as a broadly discernible cluster of words, descriptions and figures of speech which are often assembled around metaphors or vivid images. Such repertoires are used in justifying particular versions of events or validating one's own behaviour. Such justifications according to these writers are sometimes done to fend off criticism or allow people to maintain a credible stance in an interaction. Although the repertoires that people dwell upon may have implications beyond the immediate social situation they are engaged in, such implications and their consequences may not be the intentions of the speakers themselves. People are usually unaware of the consequences of their spoken words. Some of the repertoires used in schools in Ghana for most females who decide to pursue programmes in the sciences are '*Yaa Asantewaa', Margaret Thatcher, 'Obaa kokonine'* (literally translated as female-rooster), *Obaa barima* (female/male) and a witch. On hearing such terms, most females are put off. Consequently, they are usually found towing the line of what most females are expected to pursue in the society - often, the social skills.

The constructive performative use of language is known to have been applied to a number of psychological phenomena such as memory, emotions and learning disability (Edwards & Potter, 1995; Edwards, 2009). Shroyer et al (1995) have also commented on the pedagogical approaches being accountable for females' low participation.

2.3.1 Pedagogical Strategies and Female Technology-related Studies

Pedagogy is explained by Ushpa (1990) as one of the important subjects a teacher trainee has to learn to become an efficient teacher by understanding the psychological aspects of children in their learning process, the techniques as well as the use of the tools for successful teaching. Thus, pedagogy could also be described as the methods and strategies for teaching. Through these methods and strategies, a teacher is able to device a very good lesson plan that will suit the students. Pedagogy could be student-centered where the responsibility for learning is placed on the student, rather than the top-down instruction from the teacher where the teacher controls every aspect of the lesson and lectures with minimal participation by the students. The student-centered classes help students to become more independent and more responsible for how they learn. This has been discussed under the constructivist and constructionist approaches to teaching and learning earlier.

Regarding these pedagogic strategies, in a Ghanaian Television (GTV) programme, Ms Aidoo, on the 11th of March, 2015, expressed that one of the factors that account for the disinterest of girls in Mathematics is pedagogical skills. Similarly, Anamuah-Mensah et al (2007) expressed concerns about teaching pedagogy particularly with Pre-Technical Skills and Mathematics in the findings of a survey aimed at preparing pupils for future employment. In that survey, no female teacher was found to have qualified in Pre-technical skills or Mathematics nor teaching those subjects. The researchers assumed that these subjects may be considered difficult, uninteresting or lack job relevance.

At the fifth graduation ceremony of the African Institute for Mathematical Sciences (AIMS Ghana), Professor Jophus Anamuah-Mensah, Former Vice Chancellor of the University of Education, Winneba (UEW), made an observation in his speech as

Academic Director of AIMS *(*Anamuah-Mensah, 2017) that publication in Mathematics, Astronomy and Computer Sciences is negligible in Africa despite the fact that these disciplines constitute the foundation for socio-economic development. Speaking to the forty-seven (47) students made up of eighteen (18) females and twenty-nine (29) males drawn from 19 African countries who graduated with Master's degrees in Mathematical Sciences, the Professor analysed that Africa was richly endowed with mineral reserves but the continent was not rich because the raw minerals were extracted but processed in other continents, depriving the continent of industries and jobs. African Governments were therefore urged to focus more of their efforts and resources on building a strong scientific and mathematical foundation to rise above such challenges. He further stressed the need for the graduates to use the skills and knowledge they have acquired to influence trends in research and innovation in order to transform the continent. He stressed that: "You cannot fail the generation to come after you. As highly trained mathematical science graduates, one of your greatest interests should be to demystify mathematics to both young and old" (Anamuah-Mensah, 2017 p.1).

By expressing views under Learning Management Strategies, Eschenbach, Cashman, Waller and Lord (November, 2005), also discuss that it is worth considering that all participants can learn and this brings important insights and experiences into the learning experience. This would promote active learning of something new by all students irrespective of gender. In view of this, Cashman and Eschenbach (2004) suggest that physical space should be conducive to student-student interaction from the K-12 classroom that would transfer to engineering education in future. Cashman and Eschenbach further explain that the application of hands-on activities in laboratories has been known to increase students' confidence in their problem solving. Students especially females should be provided a general outline of a problem to solve, have access to some tools and then left to work in groups to design their own approach to solving problems. Students find such problem solving approach very compelling. This empowers them to design the experiment, analyse the situations, present their presentations under the real world" aspect of the problem. Though Cashman and Eschenbach (2004) further express that students are sometimes overwhelmed, by the end of the course, they show that their confidence in many areas addressed by the class has increased. Another technique to empower students as continued by these researchers is to frame examination and homework problems to include real scenarios. This approach empowers students by providing them a sense of responsibility in using their knowledge for a purpose.

Additionally, in an interview question on what teaching methods should be used to effectively engage girls in the fields of STEM, Oort-Strang (2018) explained that new methods of teaching must be based on '*Gamification*' (game-based learning). Thus, every student should have fun and therefore feel at ease when learning. That helps retention and makes learning more interesting leading to participation and engagement by girls. Vijayan and Joshith (2018) has therefore annotated 50 innovative teaching methods worth employing at the basic and second cycle stages of education to motivate females into STEM. Three (3) of these, closely associated with game-based learning are: Hands-on Learning, Story-Telling and Role Play**.**

2.3.2 Hands-on Learning, Story-Telling and Role Play

Hands on Learning is emphasised by Vijayan and Joshith (2018) as the best teaching method invented that involves active participation of students in experiencing scientific concepts rather than just having an audience view. Schools promote the use of low cost apparatus in classrooms to help students to have hands-on learning experience. Citing as an example, a string telephone could be employed to teach sound and communication whereas a matchstick mecanno could be used for teaching three-dimensional structures. In storytelling, since students love to hear stories, a teacher could explain the facts of Biology or the laws of Physics in the form of stories. Human brains as further noted by Vijayan and Joshith (2018), can remember stories than just plain facts. Some teachers could therefore present the whole concept as a story or the introductory or concluding sessions of teaching. They consider role playing as an innovative method which is turning out as an integral part of science education since students could intellectually and physically engage in activities while learning a new concept. As an example, the researchers illustrated how a group of students can take the role of atoms or molecules to study a chemical reaction or representing a scientist's group to demonstrate a particular scientific law.

Smith (2016) supports these approaches and further explains that evidence and opinions on a number of affective factors that relate to girls choosing Physics for instance may include: students' interest, career aspirations, curriculum relevance, teacher effects, single gender groupings, perception of difficulty and impact of assessment practices on subject choice. Again, in the final report of the Ministry of Education's (MoE: May, 2014's) committee set up by the Ghana Education Service (GES) to investigate science and mathematics education in Ghana, amongst the major conclusions highlighted were teacher preparation and pedagogy. The committee stated that: "The acquisition of appropriate pedagogical skills is needed to inspire and excite pupils in Science and Mathematics learning" (Ministry of Education, 2014 p.30). What could be considered as appropriate pedagogy?

2.3.3 Appropriate Pedagogy / Inquiry Method

In a joint publication for sustainable development of education in Africa, Anamuah-Mensah et al (2006) discussed issues under the importance of teacher education in Ghana. They emphasised that the sector (teacher) of education is responsible for human capital hence it plays a pivotal role in the production of the workforce. They enumerated a number of issues to be taken into consideration including a link between theory and practice, the balance between methodology and the subject content. Thus, the mentoring system and a longer period of practicing by the teacher and many others especially the policy on reflective practice, portfolio development and action research writing instituted by the UEW were enumerated as an issue pivotal in helping to address some of the developmental issues of the teacher. In consonance with these researchers, another committee set up by the MoE (2014) to oversee issues regarding pedagogy recommended that teachers should use inquiry approach of teaching which emphasises practicable teaching and learning in Ghana.

The inquiry method could be related to the constructivist approach to teaching and learning whereby students are actively involved in the learning process. Dewey's constructivism theory of learning for instance concentrates on the sustenance of inquiry learning. Vygotsky also introduced the "zone of proximal learning" whereby students are noted to solve problems within their level of potential development. They could then go beyond that developmental level to make learning appealing to both sexes especially females. Bruner is known to have initiated curriculum change based on the fact that learning should be active and a social process in which students ought to construct new ideas or concepts based on their current knowledge.

Many STEM classes are noted to be conducted in large lecture halls with associated laboratories, where the emphasis is on the memorization of content and prescribed procedures rather than the use of STEM reasoning, practical work and applications to broader contexts or real-world issues (Weaver, Haghighi, Cook, Foster, Moon, Phegley & Tormoehlen, 2009). Weaver et al explain the importance of encouraging a shift from pedagogy in terms of "teaching" to the one that considers "learning" as the primary goal. This allows educationist to link pedagogy with learning outcomes, student experience, and assessment. To change the learning environment requires shifting the pedagogical culture to one in which students feel supported, connected and informed; where high performance would be valued and rewarded. Teaching methodologies in various courses should include active learning, collaboration, problems/issues-based and critical thinking.

In order to facilitate a shift to pedagogies that engage the learner and promote collaborative team work, researchers such as Franzoni and Assar (2009) emphasis that classroom spaces should be redesigned with additional spaces that allow for informal learning in groups to ensure the nurturing of student communities' development. Since in the inquiry method, there is a focus of pedagogies that engage the learner, recent research on the learning process has shown that students tend to learn in different ways preferring to use different teaching resources as well. Learning materials must not just reflect the teacher's style, but should be designed for all categories of students and all kinds of students' learning styles. The content of the teaching should match the students' learning styles (Franzoni & Assar 2009).

Adding to brain lateralization to be discussed later, psychology and cognitive sciences have explored that humans have different ways of learning - some can assimilate in a better way the knowledge received visually, while others by auditory sense. In Beacham, Elliott, Alty, and Al-Sharrah (2002) and Sarfo's (2015, unpublished PhD) thesis, Dual Coding Theory is explained as how information is processed through one of the two usually independent channels. While one channel processes verbal information such as audio, the other one processes visual information like diagrams, images and animations. "The left cerebral hemisphere is thought to be more verbal, logical or clinical, that is, more analytical, while the right cerebral hemisphere influences the artistic and the sensing side of our intellectual faculty" (Weaver et al., 2009 p.15).

Dual encoding therefore refers to 'Whole brain' learning which involves the presentation of information both textually and verbally. This is known to be a more effective way to learn. Sarfo (2015) explains how powerful such encoding and visualization techniques have been in enabling the creation of lasting memory and improving recall. When the two halves of the brain are connected, the potential of the brain for learning becomes great and creative. If the teaching style employed closely matches the student's preferred style of acquiring knowledge, learning becomes easier and more natural which results in improved learning at a reduced time (Weaver et al, 2009). If a student is more verbal than visual for instance and everything is written on the board without auditory resources, the student would experience difficulties in attaining the pedagogical goals in the requested time. The traditional teaching style and strategies generally tend to benefit some students more than others. Adapting to each student's individual style might prove difficult especially with a large class system with diverse learning styles by students. However, the method is known to enhance females' learning of the sciences (Weaver et al., 2009). The reasons for these trends of learning are not due to students' performance or their attitudinal attributes. These writers explain that the trends are closely linked to an early loss of interest in science and the selection of the STEM subjects. Students also become overwhelmed by the pace and load of the curriculum. To reverse these trends and attract students to STEM careers, one of the suggestions made is to reform the pedagogy and culture of teaching in order to create exciting and engaging STEM learning experiences for all students. The specific means of the reformation was however not detailed by Weaver et al. Perhaps the load could be reduced and the pace of delivery made moderate. Zuga (1999) cited in LaPorte et al (2010) explains that technology teaching must incorporate females' ways of knowing and experience. Structures of subject matter according to her, need to be changed as humans continually recreate the disciplines upon which they are based. Since the behaviour of humans changes to meet the needs of various categories of humans, educators ought to create classrooms in which all can learn. Weaver et al (2009) therefore express that teachers ought to use teaching styles that address disparate needs.

2.3.4 Teaching Styles

Although Weaver et al (2009) did not discuss the specific styles, perhaps teachers could consider students within categories called 'differentiated instruction'. This is where the teacher keeps all the students in mind during the preparation of the lesson plan, setting of questions and delivery. Thus, the teaching must be learners' focussed or centred in an atmosphere that is all embracing to every student without compromising the teacher's strength or ability (Gill, 2016).

Other methods including the constructivist approach is known to favour extroverted group-oriented students who dominate activities shared in the class as compared to the introverted. There could however be a balanced-mix of teaching style where gifted students and those with attention deficit and the slow learners are engaged adequately if not equally. Although Gill (2016) explains that teachers' teaching styles are not alike, an effective teaching style engages students in the teaching and learning process and also helps them to develop critical thinking skills. Five classic teaching styles noted by Gill (2016) are: the authority or lecture technique, demonstrator or coach style, facilitator or activity style, delegator or group style and hybrid or blended style. Other methods including the constructivist approach is mentioned.

The demonstrator incorporates variety of formats including the use of multimedia presentations, lecture and demonstration. The facilitator style helps students to develop skills through questioning and exploration. This facilitates the teaching of the sciences. Delegator style is best suited for lab work like chemistry and biology. The teacher in this style is regarded as a consultant. This is considered as a modern style of presenting teaching. The hybrid style is also considered appropriate in that the teacher's interest and personality are blended to present an integrated approach to teaching. The teacher in this case is supposed to tailor the teaching to students' need and the appropriate subject matter. The hybrid is noted to present too many things to the students thus the teachers doing minimal job.

Educators should keep up with societal change hence, Zuga (1999b) and LaPorte et al (2010) explain that: technology teachers need to study feminist texts related to science and technology, and rethink their own philosophies and views in technology. They further share that in teaching, values inherent in technology must be addressed so technology education must not be approached as series of processes and techniques that are taught in isolation of the effective values which accompany all human activity. They are further recommending the study of technology from a social reconstruction perspective by blending the cognitive and affective aspects of technology in order to improve that sector for all children This would improve the society and ensure value-laden activities incorporated in the selection and organisation of the curriculum of institutions. It would also ensure participative-inquiry-driven classroom (Zuga, 1999 in LaPorte et al. 2010). In effect, students would not be dependent on the status-quo solely for creation of knowledge. Females' knowledge would be based on re-constructed activities. Whether a teaching style could be more inquiry and re-constructivist-based to appeal to females or not, leadership is essential.

2.4.1 Leadership's Influences on Females' Technology-related Education

Bilen-Green, Froelich and Jacobson (2008) and Boateng (2012) attribute females' low participation in STM to leadership's influences. Boateng (2012) for instance, reports that a number of reforms such as that implemented in 1987 in Ghana by leaders have not seen much impact in terms of female technical or technology-related programmes. She affirms in an article that: "restructuring programmes are in place to improve the quality of provision and learning outcomes to make it more accessible and attractive to all, and to ensure it is relevant and connected to the world of work" (p.108). Her article does not concentrate on subject disparities but rather educational re-structuring. She therefore emphasizes that the success of policies on reforms towards the restructuring of technical, vocational education and training (TVET) especially in Ghana, depends largely on leaders responsible for generating ideas and formulating policies as well as those responsible for transforming policies into practice. She suggests the need for Ghana to pay attention to providing leadership programmes and guidance to current leaders, new and aspiring administrators and managers of technical vocational education (TVE). Such developmental programmes, she emphasises, should aim at cultivating individual's vital attributes and characteristics that would encourage participation in TVE programmes. That would also lead to a reformation of activities in the change process. Boateng's (2012) assertion above emphasis her point of educational reforms intending to make the technical and vocational sectors attractive to all. This connotes the inclusiveness of the two sexes. Although she did not specifically stress a restructuring in gender, her inputs on leadership insightfully raise pertinent issues that could promote active participation by females in technology-related programmes through leadership styles or programmes by institutional heads. Her paper could have elaborated a bit on how leadership could enhance participation by females in the technical sector of education which is overtly dominated by males. She could also have highlighted some styles like transformational leadership which could cause changes in individuals and social systems. Burns (2015) explains that changes redesign perceptions and values thereby changing the expectations of employees.

Owusu-Mensah et al (2014) also report about the extent to which leadership promotes transformation towards achievement of goals. One of their research findings at Manhyia sub-Metropolis in Kumasi affirmed that "the survival of educational institutions is dependent on leadership" (p. 106). From these analyses, it could be adduced that female technical education could be encouraged by the form or style of leadership adopted in institutions.

Kouzes and Posner (2007) suggest five practices of exemplary leadership or behaviours that are: Modelling the Way, Inspiring a Shared Vision, Challenging the Process, Enabling others to Act and Encouraging the Heart. Within these practices, ten commitments of leadership trends that showcase real-life success stories of leaders in applying each practice and/or commitment are described as follows: With the first practice of 'Modelling the way' two commitments expected by a leader are: clarifying values' and 'setting the example'. Kouzes and Posner (2007) suggest that leaders must find their voices and affirm shared values in order to clarify values. If leaders are unable to find their voices, they "will end up mimicking others and never gaining the integrity to lead" (p.49). By their own voices in sharing their values, a promotion of loyalty, teamwork and a strong sense of the goal at hand are assured. To set the example, leaders need to personify the shared values and teach others to model the team's values.

Relating these practices to the educational structure that was particularly recommended by the educationist Dzobo to introduce practical skills at the basic level for all-inclusive practical education, female education in technical seems to have been less emphasized in Ghana. The weight or value placed on that sector is lesser than that on general secondary schools. The latter have been uplifted with careers that are more attractive to the stakeholders. The other leadership practices and commitments have been reviewed later in the next chapter.

Bakar and Mahmood (2014) also researched into the significant relationship between transformational leadership and performance of academic leaders in higher institutions. Although the aim of their study was to explore the relationships between transformational leadership style, corporate entrepreneurship and the performance of academic leaders in the public higher educational institutions (HEIs) in Malaysia, it was worth taking a cue from the research because one of the commonly accepted tasks of transforming HEIs to higher performance is effective leadership. The writers explained that leaders are in the positions of power. They influence and manage human, physical, financial and various other resources which provide crucial support toward higher achievement and success (Bento, 2011; Yukl, 2010; Gappa et al, 2007).

Achua and Lussier (2010) also discuss styles including autocratic, democratic, transformational, laissez-faire and charismatic leadership. Autocratic managers, they stressed, are not known to be climbing today's corporate ladder. The laissez-faire leadership shows expertise in interpersonal, informational and decisional roles. A democratic leader has been noted to be flexible. A charismatic leader is known to possess traits including communication skills, visionary attributes, integrity, humour, trust and delegation of authority. One such charismatic leader noted by Bell (2013) was Ronald Reagan.

Historically, Governor Guggisberg was able to implement the sixteen (16) principles of education in Ghana perhaps, based on the status-quo established in British Educational System but not necessarily on any leadership style. Since that time, various policies enacted have seen Ghanaian educational system metamorphosed through several transformations similarly based not necessarily on any leader's style but recommendations made by committees set up. The discussion therefore tilts specifically towards transformational leadership which undoubtedly can boost interest and enrolment of females in technology-based programmes.

2.4.2 Transformational Leadership

Kouzes and Posner (2007), describe a transformational leader as a person who stimulates and inspires (transform) followers to achieve extraordinary outcomes. Ifeanyi and Odumery (2013) also explain that a transformational leader creates positive change in the followers leading to each member acting in the interests of the group as a whole. The concept of transformational leadership was introduced by James Macgregor Burns in 1978 in his research on political leadership. The style connects followers' sense of identity and self to the goals of the organisation or the project to be undertaken. The followers are asked to transcend their own interest for the good of the group or organisation or society thus, illuminating social constructionist's theoretical framework. Leaders practicing transformational leadership view themselves as *primus inter pares* (a Latin phrase indicating the most senior or a first amongst equals) and followers as associates (Gardiner, 2006). Transformational leaders therefore have influence on followers and followers react with devotion, affection, admiration and extraordinary esteem for their leaders (Pastor & Mayo, 2004). Key behaviours of transformational leaders may include: articulating goals, building an image that demonstrates confidence and arousing motivation. Beside leadership, mentoring and role-modelling have been noted to promote or create enabling environment towards pursuance of technology-related programmes by females.

2.4.3 Mentoring and Role modelling: Promoters of Technology-related Studies by Females

Mentoring could be a formal, in-person experience or it can take place over the occasional electronic-mail (Ragins & Kram, 2007). These authors further express how technological advancement has promoted remarkable opportunities by establishing mentoring and mentees' flexible relationships. Electronic-mail, social media, specific e-mentoring sites such as Braincake and MentorNet connect females of all ages, interests and experience levels together. Online-mentoring has been noted to improve mentee's written communication skills and eliminate some of the pressures of meeting face-to-face. Intimidation by the mentee is less which leads to the freeness and willingness to asking questions, offering opinions and seeking support. Engaging professional women and developing ongoing mentoring relationships are noted to be key strategies in promoting females' STEM studies (Ragins & Kram, 2007). Weaver et al (2009) suggest that to maintain students' interest in STEM studies, there is a need to develop strong mentoring and supporting programmes for students along the path to graduation. Writing under the importance of mentoring, the American Association of University Women: (AAUW, 2010) emphasis that there is a need to promote a better sense of fit and belonging among faculty and departmental members. Mentoring helps to address the feelings of isolation and marginalization that females in academic settings often report.

In a survey, women rated the importance of formal mentoring significantly higher than men. Trower (2010) explains that mentoring is crucial for females in STEM for without it, females "might not be privy to the 'good old boys' club or behind the scenes conversations that are crucial to fitting in the department and to getting tenure" (p.71). It is believed that informal relationships arise organically and the females feel more natural, closer, more trusting and honest being devoid of a formal process. This is especially important to women in STEM, who are often in a numerical minority in their departments. Formal and informal mentoring of junior faculties are important in supporting the integration of females into STEM departments. Formal mentoring programmes should be monitored and evaluated for effectiveness. Departments should foster informal mentoring by encouraging senior faculty members to actively reach out to junior members (AAUW, 2010). AAUW further discusses the importance of mentoring in encouraging females to see their success in high school mathematics and science not just a requirement for going to college but also as an indication that they have the skills to succeed in a whole range of STEM professions.

Bogan and Safer (2004) also report that mentorship has been noted to be more important for females than for males because males normally get associated with senior individuals in accessing career opportunities, while females tend to look for mentoring relationships outside their workplaces or their formal lines of authority. Although the mentor could be of either sex, Bogan and Safer (2004) further argue that males are less likely to fully appreciate a female's perspective on work-family conflicts and issues of child bearing. Females, therefore feel at ease discussing such issues with females. The writers explain that females' close relationship with males at work could lead to misinterpretation though this does not imply an entire disassociation from males. There is also a need to strategise towards mentoring students of the opposite sex. In a research in Nigeria, Aderemi, Hassan, Siyanbola & Taiwo (2006), support their respondents' preference of male mentors despite being females. Their preference was based on the reasoning that male mentors were better connected to the right networks. Female mentors therefore need to tighten their networking skills to complement their mentoring fully. Arguing about the emerging issues on this subject in higher education, Morley et al (2006, p.10) also state that:

> Mentoring as a form of staff development is gaining international recognition. Mentoring is conceptualised as providing support and guidance, with mentors seen as critical friends - often in environments that are experienced as alienating or mystifying.

As a critical friend from the quote above, the significance of role modelling which is similar to mentoring has been related to Elizabeth Blackwell who in 1849 became the first woman in the US to graduate from medical school in Geneva Medical College which became Hobart College in New York. In January 2003, marking the 154th anniversary of her graduation, Bogan and Safer (2004) reported that over the intervening years, females have certainly become much more highly represented in medical schools in the US. Suter (2006), Xie (2006) and OECD (2008) therefore express that the lack of female role models to emulate, discourage females from pursuing STEM programmes and careers. In that vein, making inferences from Elizabeth Blackwell's achievement, Bogan and Safer (2004, p.305) state that:

> The number of female medical students has grown with a near constant acceleration since 1969. For example, in the 1949-1950 academic year only 7.2% of the total enrolled medical students in the United States were women. By the 2000-2001 academic year, 44.6% were women.

This significant increase in figures clearly substantiates the importance of role modelling in scientific endeavours for females. Quite a number of research projects have been conducted on the value of female role models in science-based programmes. Farland-Smith (2009) in a research, observed that when middle-school girls are exposed to female scientists as role models, they develop more positive attitudes towards science-based careers. Martin's (2011) analyses of STEM research projects at university faculties also demonstrate that females' interests in faculty work was mostly affected by career and salary satisfaction. Career satisfaction was driven by perceptions of equity, workload, and the nature of the work itself. Salary satisfaction was not always aligned with the amount of salary received but driven by flexible career paths such as those including opportunities to take breaks to care for the family. The survey therefore revealed that females pursuing especially computer science at the college level can gain exposure from women in STEM careers who are balancing family responsibilities successfully with their careers. Martin (2011) therefore explains that such women role models can boost female students' confidence and provide counterfactuals to negative stereotypes. Carrel (2009) also studied students in STEM classes at the Air Force Academy and found that high ability female students who have their introductory STEM courses taught by female instructors perform better in STEM and are more likely to receive a degree in STEM disciplines.

In America, Lockwood (2006) supports the promotion of young female members of parliaments (MPs). In a speech, citing 26-year-old Jo Swinson an MP as an example, she explained how that would inspire more women into politics and other male-dominated fields. Lockwood supported the view of females being in a position to appreciate the views of female role models more than males since they are of the same sex. In her speech, Lockwood (2006, p.46) remarked that:

> Outstanding women can function as inspirational examples of success, illustrating the kinds of achievements that are possible for women around them. They demonstrate that it is possible to overcome traditional gender barriers, indicating to other women that high levels of success are indeed attainable".

Such outstanding females however, hardly avail themselves to other women in their fields of specialization. A role-model is "a person upon whom an individual patterns his or her behaviour in a particular social role including adopting appropriate similar attitudes" (Scott & Marshall, 2005 p.571). The definers explain that role-models need not necessarily be known personally but they play essential role in encouraging females into higher education. In analysing a survey on a resident psychiatric training, Bogan and Safer (2004) found out that whether a senior resident nurse was interested in academia or pursuing a non-academic career, the presence of a role model was considered valuable particularly in transiting from training to developing and cultivating their professional identity.

Although role-modelling is found to be very important in encouraging girls into technologically-based careers, Bebbington (2002) notes that most females' works are not given the recognition deserved. It is not only in the female-dominated fields that women's contributions have been undervalued but females' work in the scientific, male-dominated fields too. The most obvious example noted by Bebbington (2002) of patriarchy and social closure is that of Rosalind Franklin. Franklin was known to have played a key role along with James Watson, Francis Crick and Maurice Wilkins in the discovery of DNA (deoxyribonucleic acid); yet, Crick and Watson became highly successful academics while Franklin remained in obscurity until her death from cancer at the age of 37. Anne Sayre, her biographer, shows how Watson and Crick stole Franklin's results and failed to acknowledge her contribution thereby ensuring that she did not receive recognition (Sayre, 1975 quoted in Bebbington, 2002). Beside these mentorship and role modelling, the undergoing are some efforts made through interventions for possible adaptation or addressing certain lapses.

2.5.1 Interventions

A simple definition of intervention by Merriam Webster's dictionary is the act or fact of taking action about something in order to have an effect on its outcome. Intervention, from the Latin word '*intervenire*' means to come between or interrupt (https://vocabulary.com/dictionary/intervention). Positive intervention is aimed at making things better or intentionally intruding into a difficult situation that needs amelioration. Haralambos et al (2004) express that society is complex and sometimes efforts to change it yield unintended consequences. They however admit that society cannot be entirely pinned down since an attempt to understand it can at the same time change it. They therefore note with a subtitle 'Steering the juggernaut' that:

> Lack of intervention is even more likely to end in calamity for the society. With care, there is a good chance that the high consequence risks that threaten modernity will be avoided, and that human society will progress further (Haralambos et al, 2004 p.981).

Nationally, in Ghana, to redress the gender imbalance by females in STEM at the basic and second cycle levels, an inception of an annual Science, Technology and Mathematics Education (STME) 'Clinics' from 1987 was initiated. Through STME, an attempt was made to check the apparent myths surrounding the study of the sciences. Females who participated showcased to the entire public their products which were mainly vocational and technical. The Clinics proactively whipped up enthusiasm in the girls especially when the resource persons interacted with them.

Further, in a Weekly Spectator newspaper article, Ampadu-Nyarko (2017 p.23), described how the Regional Manager of Plan-Ghana a Hyundai Motor Company awarded automatic scholarships to females who enrolled at the Hyundai-KOICA Technical Institute in Koforidua to study Automotive Engineering. Plan-Ghana and Korea International Cooperation Agency also offered aids in terms of machinery that eased up mechanical operations thereby attracting females into the Institute. Continentally, similar programmes were put in place.

In Tanzania, Lihamba et al (2006), report how affirmative action (AA) programmes instituted have yielded positive results. They used the phrase AA to refer to laws, customs and social policies that had the intention of alleviating the discriminations that limit opportunities for certain groups in certain situations. AA was thus, a concept for advocating "active engagement in the deconstruction of conventional and usually institutionalized norms and values that informed discriminatory behaviour and practice in society" (Lihamba et al, 2006 p.582). Pojman (1998) explains that AA was a political attempt to actively dismantle institutionalized or informal cultural norms and systems that had been ascribed to certain groups leading to their disadvantages and therefore inequalities as well. These led to people being classified according to their identities such as by gender.

From 1996 through 2003/04, AA saw improvements in enrolment from 16% to 27% in the sciences and 7% to 13% in the Engineering at the University of Dar es Salaam

(UDSM) (Lihamba et al, 2006:583). The expansion was achieved by reviewing key policies, university records and reports specifically focusing on the initiation and progress of AAs. Male and female students, academic staff and policy makers were interviewed to find out how these primary stakeholders gauged the AA initiatives. Observations were conducted in classrooms and the assessment of behaviours during staff meetings and seminars facilitated the unspoken and subtle gender messages arising from members' and people's interaction in changing the environments.

Again, Institutional Transformation Programme (ITP) aimed at improving gender mainstreaming among the staff and students of UDSM such as Pre-entry Programme (PEP) was established. This was a six-week remedial course run to assist females who wanted to enter engineering and statistical programmes and also passed the entrance examination to university. From 1997 to 2004, 486 female students had benefited out of this programme. Also, Preferential Admission Criteria (PAC) and scholarship programmes in science disciplines had different cut-off points for the two sexes of students. Whereas the matriculation point for BSc (Chemical processes and Mining) Engineering had PAC points between 6.0 and 9.5 for females, it was 7.5 upwards for males (Lihamba et al., 2006 p.585). The other disciplines such as BSc (Land Management & Valuation) also had 8.5 and 6.5 respectively for males and females revealing reduced points to ensure females' participation.

Further organs of AAs included Female Undergraduate Scholarship programme (FUSP) funded by the Carnegie Foundation, the Swedish International Development Agency (SIDA) and the Swedish Agency for Research Co-operation (SAERC) for developing countries (Lihamba et al, 2006). Although the Human Resource Development and Trust

Fund (HRDTF) operated shortly from 1997 to 2003, it favoured females in the promotion of enrolment into engineering programmes.

Muhwezi (2003) explains how since Uganda's independence in 1962, males enrolled in secondary schools outnumbered females from the time formal education was introduced by the colonizers and Christian Missionaries. She attributed these gender disparities in the educational system to historical and cultural factors that regarded the male sex as being more important than the female. Some of the socio-cultural hindrances that affected females' education included early marriage, pregnancy, and parents' attitudes which favoured the males. The educational structure underwent several modifications and the total number of secondary school students in 2001 got to 539,786 out of which 237,972 (44.1%) were females. Until the 1990s, only Makerere University existed in Uganda (Kwesiga, 2002). Higher education (HE) was noted to have grown so rapidly since the 1970s with the enrolment increasing from about 5000 students in 1975 to about 55,000 in 2000 (Kasozi, 2001). This indicated an increase of about 2000 annually and might have emerged out of the formation of the foundation for equality in education by the Castle Commission in 1963 when the need for equality dawned on the educational system (Muhwezi, 2003). Female enrolment shot up from 23 % in 1989 to 35 % in 1999 and reached 41 % in 2002 (Makerere University Academic Registrar's Records). An AA strategy employed to promote females' HE included a bonus of 1.5 points since 1990/91 academic year to females who qualified to enter public universities. This was known to have increased enrolment by a third of eligible female candidates although the figures fluctuated between 30 and 35 percent. A female scholarship scheme was also launched in 2001 with support from the Carnegie Corporation of New York to motivate female students from disadvantaged schools and rural areas. The package covered tuition, accommodation and special faculty expenses.

Although increase in enrolment of females was of special concern at Makerere, it was not specifically aimed at any particular field of specialisation such as the STEM disciplines. Mbarara University of Science and Technology (MUST) would have revealed the gender differences in disciplines but Muhwezi (2003) notes that at Uganda Technical College (Elgon), females formed 3% of the total enrolment - an average of 6% at Bukalasa and 21% at ITEK. Muhwezi recorded 3% in Engineering at Makerere, 12% in the science teacher training, 16% for pure science undergraduates and 27% for medicine (Kwesiga, 2002 p.222). Females who were admitted to Kampala Technical Institute who could have entered university to pursue engineering were also noted to have dressmaking (traditional course) as their main subject (Kwesiga, 2002).

Ghana's attempt has already been reviewed under STEM at the background of the study. An extract from UNESCO (2018) statistics on women researchers in the science disciplines has been shown in Table 2.1 earlier. Four countries were selected from each continent noted and Ghanaian women though not so appreciative is nevertheless encouraging. The two Eastern African countries featured in this study (Tanzania and Uganda are forces to reckon with). South Africa has always been in the lead for the sub-Saharan African countries. All such female researchers could serve as role models to the females in science and technical fields. Despite the interventions made to enhance the enrolment statistics, generally, there are still barriers hampering the smooth studies by females in technology-related studies.

2.5.2 Barriers and Promoters of Females' Technology-related Studies

Besides Morley et al's (2006) issues raised as social barriers in the first chapter's background information, Michie and Nelson (2006) indicate that traditional gender role expectations regarding females' efficacy for higher technical pursuits and careers still persist. Relating this with Information Technology (IT), these researchers explain that the origin of the under-representation of technical skills especially in IT has largely been created through the social structures of institutions and segmentation of the labour market. The social structures set become internalized in values and beliefs about the appropriate roles and expectations. The writers uphold the essentialist perspective that significant differences exist between females and males. Most females hold some low self-efficacy regarding expectations of their abilities to get to higher laurels. Though there are no academic sex differences, Michie and Nelson (2006) further explain that the females' perspective of self-efficacy has been very low in IT and this might not be different from any other research conducted in the technical fields of endeavour.

Interest and low confidence may have a lot to do with students' sense of self-efficacy (i.e., their belief in their abilities). Pajares and Miller (1994) demonstrate that a sense of self-efficacy mediates the effect of both gender and prior experience on performance in Mathematics. In a research, their findings revealed that "the poorer performance and lower-self-concept of the female students were largely due to lower judgments of their capability" (Pajares & Miller, 1994 p.200). There also appears to be a chain of influential factors including expectations, interest, ability and stress which may shape females' sense of self-efficacy. These may affect their studies of STEM disciplines. Hackett, Ellis, Forster, McNicol and Macaulay (1992), identify self-efficacy as a powerful predictor of females majoring in engineering or science.

Importantly, self-efficacy just like spatial skills could be developed. Illustrating this, Fantz, Siller, DeMiranda (2011) found that engineering students' self-efficacy was significantly improved with participation in pre-collegiate engineering classes involving hands-on experiences, real-life applications and problem-based projects. Students' self-efficacy could be linked to confidence and interest in STEM fields of study. Possessing more confidence increases interest and, greater interest bolsters confidence (Denissen, Zarrett & Eccles, 2007). While females and males exhibit similar performance into the high school years, females express less interest and have less confidence in their mathematic reasoning and problem solving abilities (Catsambis 1994). Thus, females' low representation in STEM fields is likely attributable more to their sense of confidence and degree of interest in STEM fields than to their abilities.

Brainard and Carlin (1997) surveyed females who enrolled in a four-year college intending to pursue Engineering or Science degree and found out that these females began their higher education with strong academic confidence which however eroded during their first year of college. They gradually improved in later years (though it did not reach its original level even by the end of their fourth year; ibid). Females who left Science and Engineering most often did so in the first two-years of college, despite the fact that they had grade point aggregates (GPAs) equal to those who stayed (ibid). Brainard and Carlin (1997) further explain that their departure from STEM fields was attributed to general loss of interest, increasing interest in other fields, academic challenges and low grades (ibid). Stereotype threat also served as a barrier.

Stereotype threat is the fear of confirming a negative stereotype such as females' lesser abilities in the field of STEM studies (Steele 1997; Steele & Aronson 1995). Marx and

Roman (2002) found that women's performance on a challenging Mathematics test improved when the test was administered by a competent female experimenter as opposed to a male. Further, simply learning about a competent female experimenter could promote females' performance by protecting their self-appraised ability in Mathematics. Likewise, in an experimental study from McIntyre, Paulson and Lord (2003), females performed significantly better on a challenging mathematics test when told that they make better participants in psychology experiments than males do. Also, when females read about women who had succeeded in architecture, medicine, and invention, they perform better than when not presented with such examples of successful women in the fields of STEM (ibid). This may explain why female role models are instrumental for retaining females in STEM fields. Finally, in a recent survey in the American South, Cho, Goodman, Oppenheimer, Codling and Robinson (2009), showed eighth graders' images of females identified either as working in STEM or non-STEM fields and asked them whether they thought these women were good at their job, organized, intelligent, attractive, and creative? They observed that "students found the images of women in STEM career fields to be significantly more intelligent, significantly more creative, and significantly less attractive than images of women in non-STEM career fields" (Cho et al, 2009 p.4). That students were already so aware of STEM-stereotypes by the eighth grade suggests that STEM-interventions may be needed quite early in students' academic careers.

On the promoters or encouragers, one factor that may help females to succeed in STEM fields is sharing a strong STEM community. Experiencing a sense of community appears to be a central support for many female students. Legewie and DiPrete (2011) demonstrate that high school experiences including support for STEM's interests stem from peers, teachers, and parents. Apart from these promoters, high level of exposure to STEM courses and information about STEM's career trajectories also strongly influence females' attitudes towards STEM fields. Furthermore, Hausmann, Schofield and Woods (2007), examined students' sense of belonging and their retention in STEM fields at a four-year college and found that a feeling of belonging predicted students' intentions to persist. Peers have also been found substantial in shaping students' academic attitudes and college plans. Having friends majoring in the same course supports STEM students' outcomes and also increases females' orientation towards science in particular (Bachman, Hebl, Martinez & Rittmayer, 2009; Stake & Nickens, 2005). Thus, the influence of friends' interests and motivation become paramount when friends are females who study STEM disciplines (Buchmann & Dalton, 2002).

2.6 Conclusion

The second chapter has reviewed the theoretical, conceptual and substantive issues affecting females pursuing science or technology-related programmes. The main objectives set for the study have been woven into the review. Biological and cultural issues, pedagogical issues, interventions strategised by two African Universities in order to admit and sustain females' interest in STEM programmes together with national ones have also been reviewed. Issues that promote females' interest and those that serve as barriers towards the pursuit of technology-related programmes are included. The chapter has also reviewed the methodological underpinnings girding such a qualitative study.

The next chapter discussed the designing and the practical fieldwork for encouraging females into STEM disciplines. It adopted mainly Neuman's (2007) as well as Kvale's (1996) models for the conduct of interviews and observation within the five (5) sampled Ghanaian Universities.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This research is focussed on gender and technology and its primary goal is to find out what motivates females into pursuing technology-related programmes such as, Mechanical Technology.

The main problem was the declining numbers and low representation of females in the science, technology, engineering and mathematics (STEM) studies at the University level. This culminates in females' marginal representation in science-based professions**.** Hoffman and Oreopoulos (2007) for instance express that more males than females complete bachelor degrees in mathematics, physical and computer sciences and engineering.

To meet the purpose of this research, a qualitative naturalistic Inquiry approach (Lincoln & Guba, 1985 cited in Lundberg, Lundqvist, Hansson, Wentz & Sivberg, 2013) Lundberg et al, 2013) was employed since this study examined motivations demonstrated by the participants in the choice of STEM disciplines. The study thus sought in-depth knowledge by uncovering and interpreting the lived or retrospective experiences (Patton, 2002) of female students who are studying engineering or technology-related programmes in the sampled universities. Although quantitative methods may provide a much broader and generalizable set of findings, the qualitative methods used provided more depth of information (i.e., thick descriptions) that might increase our understanding of the phenomenon under study (Patton, 2002). Amongst the qualitative tradition, the phenomenological exploratory design was adopted and the research design was pivoted in Neuman's (2007) seven-step framework of research.

To gain the intended depth of knowledge for the research, two main instruments employed were observation and interviews. These were found suitable for the study as Patton (2002), discloses that phenomenological inquiry holds the assumption that there is an essence or essences to shared experience which might be common experiences shared amongst the students worthy of uncovering. Such shared experiences cannot be uncovered with quantitative research, hence interviews being appropriate tools employed were situated in Kvale's (1996) model of interviewing. Gunbayi (2020) expresses that face-to-face interviews and observations are usually the main instruments utilised for qualitative studies. Merriam (2009) also states that: "a phenomenological research is well suited for studying affective, emotional and often intense human experiences" (p.26).

Other philosophical paradigms found suitable and suggested by Gunbayi (2020) such as interpretivism was used for the analysis of data.

The structure of the chapter includes: research design, population, sample and sampling, instrumentation, data-gathering procedure including the pilot study, ethical issues, next steps and conclusion.

3.1 Research Design

The design in every research is the planning and making of all the integrated statements, justifying all the technical decisions involved in the planning before the research project is conducted. Bryman (2008 p.31) states that: "A research design provides a framework for the collection and analysis of data". Any well-developed design according to De Vaus (2001), should justify the selection of a particular design especially where other valid or alternative designs are available.

For the purpose of this research, a phenomenological exploratory qualitative and a non-experimental observational designs were found to complement phenomenological studies. hence these were employed with the forthcoming justifications:

The exploratory design guided the formulation of all of the research questions hence, all the research questions preceded with 'what, why and how? Neuman (2007) explains that exploratory research addresses the question under "what" in a social activity (thus what the problem is about). Some of the specific questions framed during data-gathering went beyond the '*what*' prefix to '*why*' and '*how*' in tune with Streb (2010) who explains that exploratory research is flexible and can address research questions of all types (what, why, how). The '*why*' was necessary to acquire knowledge in the reasons why the student-participants selected science-based subjects which pre-empted technology-related studies at the tertiary level. The specific questions asked by the researcher were geared towards responses that would reveal the essences or the central rationale for the choices of the female students' subject-areas in the pursuance of their courses or disciplines as phenomenology entails.

The suitability of this qualitative paradigm to this study lies in the fact that the study adopted neither pure scientific approach nor laboratory experimental research to prove issues that emerged from participants although it could still be considered scientific. Why? Science, according to Bryman (2008) was derived from the Latin word '*scientia*' which means knowledge which could be gained through observation, experience or practice. This research did not deviate from these since, laid down procedures to achieve these were followed. Knowledge gained from participants was through the conduct of in-depth research associated with words, feelings, emotions and other elements that are non-quantifiable. Male-participants were included for the following rationale:

- to prevent lopsidedness in gender issues thus, to ensure a gender-inclusive or sensitive methodology. General insight into gender issues by both males and females who live together and interact in all facets of life can lead to bridging the gap of the imbalance in enrolment.
- Dimitriadi (2013), explains that "change can be accomplished only by changing the operating systems of our institutions. A gender-inclusive approach is needed to include men as well as women in the discussion" (p.11)
- Dimitriadi (ibid) further expresses how the problem of females' low representation is not necessarily due to the existence of the stereotype threat but it

is seeping in the consciousness of both men and women around the world. This in effect acts as a natural barrier to young girls' career development in fields where they otherwise might have performed excellently very well.

In considering the research design, it was worth complementing the exploratory research with direct observation after identifying in the literature review that pedagogy is a challenge facing females offering technology-related programmes. In this direct observational design, the participants (lecturers and students) were aware of being observed thus, in-depth observation about the behaviours of the lecturers imparting knowledge to students was harnessed. This contrasts the quantitative observational practice where the research is considered unobtrusive since subjects are usually unaware of being observed (Atkinson & Hamersley, 1994). De Vaus (2001) discusses that the problem of a research determines the type of design used. A phenomenological qualitative approach was employed with the forthcoming explanation.

.3.1.1 Phenomenology

Phenomenology "is the study of subjective experience, an exploration of the world as seen through a person's eyes" (Burr, 2015 p.198). A phenomenological approach is based on how researchers understand the social phenomena from the actors' own perspectives (Kvale, 1996). Thus, the phenomenologist attempts to understand people's perceptions, perspectives and understanding of particular situations. Kvale (1996) and Patton (2002) describe how phenomenology was founded as a philosophy by Husserl and further developed by Heidegger. The approach is noted for clarifying the mode of understanding in qualitative research. This is how the social world is experienced by the subjects and how that world is perceived to be. A researcher might study the experiences of people caring for a dying relative and by studying multiple perspectives of this same situation, the researcher can *"make some generalizations of what something is like from an insider's perspective"* (Leedy & Ormrod, 2005 p.139).

Apart from the designs employed, other qualitative research designs such as action research, case study and ethnography could have been used for this research but Patton (2002) for instance explains that action research focuses on a specific problem and adopts a very narrow focus as a research. Bell (1993 p.8) also describes that a case study is usually used to narrow down a very broad field of research into one or a few easily researchable examples. Stake (2000 p.435) in Patton (2000 p.447) also notes that "a case study is not a methodological choice but a choice of what is to be studied". In the case of ethnography, the style of fieldwork studies cultures, beliefs, groups and their lifestyle and known to ensure prolonged stay with the group in studying their natural setting (Denscombe, 2007). Such a method of research as discussed by Leedy and Ormrod (2005) takes a lengthy period; sometimes for years to complete. This research could not therefore be considered under ethnography based on the time constraint and the inability of the researcher to meet full observer participation status. Though qualitative, Grounded Theory study as explained by Leedy and Ormrod (2005) and Bell (2008) could also be employed, it is least likely to start with a theoretical framework unlike the other qualitative research paradigms. Such a format would be in contrast to that adopted by the awarding University (UEW or Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development - AAMUSTED). Content analysis (CA) research is also qualitative but performed on human communication such as books, films and music. It uses strictly pre-coded instruments just like what prevails in the conduct of survey hence, sampling could be very large which may demand quantitative statistical data analyses contrary to the interpretative analysis.

In summary, based on the objectives, research questions and the type of data gathered, this research was conducted as a phenomenological exploratory qualitative study. It was aimed at ensuring greater level of depth of understanding of the experiences of those female-students who have studied the sciences and are now pursuing technology-related programmes. Qualitative data-gathering methods were found compatible with this study hence they were employed.

3.2 Population

The approaches adopted for the conduct of this research were to seek various views to interpret the widely perceived views of gender and low enrolment in science or technology-related courses. The population, universe or sampling frame which could be defined as "an aggregate of all cases that conform to some designated setoff criteria" (Blaikie, 2010 p.172) for this research comprised two (2) public and three (3) private universities and university colleges (Appendix 5). The boundary of the population which refers to those included and those not included in this research comprised all the students offering applied science programmes such as, Mechanical and Computer Engineering and the lecturers in the sampled departments. The total student-population of the departments was 383.

3.3 Sample / Sampling

A sample is a selection of elements or segment of members from the population that is chosen for the investigation. Data-gathering for this research was based on qualitative paradigm, hence the number of respondents or the sample-size was relatively low unlike research that relies on quantitative data-gathering techniques. Out of the student-population of 383, fifty-three (53) were sampled. Eight participants comprising five females and three males for each of the six departments were purposively sampled. Five additional participants comprising three females were sampled for the One-to-one interviews. Additional five (5) lecturers sampled, led to a sample-size of fifty-eight (58). The schedule of distribution is tabulated at page 148.

The sample-size was cut down in consonance with what Kusi (2012) explains about sampling. To him, a pragmatic factor to be considered about the sample-size, especially by students conducting small scale research is that they should 'select a bite size' instead of an 'elephant size case'. Again, he emphasis that since there is difficulty in researching the entire population which is usually quite large, it is appropriate to consider geographical convenience, such as, proximity and accessibility to the study site. From experience too, in qualitative research one does not necessarily select a large sample size, since the data collection procedure (mainly interview and observation) yields massive amount of data in the expression of views which would lead to transcription of volumes of text. In this research for instance, transcription covered over thirty pages which really took over three months to complete. Again, it was really disheartening dropping some of the responses because although quite a number of responses were repetitive, the reasons given revealed variety of ideas that emerged from most interviewees. Sampling a large number might therefore diminish the ability to provide an in-depth picture of findings.

This might have led to incomplete analysis of the data since despite the repetition, all responses were transcribed irrespective of the time and other research constraints. There was also no scientific qualitative data-analysis software such as NVIVO, QUALPRO, the Ethnograph (Kusi, 2012; Merriam, 1998) to facilitate data-analysis as noted for quantitative research. The researcher learnt later that NVIVO (a scientific package) could have been used during the data-collection exercise and not afterwards.

Before the main research, a pilot-testing was carried out with eight participants. Although this was not outlined in the steps in conducting research outlined by Neuman's (2007) framework for methodology, it was considered appropriate since it eased some methodological challenges in the main research detailed later.

3.3.1 Piloting the Research

This research was pilot-tested with Level-200 and one Level-300 female Mechanical Technology Education students from 23rd to the 26th of January, 2017 at the College of Technology Education -Kumasi (COLTEK) of the University of Education, Winneba now AAMUSTED. The population of the Level 200 class was 29 and all the three females of the class agreed to participate. To beef up the female enrolment, one Level 300 student was also sampled. Eleven males decided to take part in the piloting but four were selected because the research was focused on females hence the males should not outnumber the females. The other males unselected were ethically assured of their inclusion in subsequent research projects. How was the piloting carried out?

Having held a discussion with a female lecturer at the Faculty of Technical Education at COLTEK, a pilot observational study was agreed upon but the period coincided with the

Council for Technical and Vocational Education and Training's (COTVET) programme for competency based training (CBT). The female lecturer was a participant amongst the twenty trainee staff to cater for the ten technical, vocational education and training (TVET) Colleges mapped out for the CBT training module. The observation unlike the questionnaire and interview was therefore not piloted. Experience gained professionally during teaching practice observation informed the observation. The items developed for instrumentation were adopted from the Flanders Interactive Analysis Category (FIAC) schedule and the teaching practice supervision schedule developed by the Centre for Teacher Development and Research (CETDAR) of UEW.

In the piloting, two females and a male were sampled for the focus-group discussion whilst two males and the other female completed the open-ended questionnaire. One female student from level 300 and a male were sampled for the one-to-one interview. In all, eight students comprising four females and four males took part in the piloting as shown in the schedule at Table 3.1.

Table 3.1: Schedule for Piloting

Date/ time of piloting	24th January 1-2.30pm	25th January 2017 4.00 – 6.00pm	26th January questionnaire administered at 4.00pm. Returned on 30th January 2017
Activity	Focus group semi-structured interview	One-to-one semi-structured interview	Open-ended questionnaire administration
Participant/s	Two (2) females and one (1) male	One (1) female, one (1) male	One (1) female and two (2) males
Total	3	2	3

Venue	Researcher's office	Researcher's office	
Sample-size for piloting		**Eight (8)**	

3.3.2 Procedure for the Piloting

The piloting was preceded by the conduct of the focus group semi-structured interview at the researcher's office. The one-to-one interview followed the next day at the same venue. The questionnaire was administered on the 26th but returned on the 30th of January, 2017.

The piloting provided a lot of methodological ideas and approaches which led to the identification of quite a number of possible practical difficulties in the main research. Both the individual face-to-face interaction and focus group piloting helped to correct some of the ambiguities that would have occurred. A typical example was when some student-participants tried to find out how to choose from the tertiary education indicated on their informed-consent questionnaire. Again, having held the piloting sessions in the researcher's office, there were a lot of interruptions since students ignored the instructions on the door "*meeting in progress, no disturbances*"! As a result, in the main research, the conference room of VarsA (pseudonym for one of the universities researched) was offered for the interaction and disturbances were totally curbed. In other Universities too, the Heads of Departments' offices were offered but in their absence. Though the interviews for the piloting did not last for long due to the limited number of participants, they nonetheless assisted in unearthing a lot of information during the main research. Issues such as females considering the boarding of vehicles with equipment such as 'drawing boards' was found to be a great concern why most females detest such technical or technological programmes. The administration of the questionnaire was dropped upon realizing that all the themes formulated for the specific items could be infused into the other instruments for in-depth study. Questionnaires are also normally associated with the conduct of surveys for quantitative research.

A grave limitation was that the sampling procedure was not properly carried out during the piloting since interested students were just asked to raise their hands in one of the lecture periods. Upon reflection, this procedure was a flaw because, had the three females who were the focal points for the study refused to raise their hands, the objective would have been defeated. To improve upon this, in the main research, the procedure and the timing for the various schedules were carried out with the assistance of the Heads of Departments and their class representatives without coercion as detailed later.

3.3.3 Reviewing the Items after Piloting

The duration anticipated for the focus group interview with the students was prolonged. This might have been due to the numerous probes, although probing was minimized in the main research for some of the universities with a large number of foreigners as has been detailed later. Questions about leadership were found to be less interesting to the students. In the questionnaire, the questions under the policy that could be enacted were not comprehensively responded to by the respondents perhaps due to lack of clarity or insight into leadership issues and policies. Being open-ended, this might have put the respondents off since they might have been used to the Likert-scale type of responding to questionnaire-items merely by ticking. Realising that the responses in the questionnaire were quite similar to the responses in the focus group discussion, the questionnaire administration was dropped to pave way for in-depth research with the observation and interview.

The digital voice-recorder failed in the initial recording of interview during the piloting but, in the main, backups in the form of charged mobile phones and spare batteries for the digital voice-recorder were made readily available to forestall any eventualities. After the piloting, COLTEK was excluded from the main research. If COLTEK was to be engaged further, an appeal would have been made to the students who participated in the piloting to keep the information away from other students. On the other hand, a different class within the faculty would have been approached because it would have been difficult to trust students in that direction. Again, due to lack of female students beside the three that participated in the piloting and the other from Level 300, a different class would have been sampled. Kusi (2012) explains that sometimes when the piloting is done within the context of the study, there is the likelihood of the interviewees informing their colleagues about the interview. Having fore-knowledge about the information could lead to predetermined responses during the actual study.

3.3.4 Sampling in the Main Research

Although permission was granted by eight universities for the conduct of the research, two were dropped and this did not lead to any sampling error especially with the conduct of a qualitative research. This is in compliance with Cohen, Manion and Morrison (2003) who explain that a sample must not be less than 30 percent of the entire population in social researching. Three regions selected out of the then ten (10) gives 30 percent which is appreciable for qualitative research. For the purpose of this research, the two public universities were referred to as VarsA and VarsB whilst the three private universities were referred to as VarsC, VarsD and VarsE. Three of these units are in the Greater

Accra region, whilst VarsB and VarsE are in the Northern and Eastern Regions respectively.

Out of the fifty-eight (58) participants sampled from five universities, only two sampling units (VarsA and VarsE) had full complement of the proposed staffing. Kruegar (1994) explains the need to limit the members in a focus group discussion between five and nine participants. This will ensure effective control of the participants. The researcher decided to sample eight which is not quite different from the maximum nine. At VarsE, student-participants were from two departments (pictures of one of the two focus-group interviews at Appendix 13). At VarsB, only one male lecturer was available for the observation leading to two females and three male lecturers taking part in the study. One-to-one interviews were conducted at VarsC and VarsA respectively with two (2) and three (3) student-participants.

The decision to sample small numbers for this research was not necessarily due to difficulty in scheduling large numbers based on time constraints or difficulty of controlling large numbers or financial constraints as mostly noted by researchers such as Denscombe (2008). It was rather due to the nature of inquiry thus, in employing qualitative techniques, in-depth information about participants was sought rather than breadth of sampling as found in surveys. It is undoubtedly the case that in a research, the larger the sample-size the more precise the findings could be but, this works in probability or random sampling where generalization is the core especially in quantitative research. With a large sample size in qualitative research, it becomes difficult to record and also capture input from all participants regarding the instruments used especially interviews. A sample-size of fifty-eight was considered manageable as presented in Table 3.2 below. This became a necessity in support of Denscombe (2008 p.3) who states that:

> A good social research is a matter of 'horses for courses' where approaches are selected because they are appropriate for specific types of investigation and specific kinds of problems. They are chosen as 'fit for purpose'. The crucial thing for good research is that the choices are reasonable and that they are made explicit as part of any research report.

Table 3.2: Sampling in the Main Research

Participant/s	**Observation of teaching by lecturers**	**Post-observational interview with same lecturers**	**Focus-group interview with students**	**One-to-one interview with students**	**Questionnaire administration**	**Total Sampling**
Initial Proposal for the main research	Two (2) females, one (1) male = 3	Two (2) females, one (1) male = 3	Three (3) females, Two (2) males = 5	three (3) females two (2) males = 5	Five (3) females, two (2) males = 5	Initial sampling (18 participants each x 8 Institutions) = 144
Participant/s	Observation of teaching by lecturers	Post-observational interview with same lecturers	Focus-group interview with students	One-to-one interview with students	Questionnaire administration dropped	
Revised sampling after piloting.	Two (2) females, Three (3) males)	Two (2) females, one (1) male	5 females, 3 males - (8) for each Department	Three (3) females, Two (2) males = 5		
Final **total** sampling	Five (5) lecturers		CUC 8 ANUC 16 (8+8) VV 8 UG 8 UDS 8	2 3		**Final** sampling for five (5) Institutions
Sample-size	**5**		**48**	**5**		**58**

3.3.5 Sampling Procedure for the Main Research

In considering the procedure for sampling in the main research, all the females who in most cases were found to be far lesser than the males in the population for each Department were selected purposively upon initial discussion on mobile phone with the HODs. The Heads of Departments (HODs) linked the researcher with the class representatives. Preliminary discussions on phone was carried out with the class representatives who were directed by the researcher to purposively select five females and three males pursuing the course. The sample was therefore 'hand-picked' (Denscombe, 2008 p.17) because the researcher knew something about the specific people with the help of the HODs and the class-representatives. The selection was based on those likely to produce the richest or valuable data. These were students who pursue applied science or technology-related programmes.

The non-probability or non-random sampling employed was the overriding technique in contrast to the probability or random sampling technique because qualitative researchers often use that sampling since that yields most information about the topic under investigation. Kusi (2012) and Merriam (1998) emphasis that fact and Kusi (2012) further discusses three main types which are the extreme or deviant case, maximal and the homogeneous.

In this research, the homogeneous selection was made since, all the students have science as their background. Within this homogeneity, the specific sampling was carried out through snowballing. Such sampling emerged through a process of reference from one person to the next. It started with the HODs to the class-representatives whose phone numbers were offered by the HODs, then snowballed to the other participants. This led to an accumulation of numbers (though small size).

The extreme sampling was not selected because its selection is usually based on an exceptional case, for instance, studying abysmal performance of some students in a particular discipline. The maximal variation too is selected to study individuals who display different dimensions of certain characteristics, for example, studying various categories of teachers who hold varying certificates. Such a selection could be the Certificate A or B holder, Diploma and University teacher with a doctorate degree. The third one selected (the homogeneous) is done to study people with common traits. All these sampling strategies under discussion are usually employed on small-scale qualitative research where cost needs to be minimized.

Other examples of non-random qualitative sampling that could have been used include: theoretical, quota and convenience sampling. Theoretical sampling is based on the development of theory grounded in evidence. Quota sampling is similar to stratified but individuals are selected to fill quotas to represent relative proportions of specific characteristics. Convenience sampling is built upon a selection which suits the convenience of the researcher usually those closer to him/her. Easy access sometimes drives the selection process in this type of sampling and it is not regarded as a serious sampling strategy for rigorous social research. It has been argued that it runs counter to the rigour of scientific research since it adopts a lazy approach to research (Denscombe, 2008). Although one could classify the snowballing as convenience sampling, snowballing is more purposive than convenience since, one knowledgeable person recommends another. It was not very easy reaching the participants after the snowballing because the researcher had to spend time making several calls and explaining all the nitty-gritties associated with the research. Some of the participants were very difficult to reach since in some of the universities, it was getting closer to their revision week, hence their mobile phones had been switched off. The class representatives who served as initial liaison coordinators wanted to announce the research on their 'WhatsApp' mobile-phone platforms but this was objected to since, the sampling could have surged up and it could have created a great problem or embarrassment asking some of them to step aside. Again, each participant who agreed to take part was assured of confidentiality, so the idea of going so public would have defeated that ethical consideration.

One other reason for adopting non-random sampling technique for this research was that the research took place in the real-world setting, thus following naturalistic design hence, issues that were revealed by the participants unfolded naturally. There was no pre-determined course established by the researcher during the conduct of observation like that which occurs in a laboratory or other controlled setting. Patton (2002) explains that qualitative designs are naturalistic because the research takes place in the real-world setting.

In quantitative methods however, researchers select the subjects largely by random or probability sampling mainly to generalize from the sample to the population it represents. Some examples of these quantitative sampling strategies described by Kusi (2012) are systematic, stratified, and multi-stage. In systematic sampling, a member is selected at regular interval from the sampling frame. Males and females could have been proportionally stratified by ordering the sampling frame by one or more characteristics and selecting the same percentage from each group either by simple random or systematic technique. Since quantitative research is not the focus of this research, its sampling procedure has not been detailed. The next section discussed the development of the data-collection instruments.

3.4.1 Data-Collection Instrumentation

Data-collection was based on two main instruments namely: non-participant observation and interviews: semi-structured face-to-face (one-to-one) and focus-group discussion. The observation of lecturers' pedagogical skills to examine how science-related programmes are presented, was based on the Flanders Interaction Analysis Categories' (FIAC) checklist shown at Fig 3.1. Out of the ten (10) different categories propounded by Flanders (FIAC-1970), five (5) were utilized in this study. These included: accepting feelings (empathy), praising and encouraging (motivation), accepting or using the ideas of pupils (collaboration), asking questions (questioning) and lecturing (formal presentation)

These five categories are largely in consonance with Gill's (2016) five classic teaching strategies, namely: (1) demonstrator or coaching style; (2) facilitator or activity style; (3) delegator or group style (4) hybrid or blended style and (5) authority or lecture technique (Appendix 3.3). The strategies of these two authors (Flanders & Gill) employed by the researcher in the observational sessions were augmented by the teaching methodologies known as Intern Teaching Evaluation IRB3 Form designed by the University of Education, Winneba (UEW) for its students' internship programme (SIP: Appendix 6). In lieu of this, other points on the checklist were to find out issues such as: audio-visual support materials used, methods used, student/student interaction, lecturer/student interaction, gender-sensitiveness and student-participation in terms of collaborative work.

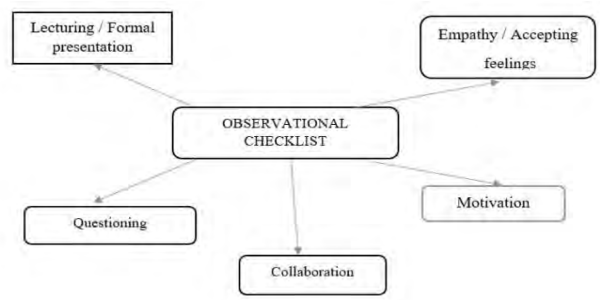

Fig. 3.1 FIAC's Adapted Observational Guide

The interviews encompassed all the six themes for the study namely: biological characteristics, socio/cultural issues, subject choice and pedagogical strategies, policies formulated, leadership's influences and interventions towards enhanced technology-related studies by females. The design was situated in the seven-stepped model by Kvale (1996) which are: Thematizing, Designing, Interviewing, Transcribing, Analysing, Verifying and Reporting.

At the thematizing stage, the purpose of the research was formulated, the concepts of the topic were clarified, the theoretical framework and the research questions were thought of. At the designing stage which Neuman (2007) also terms as 'Design Study', the planning on the details involved in the conduct of the research vis-à-vis - the type of interview to be conducted, their justifications specifically in line with qualitative research as spelt out by other researchers such as Merriam (1998) were discussed. The appropriate types of questions in line with the gaps identified in the literature were framed - thus, open-ended items (Appendix 9) regarded as relevant data were formulated and gathered.

The population, sampling, sampling procedure, sample-size as discussed earlier were determined for, until the design stage is through, one could not be considered as ready for the collection of data (Neuman, 2007). The venues for the interviews and the cost involved were considered after seeking informed consent from the participating departments of the sampled universities. A time-line was drawn to guide the research though it could not be critically followed. All moral and standard ethical issues were infused into the designing.

3.4.2 Justification of the Forms of Instruments Utilised

Regarding the problem identified for this research, and based on the primary aim**,** a non-participant observation was found to be appropriate hence employed. Observation as an instrument draws on direct evidence of the eye so it was best to be used to gather the pedagogical skills of the lecturers researched. By using the non-participant semi-structured observations in situ, a more comprehensive view of the setting was anticipated. Why? Though the unstructured participant observation is normally recommended for a typical qualitative method, that was not employed because, based on its unstructured nature, there was the tendency of recording trivialities as opposed to the significant events that occurred. Again, generally, participant-observation according to Patton (2002) takes a very longer duration since the researchers have to immerse themselves deeply in the research. Bell (2008) explains that researchers who adopt the participant unstructured observational method must be prepared to spend sufficient time familiarizing and accumulating data, postponing definitions and structures until a pattern has been observed. Ethnographers for instance are noted to normally adopt participant observation whereby they can study the participants in depth. Although an in-depth study was conducted for this research, it cannot be compared with the lengthy time-frame for the conduct of ethnographic or participant unstructured observation.

Another significant reason for conducting non-participant observation was with the use of structured observation schedule. Bryman (2008) explains that unstructured observers do not prepare observation schedule but rather non-participant observers. He states that *"structured observers are usually non-participant in that they are in the social setting being observed but rarely participate in what is happening"* (Bryman, 2008 p.257). In lieu of this, a structured schedule or instrument was designed with FIAC's (Flanders, 1970) principles in focus.

Within the form of methodology, the overt in contrast to the covert observation was designed and adopted. This was the case since overt observation discloses openness whilst covert conceals the purpose and the researcher. Thus, covert observation is an observation conducted secretly without making the participants aware of the purpose. According to Patton (2002), some of the ethical statements made by entities such as the American Psychological Association generally condemn deceitful and covert research. Covert research would have however revealed the natural behaviour of participants thus enhancing validity and reliability since Patton (2002) further explains that people normally behave differently when they are made aware that they are being observed. It was different in this research because no artificial behaviour was detected although in all cases, the lecturers introduced the researcher as a visitor for an observation exercise. If teaching methods or pedagogy in general has been noted to be corrupt, incompetently carried out therefore having negative impact on students, then perhaps covert observation could have been carried out. That would have proved difficult since no institution would permit a visitor to conduct a research without permission since in that case, the main purpose for the research would not be disclosed. Refusal to disclose the main purpose of the research however might be ethically insensitive to those participating in the research. Being an educational research with no such negative objective but just to observe variety of teaching methodology employed, and based on the relatively short time-frame, a non-participant overt observational study was considered appropriate.

Interviewing became necessary as they assisted in the acquisition of first-hand information from the participants just like the observation. Not every reason, feeling and behaviour could be observed during the observation of the teaching and besides, there was the likelihood of interpreting wrongly on inferences. Through the interviewing, the most effective means of generating perceived data interactively with people in order to gain access to how they reason and articulate issues was realised. Again, it was also a very useful means of using language in constructing knowledge and discourse. Mason (2002) expresses that knowledge-wise, interviewing is the best way of retrieving data in qualitative research. The interviewing was based on finding out specifically about 'people's perceptions, views and feelings and from an ontological point of view, interviewing people for such knowledge, understandings and experiences amongst others are meaningful realities of the social world. Denscombe (2007 p.174) notes that to "unearth these social issues one has got to talk directly with them".

What participants considered as an effective leadership style that could tackle the enrolment issue of females in gender-related programmes for instance was shared though marginal. Furthermore, the interviews conducted attempted to find out whether "females' ways of thinking" and knowing as discussed by some researchers such as Zuga (1999) could be considered a reality or mere illusion. A questionnaire for instance could have concealed very good information which could be revealed in the facial expression, hesitation and tone of the voices in the course of the interviewing. In that light, "a skillful interviewer can follow up ideas, probe responses and investigate motives and feelings, which the questionnaire can never do" (Bell, 2008 p.157).

In considering the types of interviews to be conducted, phenomenological studies were found to be compatible with the use of unstructured interview (Leedy & Ormrod, 2005) but, there was a need for slight modification to suit this research hence, semi-structured interviews were conducted. This was mainly due to the time-frame for the conduct of each interview. Interviews according to writers including Patton (2002) and Bell (2008), can take three formats namely, structured, partially structured and the unstructured. These could be respectively called formal or standardized, semi-structured or general interview guide and the informal conversational or ethnographic forms. In the highly structured form, the respondents answer simple predefined questions. Although this requires more time and work in the preparation stage, it is easy to record since all the responses are already coded. Quite often responses to such structured questions take dichotomous forms such as *Yes* or *No* or very brief answers. It is used purposely for market research or survey. This however gives little latitude for respondents' views and requires little thought which may result in giving of laissez-faire responses.

The unstructured form of interview with its limitless time-frame could lead to prolonged conversation but could offer valuable data but such interviews require great deal of expertise to control. Bell (2008) explains that the interviewees could give a lengthy response by being too verbose or repetitive since no predetermined questions are formally framed. This is so in order to remain as open as possible and adaptable to the interviewee's nature and priorities. It therefore has the danger of getting the main points or focus lost and not retrieved for the transcription and analysis (Patton, 2002). Other reasons abound for the adoption of semi-structured form employed which is the next to be discussed.

A partially or semi-structured interview with themes and their suggested questions was adopted because it allowed the interviewees more freedom and latitude compared to the pure structured-interview. With its adoption, an opportunity was created for making decisions by probing, prompting, reframing and altering of questions. Such flexibility allowed the interviewees to seek clarification of responses which would have been missed if a structured questionnaire had been administered. The follow-ups, probes and prompts used also yielded additional information on the study but these were minimized in some universities with the following reasons: In this research, quite a number of foreigners were found in the private universities and deciphering the words based on the intonation became a bit difficult hence, probing became challenging. Some of the Ghanaian participants who had been studying with these students almost always interjected the foreigners' contributions by clarifying the contributions made by them. From their utterances, it became an embarrassment but this was controlled with decent humour. This therefore led to minimal probes since the digital voice-recorder used had the intention of facilitating transcription with the numerous play-backs. Without its use, it would have been an arduous task transcribing the varied intonation. In such a case then, the written open-ended questionnaire would have been far preferable. Fortunately, although some of the sessions went beyond two and a half (2½) hours, none of the interviewees felt bored nor tired. The time however was controlled in order not to interact beyond three hours.

One-to-one and focus-group discussion were the strategies adopted for the semi-structured formatted interviewing. Both one to one and one-on-one are the most common interview techniques where the interviewer and one interviewee is present The one-on-one, is however, more of what applicants for employment or jobs for instance expect when called in for an interview. It is usually conducted by job interviewers and discussions are job-centered (Chron, 2021). This style of interviewing is typically more convenient for an employer and Chron (2021) further explains that applicants should try to learn about their interviewers in advance by taking the time to look them up on the company's website. The dressing by applicants too ought to be formal. The one-to-one is carried out in a more relaxed and conversational atmosphere with the interviewer driving the agenda. The interviewees need not gather any advanced information about the interviewer and, there is no need for formal dressing too. There is real establishment of rapport between the interviewer and interviewees in the one-to-one, face-to-face interviewing.

Really, in line with Denscombe (2008), the one-to-one interview type of data-gathering was easy to manage and retrieval of one person's information too was easy and straight-forward during the transcription. Most of the one-to-one interviews were conducted in the researcher's car with the windows rolled up and air-conditioner switched on. The sound from the appliance however distorted the responses slightly but with a playback several times, all the information could be retrieved. Locating specific ideas was straightforward and controlling only one voice at a time during the transcriptions was very easy. Again, the one-to-one interview conducted was comparatively noted to be very useful in cases where the information was so confidential like seeking the most preferred lecturers' pedagogical skills. It was however realised that the one-to-one responses tended to concentrate on the biography of the interviewees instead of them narrating general experiences. There was therefore, a limitation of the number of views and opinions available to the researcher.

The focus-group interviewing or discussion in this sense became very advantageous because the discussions sometimes led to consensus building or occasional disagreements which greatly enhanced the data-collection. It somehow minimised confidentiality in asking certain questions such as 'who is your favourite lecturer', 'why do you like or dislike him/her'? Also, in support with Patton (2002), sometimes in a focus-group interview, some participants amongst the group dominated the discussion depriving the shy or slower ones of giving out their responses which might also be beneficial. It was a little bit agitating always hearing the females stating that a male should start when thrown the option. Sometimes too, attempts made to control the dominant interviewees nearly led to controversies but these were skillfully controlled. Many participants however, could be interviewed within the limited time. Since issues of dominance surfaced during the piloting, attempts made in the main fieldwork to curb this dominance were superb.

The focus-group discussion adopted is slightly different from group interview in the sense that although both involve the use of more than one interviewee, whereas the former concentrated the discussion on a particular issue in this research - gender, researchers conducting group interview under certain circumstances would have sampled participants who are different in order to gather variety of views and experiences on the topic under discussion (Denscombe, 2008). As a result, unlike a group interview, participants for the focus-group were few during a sitting and they had common knowledge about the topic considered. The focus-group items similar to the one-to-one also helped to unearth a lot of information which the interviewees could have otherwise withheld in other methods such as structured written questionnaire-administration. Apart from these merits, the focus-group facilitated the gathering of information at one sitting and also assisted in checking whether a particular item or experience evokes consensus, disagreement or exposes a range of contrasting views amongst the interviewees. Reticent participants were encouraged to participate effectively on prompts and clues from others unlike individual one-to-one interviewing. In essence, it helped to gauge a fair level of agreement and shared views amongst participants. The audio digital voice-recorder used really enhanced the interaction and also eased transcription. To facilitate deciphering of the intermingling voices, before an interviewee responds, the researcher called out the name for instance; "*Yes, ManE, let's hear your version*". The names were all listed in the interviewer's notepad but since the interviewees were ethically guaranteed confidentiality and anonymity, they were assured of the use of pseudonyms when recording the findings.

As already stated, the questionnaire as an instrument was dropped after piloting to ensure in-depth research characterized by qualitative studies. Denscombe (2008) also expresses that in considering the methods for particular topics, researchers should base their choices on the usefulness towards the achievement of the objectives. Bell (2008), Merriam (2008) and Denscombe (2008) further explain that the use of more than one method allows the researcher to use triangulation. Triangulation, in its various forms such as methodological, data, investigator (use of different investigators) and theory triangulation were described by Denscombe (2008 pp.135-136). In that vein, method triangulation was adopted in this research (focus-group discussion, one-to-one interview, non-participant-observation). Leedy and Ormrod (2005) cite that typically, the approach is common with qualitative research where a researcher may engage in many informal observations in the field and conduct in-depth interviews and then examine themes that may appear in the 'data gleaned from both methods' (p.99).

Although questionnaire administration could have been an effective tool since in general, being anonymous, respondents may feel at ease and might offer honest responses yet this was dropped especially being qualitative. The nuances of the interviewees during the interview portrayed that some of them were a bit hesitant in offering genuine responses when the question on the most preferred lecturer in terms of pedagogical skills was asked even though confidentiality was assured. Perhaps, the students were still not sure of absolute confidentiality based on their previous experiences. When others opened up, all felt at ease and contributed massively.

Another instrument that could have been used for data-collection was the diary. Bell (2008), expresses that diaries could serve as 'observational log' by the participants which could be used as the basis for intensive interviews. The use of diaries for interviews is however noted to be useful under situations where direct observation might resist solution to the problem or where extended or further observation may strain available resources. In view of this, it was very difficult contemplating what should be observed in the diary for this research. One hardly keeps diaries these days due to the use of transformed technology such as the use of planner on the mobile phones. Inquiries were rather made from the lecturers observed as to the preparation of lesson plans prior to the lecturing but, they had their power-point slides and notes guiding the lecturing but not detailed formatted lesson plans. The researcher checked how reliable the study could be with the forthcoming discussion.

3.4.3 Reliability

The data-gathering instruments designed for this research were mainly to seek respondents' opinions hence, a wide array of responses informed the research but, an attempt was made to ensure reliability by framing the same questions in the semi-structured interview guide and relying on the FIAC-adopted checklist under observation throughout the data-gathering process. Interview items for one university had the same content for the others. This was in conformity with the term reliability which is explained as the extent to which a test or procedure produces similar results under constant conditions on all occasions (Bell, 2008 p.117). It was thus, to verify the extent to which the techniques employed provided consistency and accuracy by yielding the same results should the same study be conducted elsewhere using the same methodological choice and application (Punch, 2009).

The researcher also considered consistency over time, stability and internal consistency in the conduct of this research. As explained by Punch (2009), consistency over time means if the same instruments were given to the same people under the same circumstances but at a different time, to what extent would the same results be obtained? Internal consistency refers to the extent to which the items are consistent to each other. Quantitative researchers have developed techniques such as the split-half for assessing the extent to which all items work together and to controlling the margin of error. Qualitative researchers regard reliability as the elimination of casual errors that can influence the results. Due to the technological changing status of society, the same results might not be obtained over time. Initially, to further achieve reliability, an attempt was made to sample students in two universities (University of Dar es Salaam -UDSM- in Tanzania and the Makerere University in Uganda) outside Ghana to respond to telephone interviews and electronic mailed questionnaire items but, this proved difficult since several calls and messages on WhatsApp social media to reach them proved futile. It was difficult reaching the staff who promised to participate during a conference (International Women's Forum and Leadership Foundation Fellows) attended in the year 2008. Upon reflection however, due to the experience with the one-to-one telephone interview with the foreign student in Ghana, this intention of conducting this phone interview might have yielded least positive results based on the dialectical challenges. By multiple-use of instruments (two forms of interviews and observation) the merit of assuring increased reliability (Danso, 1996) and perhaps also reduced bias in the findings was high. Merriam (1998 p.137) and Patton (1990 p.244) explain how the field worker is also able to use different data sources to validate and cross-check findings too. How valid was this research?

3.4.4 Validity of Data

Validity refers to the propensity of the collected data to answer the research questions (Somekh & Lewin, 2007). Being qualitative research, validity in this study was checked with the credibility of the data-collecting-techniques adopted since validity in the field of educational measurement refers to the degree to which a test, tool or technique measures what it is supposed to measure in a study (Somekh & Lewin, 2007). The items framed for the interviews and the checklist for observation as measurement conformed to standards expected for qualitative research. An attempt was made to minimize the distorting effects of personal bias.

Face and content validity were ensured in this research by framing guiding and focussed research questions that sought to measure the experiences of the students with retrospective and introspective perspectives. Items or questions set were based mainly on non-quantifiable measures as compared to the more quantifiable and statistical setting for quantitative data gathering research. This is because perspectives, views, emotions and ideas cannot be measured by statistical means but through asking questions or observing. Denscombe (2007) explains that the strategies adopted should be appropriate for specific kinds of problems or "fit for purpose" (p.3). In the development of the instruments, adequate specific items were framed to cover each of the broad research questions (at least three) framed to ensure content validation. The participants' reports too were correctly recorded and plausibility of the different interpretations given was also checked. As intuited, the validity and reliability of a research study hang on issues of accuracy and relevance of procedures used for the data collected for the study (Punch, 2009).

Punch (2009) addresses various forms of validating a research such as construct, internal, external, content, face and predictive validity. These could be associated with quantitative or qualitative data gathering procedures of research. Internal validity for instance is a term associated with purely quantitative research such as the conduct of experiment. Blaikie (2010) explains that internal validity deals with cause and effect in experimental design and lack of it could arise from a situation such as selection bias. External validity is the extent to which a study's findings could be generalised beyond the sample used in the study. Content validity verifies whether the method of measurement actually measures what it is expected to measure. Thus, it focuses on whether the full content of a conceptual definition is represented in the measure. One of the definitions given by Beck and Polit (2006) about content validity is: "the degree to which an instrument has an appropriate sample of items for the construct being measured" (p.489). Face validity, a type of content validity determines the suitability of a given instrument as a source of data on the subject under investigation. An instance is whether an interview is best suited to data seeking the opinions of people and not testing the blood sample of certain breed of animals. The validity of a piece of research conducted under the positivist paradigm for instance is assessed by how well it meets the scientific criteria of measurement. In discussing issues related to epistemology, Bryman (2008) expresses the central issue of whether research carried out in the social world ought to be conducted according to the same principles, procedures and ethos as the natural sciences.

3.4.5 Data-gathering Procedure

After piloting and refining the instruments, the main research in terms of data-gathering was carried out between April and November, 2017. In Seeking Informed Consent as ethical considerations demand, written permission was sought from the gatekeepers (Deans, Heads of Departments) of the Universities (Appendix 2). When the time was due for the fieldwork, a second letter was written seeking permission to sample, and these were granted (Appendix 3). This was followed up with a visit for sampling of the participants. Negotiations were made for the dates for the conduct of the observation and the interviews as well. The participants were not immediately available but through the assistance of the Faculty Officers, telephone numbers of the lecturers were obtained. The lecturers also issued the telephone numbers of the class representatives as discussed under the sampling procedure. Whilst waiting for the responses to the applications, piloting was done.

In the main research, VarsC was the first university for the conduct, followed by VarsE. VarsD was third, followed by VarsA. VarsB was the fifth to be researched. Except VarsE where data were gathered from two different departments, all the others were conducted with a department each. Eight members were selected for each focus-group discussion. The one-to-one interview was conducted with five (5) students in two of the sampled Universities.

In the interaction, a semi-structured observation was conducted as justified earlier and based on the varying time schedules for the various courses, whereas some presented for a duration of one and a half hours, others took about an hour. This really confirms what Patton (2002) explains about the duration of the conduct of observation that it may depend on the time and the resources available in relation to the information needed. The time-frame was found adequate for it enabled observation at different stages of the teaching vis-à-vis the introduction, development, evaluation and conclusion to be carried out.

The duration anticipated for the conduct of the observation was reduced but, that for the focus group discussion was prolonged. This might have been due to the translations offered by other participants during probing where the researcher encountered the dialectical challenges. As a result, the probing was minimized in three universities with a large number of foreigners.

All the lecturers observed agreed to be video-taped contrary to the initial fears held by the researcher. This eased up the observation exercise and also helped in tracking lecturer-centeredness or student-centeredness and therefore gender-sensitivity in the delivery. In support of Bryman (2008), FIAC's method is found to be the best means of exploring differences especially in teaching styles between lecturers and teachers. The videotaping also complimented the observation since regular reference to it facilitated the transcription of data afterwards.

The non-participant observation that was employed ensured maximum concentration on the activities of the participants (Mason, 2002). Some aspects of familiar pedagogical strategies anticipated to be observed included the lecture technique, demonstration, collaboration as noted in the FIAC's adopted schedule (Appendix 11). These were ticked, noted and also videotaped. Conscious effort was made to concentrate on the students sampled for the research especially the females. The lecture theatres' atmosphere in terms of physical setting vis-à-vis resources and the class size, the sequence of activities, individual attention and subtle factors such as non-verbal communication as noted by Merriam (1998) as guidelines were keenly taken note of. Other gendered compliments noted in the literature that encourage or discourage females from learning such as compliments or praises were all observed and noted.

At VarsE, a male and a female lecturer taught Oil and Gas Engineering and Biomedical Engineering respectively. At VarsA, similar to VarsE, two lecturers (a male and female) presented their lectures on Material Technology and Technical Communication Skills respectively - the latter being a topic under interdisciplinary discipline though the female lecturer was in Agricultural Engineering. No post-lecture interview was conducted with the students about the female lecturer since the course observed was outside applied science discipline. Only two (a female and a male student-participants) were part of that Level or class so the researcher waived that section during the post-observational interview with the students. The female lecturer however invited a female level 400 Agricultural Science student (YaaT) who was not part of the sample originally selected to be interviewed. The one-to-one interview with that female student concentrated on the most preferred lecturer in terms of pedagogical skills and the retrospective experience of her second cycle education.

The post-observational interview with the female lecturer concentrated on how she entered engineering and interventions that had been put in place by the university to encourage females into technology-related programmes. Similarly, the post-observation interview with the male lecturer at VarsA concentrated on his background and the kind of interventions being put in place to motivate females into technology related programmes. At VarsE, brief post-observational interviews were held with the lecturers who taught after the sessions since they had other lectures. At VarsC, the date fixed by the gate-keepers for the observation coincided with a meeting so no observation of a lecturer took place. A similar incident happened at VarsD. In both universities too, there were no female lecturers in the faculties to be observed. At VarsB, only a male lecturer availed himself to be observed. The female lecturer who was supposed to have handled Mathematics explained on a telephone conversation that she was no more handling Mathematics but rather Business Management. The male lecturer presented the discipline (Analytical Chemistry) to a relatively large class from 3.00 o'clock in the afternoon.

The FIAC'S schedule devised helped in monitoring the stages and this became very helpful. A national service person at COLTEK who was skillful in video-taping was briefed on the details of the research and permission was always sought from the lecturers participating to enable him videotape. This service person was given an orientation by the researcher regarding confidentiality and anonymity before being engaged. With the FIAC's schedule or checklist indicating what ought to be observed and the processes to be followed, the researcher always took a seat at the back of the lecture theatre - an experience gained during teaching practice supervision of students.

The video-taping facilitated the capturing of all the details regarding the interactions with the students and the sequential manner in which the presentations were made, the gestures, the procedures used in operating the projectors, the enthusiasm infused into the lecturing and others. These really fit into the social constructionist theory in which this research was predominantly situated. Collis and Hussey (2014) support this with an explanation that the choice between quantitative and qualitative methods of data collection depends on the area of research and the aims and objectives of the research.

The observation of lecturers was followed by the interviewing which was based on stages suggested by Kvale's (1996) model of interviewing discussed under the instrumentation. In each sampled university, although informed consent or permissions were sought, prior to every interview, all the necessary protocols and courtesies were observed. On commencement of each interview, informed consent letters specifying the participants' bio-data and the purpose of the research (Appendices 8, 10) were submitted to all the participants including the lecturers and they appended their signatures to confirm participation. At every setting too, the purpose of the research was explained and participants were again assured of confidentiality and anonymity - thus, non-disclosure of their identities. In establishing rapport for some degree of trust during each session of the data-gathering, a brief statement such as the following was made:

> I am not around to make judgements about whether the students in this University are good or bad. I am here to observe teaching methods for others to learn from. The area has not been significantly researched into and so many excellent teaching styles for practical work go wasted but others could learn from the styles. The interviews too would help ascertain your past and present experiences with the areas of your study. They are not meant to examine or test your intellectual ability but to gain variety of ideas from you.

After this rapport, permission was sought for the use of the digital voice and video recorders. At each setting, one or two participating students inquired into the use of the recorder for the interview perhaps doubting the veracity of confidentiality assured. Having explained, all the participants permitted their usage. If they had insisted, their use would have been stopped since the participants' rights ought to be upheld with the use of such gadgets as noted by Bell (2008). In all the cases, the use of the recorder was also explained as serving as evidence for the conduct of the research.

The notepad just like what was noted under the conduct of the observation was also used to record the nuances or non-verbal gestures that could not be recorded by the supporting gadget (audio voice-recorder). The notes also referred to as memos by Leedy and Ormrod (2005), were taken since the gadgets could have failed just like what happened during the initial stage of the piloting of the interview. The videotaping would have provided richer contexts for interpretation in terms of capturing the non-verbal gestures as well as the facial expression and bodily posture but this was not requested since the researcher felt that the audio recording was adequate. Few static photographs were however taken during the interview sessions. From the harmonious atmosphere within which the interviews were conducted, had the researcher requested the use of video, the participants would not have objected to it. If an attempt was however made and the participants objected, the researcher would have complied since Kvale (1996) and Bell (2008) express that no coercion must be exercised. In all the strategies, the researcher served as a moderator to facilitate the group interaction. The foreigners usually prolonged their statements.

Due to the experience gained during the piloting of the interview, the digital voice recorder never failed and each interviewee in responding to the questions, held the recorder and passed it on to the next interviewee. As the interviewing progressed, three main points amongst a lot that Kvale (1996 p.145) emphasis as quality criteria for conducting interviews were well applied. They are:

1. The extent of spontaneous, rich, specific, and relevant answers offered by the interviewees.
2. The duration of the interviewees' responses in relation to the length of questioning.
3. The degree of difficulty in following up and clarifying the meanings of the relevant aspects of the answers given by the interviewees.

Typical of phenomenological studies, there is a need for 'bracketing' but there was this difficulty of assuming neutrality entirely regarding the interviewees' negative knowledge towards certain cultural beliefs. Sometimes a lengthy explanation had to be done especially when the participants could not differentiate between cultural practices and gendered roles practiced in the societies. No argument or debate however ensued regarding personal views of the interviewees. Actually, conscious effort was made to avoid the conduct of interview fraught with possible distorted responses due to personal bias, anger, anxiety, politics or lack of awareness since as noted by Patton (2002), interviews can be affected by the emotional state of the interviewees at the time of the interview. Bell (2008) supports this by expressing that interviewing is highly subjective and therefore there is the danger of bias. Beside these styles of interviewing, a telephone interview was conducted with one foreigner who missed the interview session at VarsD.

3.4.6 Telephone Interviewing

The participant arrived just after the session although the time was scheduled for all the focus group members. He was scheduled for telephone interview and during that session, the mobile phone of the researcher was put on loudspeaker so as to note the points with the free hand. Although a successful conversation ensued for about ten (10) minutes, confidential issues on pertinent questions like the lecturer most preferred in terms of pedagogical skills could not be asked since the researcher was not really very sure whether the interviewee was alone. Beside this limitation, the nuances or gestures made by the interviewee could not be seen. The interview was a bit stifled because of the dialectical barriers thus, being a foreigner, there was real difficulty in probing since most of the words could not be deciphered. In such a case, if he had been part of the main focus-group, others would have assisted with the interpretation. It also became very difficult for the researcher to write the responses down.

This really confirms what Cresswell (2008) notes about telephone interview that; lack of direct communication creates limited communication especially loss of non-verbal aspect that may inhibit the researcher's ability to understand the interviewees' perception of the phenomenon. Kusi (2012) also objects to the use of telephone interviews in qualitative data gathering research and emphasis that it is normally used for quantitative studies which involves a relatively larger number of participants located in larger geographical areas. Despite this shortcoming, the telephone interviewing is a very useful data-gathering technique which could have been employed since it is cheaper and does not require any serious logistical infrastructure apart from the telephone. Regarding the dialectical difficulties too, the questionnaire administration would have been useful.

The participants were continuously reminded of confidentiality at all stages of the interviewing. The possible repercussion of victimization was disclosed to them hence the participants shared their views willingly without coercion. The interview for the universities where no observation took place focussed on the questions framed on the interview schedule as well as the participants' opinion on the most preferred lecturers in terms of pedagogical skills. The items also covered a retrospective experience on teaching at the second-cycle levels.

Having adopted the semi-structured interview, a lot of un-thought-of responses too emerged. Indeed, it was realised that in contrast to the unstructured interview, one feels more confident with the use of the semi-structured format. In a way, the interviewing turned out to be a real conversation and perhaps, this is one of the reasons why Mason (2002) describes an interview as a conversation with a purpose. The semi-structured nature also led to the gaining of expertise by permitting the use of hypothetical, devil's advocate, and interpretive questioning techniques. Multiple questions, leading questions and those that could be responded to with simple 'yes' or 'no' were avoided completely.

In consonance with the literature reviewed, the interview was set off with neutral and general questions after the rapport establishment. Such questions included participants' views on whether they think boys are born with traits that make them mathematical experts while girls on the other hand have language expertise. Demographic questions were skipped since these were added to the informed consent letters completed by participants prior to the commencement of each interview. This sequence of asking questions was in tune with Merriam (1998) who explains the need to start with neutral descriptive information and general questions. It is really an accepted fact that "questions are at the heart of interviewing, and to collect meaningful data a researcher must ask good questions" (Merriam, 1998 pp.82-83).

Having adopted the semi-structured format, an attempt was made to cover most of the relevant issues but at times a concentration was made on one person with an attempt to probe the difficult-to-hear responses from the foreigners. This also might explain why Merriam (1998) enumerates the need for a format for asking questions in the interview schedule. The interviewing with the lecturers went beyond the pedagogical skills to how they entered the sciences and the encouragement extended to female students. Ethical issues were also discussed.

3.5 Ethical Considerations

In all the stages of the study and reporting, ethical issues in terms of research code of ethics as expected by the awarding university (UEW) and international research body on issues such as written informed consent (Bell, 2008) to the gatekeepers of all the Universities concerned were observed. Thus, permission for inclusion as participant was sought through verbal and written informed consent to the gatekeepers of all the

Universities sampled. In the consent or permission letters (Appendix 2), the purpose of the study was spelt out for scrutiny and approval as suggested by Bell (2008). Cohen et al (2003) emphasised the same point and added that informed consent must be sought from subjects who are to assist in the investigation and the institutions or organizations providing the research facilities.

The principle of informed consent arises from the participants' right to freedom or democratic rights. Such consent by Cohen et al (2003) again, involves four main elements which are: competence, voluntarism, full information and comprehension. Under the 'Competence', responsible mature individuals who were able to make correct decisions were sampled. 'Voluntarism' was also adhered to in the sense that the participants were given the right to freely decide to take part or not in this research. There was no coercion as shown in the sample completed consent form (Appendix 8). 'Full information' was also given in the sense that the purpose of the research was fully disclosed (p.51). Again, the procedure to be followed was also explained as outlined by the United States Department of Health, Education and Welfare (DHEW) Policy (1971) in Cohen et al (2003 p.51). Any benefit expected was also disclosed and an instruction about the possibility of participant withdrawing at any time was also given. From experience, personal benefit prior to the conduct was not discussed since that might be tantamount to bribery but the general benefit to the society or nation was disclosed to the participants. Prior to the commencement of the research, negotiations were made concerning specific times and venues. In conformity with research Code of Ethics, participants' safety, confidentiality and anonymity were assured. If anyone decided to withdraw participation, there would not have been any exertion of coercion. None of the participants however declined participation. Again, where the participants might have objected to the use of recording gadgets, their decisions would have been upheld on the dates of data-gathering. One concern was that although the researcher informed participants that the interviews may not last long, the interviewing really went beyond the anticipated duration for all the focus-group sessions. None of the participants however felt agitated due to the extended time frame though.

Other ethical concerns were on anonymity and confidentiality and by anonymity, the participants were assured in conformity with Bell (2008) that their identities would not be disclosed. Thus, the researcher or a reader would not be able to identify which responses came from which respondent. In this regard, since various teaching methods were recorded (skillful and not), the participants were assured of utmost anonymity. Similarly, since students revealed the behaviours of lecturers, non-adherence to anonymity could lead to some students perhaps getting victimised. Bell (2008) again explains confidentiality as a promise offered respondents of non-disclosure of their identities in any form. The rate of response from each University was recorded instantly with letter codes known to the researcher alone.

On rights of participants, those who agreed to participate in the research were asked to append their signatures on the written informed consent letters and before the interviewing or observation, verbal consent was again sought since as Bell (2008) and Cohen et al (2003) put it that participants might have changed their stance on participation. Scott and Usher (2003) also explain that compelled participation need not to be observed. Again, Cohen et al (2003) explain that participants' withdrawal at any time should not be questioned but if latter rapport is established, the researcher may approach the participant for consideration. In the case of this research, participants were also given veto rights over the content of the report through verification. This was to ensure fairness, accuracy and relevancy of the content of the report (Scott and Usher, 2003). It is also in line with Kvale (1996) who suggests that participants should be given the opportunity to verify the information given. At the end of each interviewing session, a token of diaries stuffed with pens were issued to the student-participants to show gratitude.

3.6 Data Analysis

After the gathering of data, transcription which began right from the date of data-gathering was found to be very advantageous since those issues that could not be captured direct were fresh on the researcher's mind. Although Cresswell (2008 p.246) notes that generally it "takes approximately 4 [four] hours to transcribe 1 [one] hour of interview", the transcription of each focus-group discussion for instance went beyond twelve hours due mainly to the difficulty in deciphering the intonations of especially the foreigners. The analysis of the transcribed data was mainly based on inductive interpretive reasoning which depends on the collection of diverse information and drawing conclusions or inferences out of them. Such an analysis is usually considered subjective whereas that of quantitative data which dwell on deductive analysis are often considered objective. Measures were, however, taken to minimize subjectivity in gathering and analysing data in this research via the open-ended questions framed during the interviewing, the way of framing the questions, and the trend of analysing. Although validity might not be totally proven in qualitative as in quantitative research, the researcher's values did not influence the respondents' opinions or viewpoints during the analytic stage. The researcher assumed neutrality therefore 'bracketing' responses as characterized by phenomenology. By bracketing, the researcher ensured that no preconceived idea influenced the responses offered by the participants.

In analyzing, the recorded responses were uploaded into the computer from the digital voice recorder and replayed several times to capture every response. The responses were categorized under themes or concepts in accordance with the preparation of the research questions framed. Most of the transcripts of long sentences were condensed. The most interesting and revealing responses were recorded verbatim. All these actions were taken in conformity with Kvale (1996) who defines the word 'transcribe' as "to transform, to change from one form to another" - thus, a transcript of an interview "is a transgression, a transformation of one narrative mode - oral discourse - into another narrative mode - written discourse" (Kvale, 1996 p.166). Based on the socially constructed nature of transcriptions, Kvale (1996) describes certain procedures for increasing trustworthiness and enhancing rigour in qualitative research thus, the transcription from the tape to the text involves series of technical and interpretational issues on which there are few standard rules.

In all cases, the researcher was conscious of ethical issues especially with publication of verbatim transcripts. Incoherent verbatim transcriptions for instance could lead to stigmatization of people in case others have access to the report or if the final report is kept at the library without adhering to anonymity. Besides, one of the Deans of the sampled universities made a request for the report on the findings (Appendix 3). In the case of the observation, the actions mapped out in the FIAC's schedule were tallied and contractions and similarities grouped. Additional information under the transcription in terms of the observation schedule has been detailed at the data treatment section.

The fifth step considered under Kvale (1996's) model and Neuman's (2007) steps is the analysis of the transcribed data. Although no standard methods have been structured in qualitative research, the five approaches generally accepted for analysing qualitative interviews by Kvale (1996) vis-à-vis categorization, condensation, narrative structuring, deeper interpretations and ad hoc tactics were considered

In categorizing, consideration was given to the most relevant data. Since the analysis was started right from the day of interviewing, during the transcription, manageable amount of interview material could be analysed about the subject matter and the reasons why such responses were given by the participants. Well aware of the time-consuming nature of the analysis, it was built into the interviewing by seeking clarification through prompting and probing. The transcriptions of the interviews were coded into categories by reducing long sentences to short ones. Some of these categories were developed in advance during the development of the instruments for the collection of data. After the categorization, long sentences were compressed into briefer statements by rephrasing at the condensation (reduction) stage. The main texts were organized to bring out the meanings at the narrative structuring stage.

All these methods were designed in advance in conformity with Kvale (1996) who explains that in the designing stage of a research, one has to state the most appropriate form of analysing the findings. One should think of how to analyse questions framed for the interview before they are conducted. Thus, before the rocks are prospected for the mineral and excavated, one ought to have indicated the method for refining the ore for the mineral.

At the deeper interpretation stage, the texts were expanded by re-contextualizing the statements within broader frames of reference. The researcher went beyond the responses of the participants and worked out structures and relations of meanings not immediately found in the text. In the final stage of generating meanings out of ad hoc methods, in support of Kvale (1996), a lot of commonsense approaches, sophisticated textual or quantitative methods were used to bring out the meaning of different parts of the interview material. Thus, in the ad hoc methods, no standard method was used for analyzing the whole of the interview material. There was therefore a free interplay of techniques during the interpretation of the analysed data.

Considering the sixth stage of Kvale's (1996) model - Verification stage, the generalizability, reliability and validity of the findings of the interview were ascertained. This stage was carried out when the report was put together. The verification in particular, included checking the empirical evidence either for or against the interpreted data. Additionally, the researcher verified by examining how coherent the theory or text was. The findings were forwarded to the chief supervisor prior to forwarding to the university that made request for them. Kvale (1996) intuits that the participants or interviewees are obliged to test or verify statements about the truth and falsification of propositions. Such a discourse is noted to be an ideal form of argumentation where no social exertion of power takes place. If the researcher failed to adhere to the request by the Dean, this could curb further attempt by other researchers.

3.7 Summary / Conclusion

This chapter has discussed the various methods adopted for conducting this phenomenological qualitative data-gathering research. It has also enumerated the fieldwork practices and succinctly justified the two principal instruments that were employed. The outlines for designing of research and interview formulated by Neuman (2007) and Kvale (1996 p.83) for investigators in qualitative research were adapted. Participants were homogeneously sampled from two public and three private universities in Ghana. Piloting was carried out prior to the main research. To enhance reliability, validity and also ensure triangulation, a combination of data types, variety of methods were employed (observation of lecturers' teaching, one-to-one interview, focus group discussion). Such triangulation had the purpose of compensating for the weaknesses of another approach (Patton 2002 p.306). The methods adopted to achieve validity and reliability as well as consideration of ethical issues have been explained. Data analysis and interpretation in line with qualitative / interpretative data treatment have also been enumerated. Taking a cue from the seven-step model by Kvale (1996), some of the participants upon request would be given the opportunity to verify information they volunteered before the final report writing. The Dean at VarsA who made a request for a copy of the findings too would be adhered to. The report was also well substantiated. The next section communicated the findings of the research based on laid down criteria, considering ethics and the text in a readable mode.

CHAPTER FOUR

FINDINGS OF THE RESEARCH

4.0 Introduction

In the previous chapter, the methods employed in collecting data were discussed in line with the purpose and objectives of the research. This chapter presents the findings gleaned from the raw data gathered from the field. It is organised under the demographic characteristics of respondents followed by the six main themes of the primary instruments framed from the research questions. It sets off with the demographic information of the participants.

4.1 Demographic Information

This section examined the background information of the participants which was considered relevant because it demonstrates the relationship between the calibre of people engaged by the study and the central issues of the study. The main issues considered were gender, age and background information for the staff and the student-participants. The second cycle institutions attended by the student-participants were also found worthy of study to check the retrospective influence on the science-related area of specialization.

4.1.2 Gender and Age of Staff-participants

The male lecturers who availed themselves to the researcher's observation exercise outnumbered the female lecturers by one thus constituting 60 percent of the staff-participants. Two of the male lecturers were under 35 years whilst the other was aged between 41 and 45. One of the females was aged between 36 and 40 and the other between 41 and 45. The average age of the staff-participants in general was 40 years.

They could be said to be youthful. Items seeking Informed Consent and participants' demographic profile are found at Appendices 8 and 10.

4.1.3 Students' Demography

4.1.3.1 Enrolment and Age of student-participants

Out of the fifty-three (53) student-participants, thirty-four (34) were females. This represented approximately 64.15 percent of the students sampled (Table 4.1.2 below). Majority of the participants were between eighteen (18) and twenty-three (23) years. Only three (3) representing 5.7 percent were either twenty-seven (27) or more years. None of the participants was below eighteen (18) years (Table 4.1.3). They were all adults who could decide to take part in the research without coercion.

Table 4.1.2: Gender Distribution of student-participants

Gender	Frequency	Percentage
Male	**19**	35.85
Female	**34**	64.15
Total	**53**	100.0

Table 4.1.3: Age of student-participants

Age (years)	Male	Percentage M	Female	Percentage F	Total	Percentage Total
18-20	10	18.9	**15**	**28.3**	25	47.2
21-23	7	13.2	**17**	**32.1**	24	45.3
24-26	1	1.9	**0**	**0**	1	1.9
Over 27	1	1.9	**2**	**3.8**	3	5.7
Total	19	35.8	**34**	**64.2**	53	100.0

4.1.4 Geographical Background of Student-participants

The participants were purposively sampled by snowballing. Foreign participants constituted a high percentage of the sample-size thus, out of the fifty-three (53), fifteen (15) comprising eleven (11) females and four (4) males were foreigners. The foreigners therefore represented 28.3 percent of the entire student-participants. The participants who come from the Eastern Region were second highest in number with female students forming 11.3 percent out of a total percentage of 20.8. No female student from the Central and Greater Accra regions took part in the study. In the male category, there was none from the three northern regions (Northern, Upper East and Upper West). The demographic information is represented in Table 4.1.4 below.

Table 4.1.4 Geographical Background of Student-participants

Ethnic Regions	M	Percentage M	F	Percentage F	Percentage Total of M and F
Ashanti	4	7.5%	2	3.8%	11.3%
Brong-Ahafo	1	1.9%	2	3.8%	5.6%
Central	2	3.8%	0	0%	3.8%
Eastern	5	9.4%	6	11.3%	20.8%
Greater Accra	1	1.9%	0	0%	1.9%
Northern	0	0%	1	1.9%	1.9%
Upper East	0	0%	2	3.8%	3.8%
Upper West	0	0%	1	1.9%	1.9%
Volta	1	1.9%	6	11.3%	13.2%
Western	1	1.9%	3	5.7%	7.5%
Foreigners	4	7.5%	11	20.8%	28.3%
Total	19	35.8%	34	64.2%	100%

4.1.5 Second Cycle School (SCS) Attended by Student-participants

A larger proportion of participants (96.23%) were found to have generally attended Senior High School (SHS) and not technical schools. With the exception of two Level-200 male and female students pursuing Agricultural Engineering and Biochemistry at VarsA and VarsB respectively who attended senior secondary technical, all the students who participated attended SHS as shown in Table 4.1.5 below.

Table 4.1.5 Second cycle school attended by Student-participants

Gender / Mode	Sen. High	Percentage	Sen. Technical	Percentage	Total	Percentage
Male	18	33.96	1	1.89%	19	35.85%
Female	33	62.26%	1	1.89%	34	64.15%
	51	96.22%	2	3.78%	53	100%

4.1.6 Choice of programme

The course (Oil & Gas) is highly tailored to suit industrial requirements and per the enrolment statistics shown above on geographical background (Table 4.1.4), both males and females of foreigners were appreciably represented. Out of the 28.3 percent foreign students, 20.6 percent were female-students who participated in this study. Further probe into the dominance of foreigners at VarsE for instance revealed by the head of Oil and Gas Engineering showed that conscious arrangement is annually made by the Council of the University to advertise in other countries apart from Ghana to attract foreign candidates. He explained that a liaison officer is responsible for that annual arrangement.

4.1.7 Areas of Low Patronage in The Study of Technology-related Programmes

No female student from the Central and Greater Accra regions took part in the study. In the male category, there were none from the three northern regions (Northern, Upper East and Upper West). It is really very difficult discerning why none of the staff as well as male students hailed from the three northern regions. In the pilot interview at COLTEK, the participants expressed that indigenes from the various regions have their special areas of study. One can however not draw conclusions about these marginal representations in the three northern regions – whether there is a lack of interest in the engineering courses or mere stereotypical trend. This research too is not a national research therefore lacking adequate sampling to draw inconclusive conclusion.

4.2 Analyses of themes

The next activity examined the findings of the fieldwork in terms of the specific questions framed in the study. The first question was to seek the participants' views on whether scientific pursuits were based on genetic inheritance. With regard to this, the Research question one (1) was**:** ***What are the biological characteristics that influence subject choices for female and male students?***

4.2.1 Views on Gender / Biological Issues

This first specific question was to seek the perception of the participants on brain lateralization: thus, whether they think males have mathematical traits or spatial abilities as compared to females having language or verbal traits/ abilities. After coding and analyzing the raw data, of the participants, the most popular response was that 'brain lateralization' could be a fabrication of the society. They shared experiences to the effect that both males and females excel equally well in academic work. They also alluded to the fact that they have witnessed both females and males occupying the topmost positions in their class examinations. They further expressed that back were the days that females were restricted in pursuing mathematics-based courses because the parents were not seeing the mathematical abilities in their female children. This in effect restricted them to learning the fine Arts and the humanities. Afb, a level-200 female from VarsE explaining a point on this stated that:

> In some aspects, it is a perception in the olden times that males are good in mathematics and females in languages but now things are changing. It might be that in the olden times, they would have to use a lot of energy to do most work [labour intensive] but, we are in modern times; you have technology to do that. If you want to calculate something, if you want something to go up, you just need technology, you just have to programme it that you want it to be so. I don't agree with the fact that boys are better in Maths than girls. For example, myself, when I was in J.S.S., I used to actually teach my class in Maths and all with other boys in the class so I don't think so. It requires effort studying because if you don't put much work into what you are doing you wouldn't achieve your aim. (Interview Transcript 3: April, 2017)

OKA, a male student of VarsC also stated that:

> I think in the larger sense; it is true that many boys enter the sciences depending on the type of sciences. Let's say engineering per-se, we have [many] boys doing it than the ladies because of the type of work it entails. Civil Engineering like this, if you are not a consultant to be in the office you have to be on the field that needs a lot of stamina which maybe the ladies wouldn't want to be into that uncomfortable situation because you have to be in the sun supervising the people to work. When you get to the Mechanical Engineering, that field also has manufacturers meddling with machines. It requires energy because people have to move to sites to fix machines, they have to be under cars and so on. Electrical Engineering too, you have to climb poles to connect wires but some ladies are not prepared to do that because they may say 'the sun will affect my colour' because if you are not beautiful it will be very difficult for someone to marry you. So, most ladies prefer banking and others to get into air conditioners (Interview Transcript 1: April, 2017).

OKA's quotation seems to partially reaffirm brain lateralization and shows stereotypical influences adapted by the society. This could be related psychologically to cognitive properties based on capabilities, constraints and mode or strategies of operation. This could also be considered under cognitive structures or knowledge adopted by the society. Such stereotypical knowledge stimulates or discourage particular interests. Thus, females are noted to prefer comfortable and less strenuous working environments. This might have been inculcated in them through what happens in the society thus, emphasizing social constructionism. Emla a female from VarsA, also said that:

> The issue is of perception. Those kinds of courses (sciences) are more related to guys and so if a girl decides to offer such a course, sometimes she's discouraged. People tell them those courses are difficult. Sometimes people in the society discourage them. (Interview Transcript 4: April, 2017)

Emla is also reaffirming brain lateralization based on the various job patterns identified in the society. The cultures seem to intimidate females if even they have the capability and interest to study the seemingly-male dominated disciplines. OKA further added that:

> The reason why most guys study the Mathematics and most girls like the reading aspect and the language is that Maths goes with a systematic approach. There are laid down procedure that one has to follow. The ladies are more curious than the guys so when books are given to boys and girls, the girls will finish earlier because they are more curious and want to find out what is in the book. The guys are more comfortable with the laid down procedures like 1+1=2. (Interview Transcript 1: April, 2017)

OKA might imply that an association has been formed through repeated practices by males and females. Associations formed become challenging in dissociating. Ideas and practices encoded in the long-term memories become difficult to disentangle. The reading habits formed and mathematical interests acquired respectively by females and males get ingrained in them. Oval, a female at VarsB also expressed her views this way:

> No, I am not in support and I am not in favour. This is because it is not all females. It is some people who have been limited by certain circumstances, like when they were growing up, they grew up to meet that; oh you are a girl and mathematics is for the guys but it is not for the ladies. Ahaa… because of that fear they grow up with, most children they pick up from initial stage. So if you are able to pick up that mentality, as you grow up, it will continue to be there, you will just have it that way all the time. The people surrounding us like friends, parents, adults and those grown use to tell you that you are a lady, and as a lady when you are growing up Maths or education in general is not your field. It is for the guys, so because of that you just grow up with that fear of not liking Mathematics. (Interview Transcript 5: November, 2017)

Oval's quotation again reaffirms social constructionism. Females are programmed in the society with the fear of science and mathematics. They are not given the opportunity to rethink for themselves but always being dictated to of what society thinks is appropriate for them. At teen-age stage, the choices become challenging unless they have other stakeholders, like their parents interceding as it is realized from the responses. The fear put in females become challenging to erase.

HamG, a male participant from VarsE explained that he does not wholly support the idea of boys endowed with mathematical brain and girls with verbal brain because back in the secondary school, some of his female mates were very good at Mathematics whilst some boys too were very weak in that same Maths. Paradoxically, HamG continued that when we consider journalism, most fluent journalists are women hence in that regard, he partially sides with females having verbal ability though not completely. He stated that "Journalism is the ability to speak fluently and women are excelling in that domain so saying that women are born with verbal intellect, to some extent, it could be right". This quotation by HamG also reaffirms brain lateralization.

Dens, a male foreigner at VarsE responded to HamG's analogy by explaining that more females taking up journalism could be that ladies have the spirit and are generally not the shy type when it comes to talking or expressing themselves. For the males, he thinks that they always want to be the head of everything. On the other hand, Dens expressed that back in his secondary school outside Ghana, in the science department, one sees more guys and in the Arts, more ladies and they all perform. This again depicts the stereotypical view of subject choices

HamG again shared further opinion that the issue is realistic and should be considered on a 50-50 basis: lesser guys on the other side. Asked whether it is based on trait, HamG responded that: "*to an extent, yes*", because his best friend (a lady) does wonders in Mathematics competitions and her daddy was very good in Maths; but, "*her kid brother is dumb – he doesn't like Maths*". HamG thinks the appeal for Mathematics could be sometimes based on inherited traits or at times just by hard work and development. TunF, a female foreign-participant, also pursuing Oil and Gas programme had a neutral perspective about the issue. She stated that:

> Personally, I don't think anyone is born with the ability to speak verbally or in Mathematics. I think it's all about development and how our society has made it. In my former school (Christian Pacesetters in Accra), in the science class, we were only three girls out of 26 or so

> guys. … I think it's the society that has made it seem like the girls don't or they can't really do science so the guys want to put themselves up for the sciences as if the ladies are more of the Artist or so. In primary school for example, you are about to enter secondary school maybe in class six and everybody is talking I want to be in science, I want to be in Arts and you realize that most of your girlfriends will say, I can't do Maths, Maths is for the guys, it's very hard. So only a lady who has put her mind to it that; this is what I want to do, will do it. For majority, I think society has a role to play in it. (Interview Transcript 3: April, 2017

PEF another female at VarsB also stated that:

> Everyone is born naturally with a gift and all that. It's all about determination. If a girl wants to be good, it's a matter of dedication, hardworking - learning, reading, solving, practicing to improve her Mathematics skills. The boys could also read more and watch news. (Interview Transcript 5, November, 2017).

Majority from VarsD reached a consensus that the idea that males have more of the mathematical mind than women is not true but just that most women fear Mathematics. Females are considered fearful and scared of calculations. They have less confidence and thus they lack the 'can-do' spirit. On what scares females, Oaten a male at VarsB thinks that it is just by nature because he has some female friends who refused to do Mathematics because Mathematics to them is complex. Oaten expressed further about the females considering mathematics as complex because:

> One has to think and do this and do that. They always want the easy way out because there is a perception that as a woman, she just has to grow up and somebody will marry her. So they don't want to use the minds to the full potential. They limit themselves with fear like, oh I

> am afraid. I can't do it, so they won't be able to pursue that thing all because they have been limited by society, parents and other things (Interview Transcript 5: November, 2017).

Thus, in consensus, the participants at VarsB attributed the maths phobia to lack of confidence by females. Both male and female-participants shared that females have been limited by certain circumstances within their upbringing. They were made to imbibe that: "*oh you are a girl and Mathematics is for the guys*". They expressed how most children from the onset pick up that mentality. Oval further stated that:

> The people surrounding us - like friends, parents, adults and those grown-ups use to tell you that you are a lady, and as a lady when you are growing up Maths is not your field. It is for the guys. As a result, you just grow up with that fear of not liking Mathematics (Interview Transcript 5: November, 2017.

The participants also shared that the choice of subjects is driven by the future occupation or career hence if an average is struck, a greater percentage of boys prefer to pursue the sciences more than the girls because, when one visits the beautician's salon, there are limited males as compared to females. Emla a female from VarsA indicated that in their youth, they saw the world in a different way and when they considered themselves as scientists when they grew up, they were usually told that "*you are a lady so you can't do it and they discourage you".*

As analysed in the literature, a train of thought attributes an additional influence from females' biological makeup. Females are noted to be better in verbal tasks, while men perform better in spatial tasks. Sabbatini (2007) a neurophysiologist and other host of researchers such as Mohler (2008), Balliet et al (2011) analysed the external anatomical and sexual differences of humans and found out that the male and female brains exhibit differences in their anatomical and sexual differences. Reportedly, testosterone and estrogen hormones have significant roles in mediating male and female differences. Most pronounced are the differences with spatial, cognitive as well as verbal and social abilities. Such biological makeup during growth, has a bearing on the differences in cognitive function between males and females.

This brain dichotomy was however analysed by Diamond (2003) a scientific analyst who pointed out that up to date, no live human beings have donated brain tissues to be used in conducting an experiment on the brain difference dubbed 'brain lateralization'. This has also been detailed in the literature at Chapter Two (2), Thus, although participants such as OKA's submissions reaffirm brain lateralization, his reasoning could be attributed to constructions, perceptions and stereotypical attitudes of the society that seem to have psyched females towards the seemingly social and verbal abilities as compared to the manipulative, aggressive spatial characteristics of the males

It has been observed that boys and girls perform at similar levels until they are teens. The teenage stage finds boys beginning to develop greater visual and spatial skills. They are therefore better at visualizing objects and solving mathematical problems. The researcher believes that perhaps in addition to the observed aptitudes mentioned, from the onset of their teenage years, male and female expectations from society (especially family, peers, teachers) take differing directions. The encouragements or lack thereof definitely have a significant bearing on them. In summary, from the responses of all the participants, the main problem is the phobia for maths and science by females due to societal influences and perception. The participants concluded that it takes hard-work, commitment and 'can-do' spirit for females to also acquire the spatial skills.

Research Question two (2): ***Who / What influenced you in the society towards your choice of technology-related disciplines?***

The question as found in Appendix 9 on the Interview Guide was to find out about people in the society that influenced participants' decision in entering the Science and Mathematics (S&M) disciplines. It was also to find out the main socio/cultural reasons for encouraging the participants into the areas of the S&M. This was important since such subjects are the foundation for the technology-related programmes. As noted in Table 4.2.1 and Fig. 4.2, the family members were noted to play major instrumental role in the choice of subjects,

Table 4.2.1: Influencers of subject choices

a. Who encouraged you into the technology-related studies?	Parent	Uncle	Cousin	Self	Teacher	Others – peer / Grand-dad / brother / Internet search	Total
Male	11	0	1	1	4	2	19
Female	22	2	1	0	7	2	34
Total	**33**	**2**	**2**	**1**	**11**	**4**	**53**
Percentage Total	62.2	3.8	3.8	1.9	20.8	7.5	100

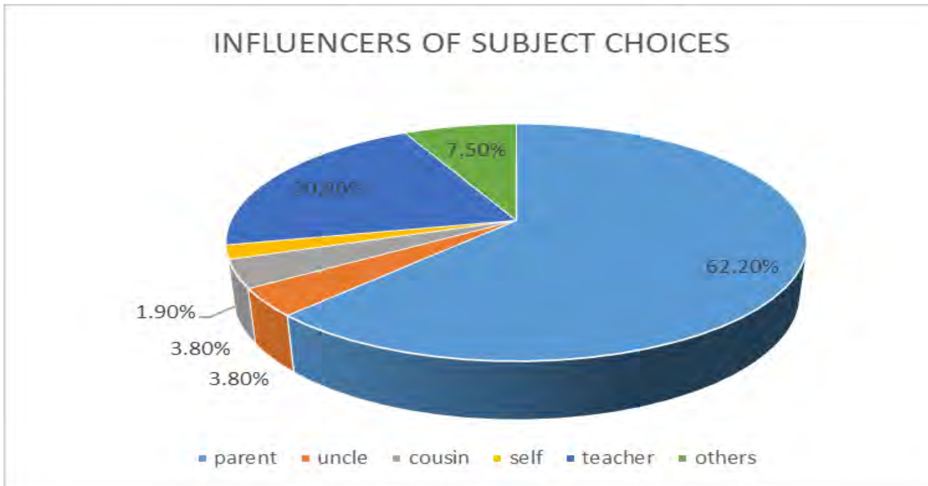

Fig. 4.1: A Chart of Influencers

4.2.2 Parents as Influencers of subject choices

As noted in Table 4.2.1, and graphically at Figure 4.1, about 62 percent of the participants had their parents influencing them in the choice of the sciences-based programmes. The parents' influences cut across the sexes. Semar, a female at VarsC stated that:

> Ok for me, my Daddy actually encouraged me when I was about finishing J.H.S. and applying for S.H.S. I wanted to choose Business. I have two sisters who actually did science so I had wanted to do something different. My Daddy told me I would be able to do Science. Encouragement from my sisters too helped since they are doing science. (Interview Transcript 1: April, 2017).

EmlaB, a female also from VarsC during the second batch of interviewing stated that:

> My daddy encouraged me. After JHS, I wasn't sure of what course I need so I used to talk to him and he used to tell me about courses in engineering. I researched on the net and I found Industrial Engineering and actually liked what it entails about factories, but, I also liked Civil

> Engineering too. So I chose that (Interview Transcript 1: April, 2017).

The others like Keyna (a male) at VarsA explained that their fathers encouraged them because some of them are in Civil Engineering so they accompany them to their sites. Keyna therefore said:

> I remember at JHS when we were choosing our courses, he asked me - what do you want to do? For the first time, I wanted to do Medicine but I wasn't interested in it. I just don't like the working environment. **...** My family per-se will not force you to do this or do that so I said I wanted to do science and nobody stopped me (Interview Transcript 4: April, 2017).

From VarsD, a female participant EmlaC also shared that: "*My mother encouraged me though initially, she decided I read Law. My dad did Agric in school but both agreed that I pursue the sciences since I did better in science"* (Interview Transcript 2: April, 2017).

A male from VarsE - Urra also shared issues about his grandfather who decreed that:

> We are all doing science [family] whether you like it or not! We are all going to do professional courses related to science - either in science or aerodynamics like aeronautics. No Business! … He doesn't need any Businessman in his house. So for instance, if you are going to secondary school and you are to opt for Business, when you ask him anything, he won't mind you, but if you say, I'm going to do science, he will pay your school fees and give you chop money, buy provisions and everything for you. So my grandfather influenced me a lot and he's a doctor so I admire his life. So he just influenced the whole family whether a boy or girl. (Interview Transcript 3: April, 2017).

There was no discrimination amongst the two sexes for that house since the grandfather perhaps knew that both males and females could excel in the sciences. Probing into why the grandfather was insistent, Urra could not offer any tangible reason.

Thrif from VarsB also shared how most parents are doing very well in educating their children (female and males alike) these days. Being one of a number of sisters in their house, her mother guided them to take up males' responsibilities otherwise their father would suffer as the only male in the house. Thrif therefore expressed that:

> Some of us are lucky because we had males bringing us up, so leaving around them have made us feel like we can also do it just the way they do it but sometimes too, society makes you feel like you are doing it too much (Interview Transcript 5: November, 2017)

YaaT, at level 400 at VarsA also expressed that her father introduced her to the sciences. Her father is a Mathematics teacher and that he taught her Mathematics. When she was in the primary school, she did not really know what she would be reading later but, when she came out, being confused, she asked her father what should be pursued and he said she should read Science but ought to work hard. Again, her father advised that it needs more time so she should forget about certain things. She has not had it easy and she said it is her father's encouragement that has sustained her interest because sometimes she gets low grades but upon crying and calling her father, he will say that:

> The fact that you've got that [low] grade doesn't mean you can't make it. You can still make it so if you think you want to write it again, you just register, sit up, learn and do it. The fact that you've gained admission means you can do it. Just sit up! (Interview Transcript 4: April, 2017).

Inquired into the preference of study style, whether individual or group, YaaT expressed that she preferred studying alone to having a group study because some of the study-mates would study ahead of time and might dominate the discussion. Study group mates she further expressed, "*makes me feel I have nothing in my head. If I learn alone and don't understand anything, I go to friends for explanation but in groups, I can't cope"* (Interview Transcript 4: April, 2017). Joanat a female at VarsA, AnPB, a female at VarsD and Oaten, a male at VarsB, enumerated how their parents' pieces of advice in terms of variety of opportunities on the job market aroused their interest in the sciences. Keyna, a male at VarsA initially wanted to study Business but the father guided him that with Science, he can gain a lot.

Boam, a female at VarsE recounting how parents consider engineering explained that it is generally the mentality that has eaten into the social fabric of the current generation that engineering is difficult. Such difficulty attributed to the *sciences* is analysed later under the sub-heading '*Difficulty of the sciences'*. In a consensus, the participants in the focus group at VarsE expressed how parents are currently encouraging their females into the sciences. Boam therefore stated that:

> When I got into the senior secondary, I wanted to go into the Arts a little bit but my mum wanted me to enroll in the sciences because all her dreams was for me to be an Engineer because she said that field has more money. (Interview Transcript 3: April, 2017)

In reaction to Boam's mum's dreams, Joshmat (a male) at VarsE said that:

> There is an adage that "he who pays for the piper, dictates the tune"; so if you're a lady and you have parents who are not going to assist you in a chosen field, then you draw a conclusion that since they are the ones paying for your school fees, if they choose a certain field for you, you

> have to do it. Most of the time, it ends up being ladies and the Arts courses. So, since the parents are paying, you feel that whatever they say is good for you so you should just accept it (Interview Transcript 3: April, 2017)

The researcher however has a contrary view to what was quoted by Joshmat in the sense that the female ward's capabilities must be considered by the parents and the necessary assistance offered to her rather than considering what interests the parents hold based on affordability.

In a similar vein at VarsE, the participants pointed out that the society has carved certain roles for ladies right from the home thus, they usually see the father engaged in giving instructions to the mother whilst he sits and gets the analytical activities done. The society is known to frown at the female who goes contrary to the societal norms. If this trend is reversed to give room for females also to make decisions and instruct equally as the males, the up-and-coming generation or children would imbibe those behaviours.

This response really depicts the concept or theory of social constructionism and weaving it into scientific carriers, the participants again expressed that if even the female child is good in the sciences, the parent especially the father's choice dictates the pace so his choice cannot be refuted. The question however is: 'what indicates that the mother would opt for science to be read by the female child if given that option? Kamsoc, a female at VarsE shared her experience of nearly getting dissuaded from her programme with:

> Those who are into education know what Engineering is about. I remember one of my uncles telling me to abandon Engineering and go for nursing training. It was my other uncle who is a Professor in Canada who said "*she wants to be an engineer so she can do it*". Some have it in mind that with engineering you have to go a long way before

> you get a job and start making money but if you go to Training College or Nursing, you just finish and start getting money (Interview Transcript 3: April, 2017).

Lankok a male at VarsE also expressed that parents consider the physical aspect of Engineering disciplines thus the labour involved hence discouraging their female children in enrolling in engineering. He stated that: "*About the parents, they would like to educate their children [females] to take care of their children, husbands and so on than being in engineering.* He further continued that; ... *Certain jobs require physical strength, at times demanding that one goes under a rail for one month and if both partners are engineers, it means calling for external help for the children. This they [the parents] thought would not augur well for married couple* (Interview Transcript 3: April, 2017). Lankok further expatiated that Engineering for instance Oil and Gas is viewed as a dirty work hence females would feel reluctant to get some jobs carried out whereas the males would not be bothered. He however, added that engineering is not about going out alone but one could deal with the software aspect which most parents are unaware of.

The researcher finds that Lankok's argument has limited merit. Couples could have different professions and still require baby sitters or nannies to help during their absence. Also, Lankok does not seem to have a full grasp of what engineers do. Lifting weights, wiring circuits, replacing parts and most manual work is typically carried out by technicians under the supervision of engineers. The physical demands in an engineering work may be not more than that in trading or teaching. Again, there are forklifts and other devises to deal with lifting and other strenuous activities. It is therefore difficult to imagine how this need should prevent the females from careers in engineering per se.

Lankok also mentions children! The truth is that culturally and all too often, some females get discouraged by their parents out of concern for their future marriage. There is the fear that the greater the academic achievement by a woman, the more diminished her prospects for marriage become. In view of this, some parents would do their best to dissuade their female children from careers in engineering, medicine, architecture, and the like.

4.2.3 Teachers as Influencers of Females' Subject Choices

Teachers were the second influencers to the subject choices. About 20.8 percent of the participants attributed their choices to the guidance offered by teachers. Tay, a Female-Nigerian at VarsE for instance expressed that:

> For me, my Maths teacher guided me to choose the science. In school, they used to tell us that when you do Science in SHS, you can do anything you want. You can divert to do Business and into the Arts field so Science is something broad (Interview Transcript 3: April, 2017).

Dalen at VarsC expressed how she had a close relationship with the proprietress who used to call and advise her to follow her footsteps by working hard in order to enter Wesley Girls High School in Cape Coast which happened to be her (proprietress') Alma mater. According to Dalen, at the end of every term, the proprietress inquired into her performance from all her teachers. When they were about to write the Basic Education Certificate Examination (BECE), the proprietress called her and inquired into the course she wanted to pursue at the Senior High School (SHS) level and having responded that either Arts or Science, '*she advised me to choose Science to challenge myself*'. SemarB, a female from VarsD also said:

> At the basic school, I was very close with my science teachers so before BECE, I didn't know what to do at the SHS and my dad asked me to consult my teacher since he knew my strength and weaknesses and therefore may be able to help me select the best subject. I did that and upon his [teacher] advice, I chose the science. So I can say that I had the encouragement from both my father and my teacher (Interview Transcript 2: April, 2017) .

NanaY a female at VarsC just like other participants wanted to pursue Arts in order to read Law at the University level but was advised by their teachers that they could divert to any course after reading the sciences. Being friends in the same school, they chose the same courses in the sciences. They said however, that; somewhere along their studies, the teachers' pedagogical skills put them off. They had no close acquaintance with the teachers whom they found not easily approachable. The classes were therefore a struggle for them. In lieu of this, the question that really needs to be pondered on critically is, what about the students who do not share close acquaintance with their teachers? Apart from the teachers, other societal views came up.

4.2.4 Social Influences / Public Perceptions

Other comments focused on the society as social constructionism depicts. What came out of the interactions is the expectations and limitations that the society has placed on boys and girls based on its erroneous perceived aptitudes attributed solely to boys or girls. In line with this, Thrif at VarsB explained the value placed on certain disciplines by the society in general for males and females. She stated that:

> It's like you are trying to take a position of a male. I don't know if you get it, like if a lady is the best in a Maths class, errh… everybody goes

> like - she is too-known, she's this, she's that. Ahaa! (Interview Transcript 5: November, 2017)

By this, Thrif is explaining the misguided notion that if a female studied hard to be the best in Mathematics in her class, she was seen playing the role of a male. The society has instituted certain gender roles and attitudes that are passed on from generation to generation. An instance was how a male classmate of Thrif expressed that he would not be in a class where a female will excel higher than him at the second-cycle level so when two female-students topped the class in Elective Mathematics, he changed the course. This nearly succeeded in killing Thrif's interest in Elective Mathematics so the following term, she relaxed in studying Maths. It however dawned on her that she should still work hard and ignore the behaviour of her mate. This is how she expressed it:

> It made me feel bad and the following term, I didn't take interest in Elective Maths but later on I was like if you want to leave, leave, I don't care so it came back. Sometimes society makes you feel like you are doing it too much. You don't do it and is, you are not doing and you are down. You are doing it and it's you are doing it too much. So with time, things will change (Interview Transcript 5: November, 2017).

This kind of stratification as reviewed in the literature really leads to skewness of careers in engineering by females. In other jurisdiction, the girls who topped the class in the Elective Mathematics could have been ridiculed and labelled as witches or others. Thrif was not overpowered with intimidation but was able to work hard in the sciences. Such a positive stance preempted the need for a discussion on the sustenance of interest in Mathematics and the sciences in general which is discussed after the cultural, economic and traditional practices that influence choice of scientific and technological subjects.

4.2.5 Cultural / Economic Influences

Culture has generally been defined as the way of life and living of a particular society. As was noted particularly in Ghana in the historical background analyses, males usually took up the trades and occupational skills of their fathers whilst females adopted the domestic chores. In the interviews, religion and marriage were issues of concern to females' science-related studies.

Most of the participants across the sampling were unable to state pure cultural practices within their environments but mixed them up with gender roles and religion. Thrif, a female from VarsB for instance, considered religion as a barrier to the participation in the sciences by females. To her, some religious leaders disallow females from mounting the pulpit which contributes to why females lack 'the can-do spirit'. This puts fears in females and reduces their confidence. The others at VarsB emphasised further that such religious inactivity by females inhibits their potential to disseminate information. They expressed the view that science deals with the dissemination of research findings by saying for instance, "*I saw this, I think this should be done"* but the restrictions of the sermon delivery lead to a stance whereby the females consider it normal to be inactive in speaking publicly. To the participants, if females are restricted to speak, it puts them off.

Again, the participants emphasised that males are religiously supposed to be the heads whilst females assume subordinate status hence sometimes some men refuse to acknowledge the importance of females. Such mentality often leads to the withdrawal of females in social set-up thereby limiting their initiatives - the participants asserted. This view was raised solely by the participants at VarsB who further expressed that such religious barriers can negatively transcend into technological practical activities. Two participants however, opposed this religious analogy and shared that some females play the roles of prophetess in the society thereby speaking publicly. It was difficult correlating these opinions and scientific practices and careers about females.

YaaT at VarsA on one-to-one interview admitted that she does not know about a specific culture but thinks that females pursuing engineering engage less in early marriages. She stated that:

> … our courses are demanding and need a lot of time. For Engineering, it is like when you go to class and you are being taught, you understand it but, if you don't sit up and spend a lot of time on your own learning, you will not get it. So we need to sit down on our own aside the teacher teaching us (Interview Transcript 4: April, 2017)

ManE at VarsD supported this view about marriage. To him, studying the sciences demands prolonged studies and most parents are impatient to see their female wards staying out of marriage for a long time.

Apart from religion and marriage, Jaet, a female at VarsD economically explained how reading the science courses is expensive hence some parents considering that as a burden and therefore guiding their female wards in choosing the Art courses. Probing into a situation about a condition where the parents are rich, Jaet responded that it may depend on the mentality of the parents that is, if they are not educated enough, they might think that choosing the sciences might lead to the females being absent from the home thereby denying the parents their upkeep. To the parents, females should take care of the family and the children but since science is demanding, it takes a very long time to complete. Dicta at VarsD also added to the financial constraint about the study of Computer Engineering. She thinks that a number of engineering courses ought to be subsidized by the government to ease up the financial burdens on parents since they might have incurred high debts catering for their wards from primary schools to that level.

4.2.6 Traditional Practices

Beside culture, traditional issues were raised. A tradition being an aspect or subset of culture, could be explained as a living social practice, value, habit or behaviour handed down through multiple generations and taught through emulation or living practice (McCormick, 2018). A tradition may be unwritten but accepted by a society. Regarding this, ManE, a male at VarsD expressed his views about the 'Trokosi' system practiced in certain parts of Ghana. To him, when the virgins are kept by some shrines to serve, it inhibits their inherent ability to explore their skills in science over there. Thrif, a female at VarsB also revealed that in a particular carpentry's workshop in the Upper Western region of Ghana, females are not allowed to hold the working tools. She expressed that:

> I saw this when I went for my Community Service (CS) that time during our third trimester in Wa, Gumeipala. In that CS, as part of our training, we were supposed to help the carpenters and engage in what they are doing so that we can also get information. They were all males. When we got there, one of the ladies said she wanted to know how they do it. She was just speaking and a man was like "no don't touch it, ladies don't touch it'… Since it wasn't our community and we have been told that when they say, don't do this, don't do it, we came back and were like -why don't women touch this thing?" (Interview Transcript 5: November, 2017)

Upon probing, Thrif explained that when they inquired into the reason, no explanation was offered except the statement - "*ladies don't touch it"!* She continued that the tool was a jack-saw and the male students on the same CS were allowed to touch and work with it. The explanation offered by two old women upon enquiries by the female-students on the CS was that the carpenters had no knowledge about the menstrual status of the females and it is an abomination to hold the tools since that could collapse their business if in the menstrual cycle.

Although the participants did not highlight issues connoting superstition, they expressed their views on the segregation of roles by the people in the communities. EmlaB, a female at VarsC expressed how the people in the communities consider certain practices more suitable to boys and others to girls as expressed under societal perception earlier. EmlaB said; "*they, for instance, think that the tools are too heavy for the girls to carry*". Supporting her, Dalen, a female at VarsC expressed that she personally does not think that any traditional practice affects the study of science but with the olden mentality that girls are for the kitchen, girls are to be house-wives, she stated:

> If you are a girl and you are pushing into the sciences, sometimes people will tell your parents that 'hei, the way this your daughter is going, she will become like this. They will all bring you down. I think it is the mindset of the people (Interview Transcript 1: April, 2017)

ManE, at VarsD who seemed more mature than his level again expressed issues of male/female dichotomy slightly associated with brain laterilization by explaining that the African system of education is stressful for females since females are not created to compete with males. Jazz (a male Nigerian) at VarsE expressed similar sentiments about females' inability to endure stress. He explained that everything boils down to the mentality of females: thus, they cannot face anything stressful so if something requires them to think, they would feel like it is for the males. She stated that: "*Ladies like more* *talking. When you ask a lady 'what is this? (pointing at a book), she will tell you everything but a guy will tell you - this is a book; simple! No more explanation!"* Phelps, at VarsC also added that: *"I think that largely girls do not like Maths. In Engineering, you have to be on the field most of the time. They prefer to be in the banks and stuff, be in air conditioning rooms*" (Interview Transcript 1: April, 2017). This also depicts the stereotypical notion accorded females in the society

Domestic chores were also discussed extensively. The participants generally, expressed that the males are usually allowed to rest therefore having enough time for themselves and their books in their homes whilst the females go through all the house chores before studying. As a result, the participants thought that the house chores could be distributed equally. OKA, a male at VarsC shared views about his sister who is a non-residential or day student that:

> When she returns from school, she has to engage in domestic chores like going to fetch water but the boys would not go and fetch water. Even if we the boys would go and fetch the water, after that we won't cook but the ladies would cook and wash utensils. Aside that I have been advising my sister to learn; that whatever she doesn't understand, she should see me but she won't do that (Interview Transcript 1: April, 2017).

On this issue, it was further discussed by the participants that since the boys in the single sex boarding schools sweep and still survive, this should be replicated at home too so everyone should be involved in the house activities. Each member of the house they think must be aware of the routine in the house and that the society should stop the practice of considering those who 'seemingly' go against that norm as disobedient or insubordinate.

Further discussions by the participants revealed that when a woman rises to a certain level, the society believes that "*she acts something else; she acts above her power"* so the society discourages females from attaining certain status. To the society, females have got to be submissive to men. On this issue, Shino a female at VarsD expressed an issue from post-modernist perspective that:

> There is this theory they call Feminism indicating that women have come to take up the world. When they take up the world, they will become their own bosses and they become independent… So they will not want to get into any relationship. The men don't like that so the society does not encourage females into venturing into that area. (Interview Transcript 2: April, 2017).

Probing into whether it is only by studying Engineering that leads to this assertion, the other participants in the focus-group explained that when the women enter Engineering, it means they can do everything that the men are doing. During the transcription of the interviews too, a Nigerian male-participant mentioned a cultural or traditional practice known as '*nzulezelo*'. This could not be probed during the interview because it was presented undertone. Attempt to discuss it outside the interview on phone failed. Curious to find out what this was and though outside the sampling, a further follow-up with a Nigerian Professor revealed that the word (nzulezelo) is unfamiliar but there is a myth in some rural communities in Nigeria and other African countries where parents discuss that the study of Science and Mathematics by females leads to madness in females and those subjects are to be studied by males. The Professor added that literacy is gradually eroding that notion. These issues being discussed may not all be cultural or traditional but often the social environment of the school community too. In some cases, females may show appreciable interest in the sciences but would be frustrated by other issues happening within the learning environment.

This led to two females Ela and Elena respectively at VarsC and VarsA discussing the encouraging aspect of lecturers directing Teaching Assistants (TAs) to assist the students with further tutorials after the normal lectures. This was however found different at the second cycle level where National Service (NS) personnel were posted to the schools to assist. Emla, a female at VarsA, in retrospection, expressed how she got discouraged in studying certain science-related subjects at second cycle level due to the behaviour of a NS person. She regretfully stated that:

> I wanted to be a doctor (she repeated), because I liked the science subjects. I had problem with Chemistry so did not get the required grade. I had to write it thrice without success. This problem was because the Master who taught Chemistry (young NS person) did not like me (with tears welling in her eyes). This was because he will ask me to come and work in his house but I always went there with my friend. … The Master therefore hated me so when he comes to class, I will dodge and that's the main cause for my failure in Chemistry. The science girls might have faced similar problems (Interview Transcript 4: April, 2017).

Other opinions shared by some of the participants revealed the difficulty associated with the studying of the sciences and mathematics and this has been interwoven in the next analysis.

Research Question three (3): ***How do identified pedagogical strategies influence the interest and choice of technology-related disciplines by females?***

4.3 Pedagogical Strategies

The observation of lecturers' pedagogical skills to examine how science-related programmes are presented was conducted in three of the sampled Universities. The design was based on the Flanders Interaction Analysis Categories' (FIAC) and UEW Intern Teaching Evaluation form IRB3 checklist designed at the methodology stage. The five out of the ten (10) different categories propounded by Flanders (1970) utilized in this study included: lecturing (formal presentation), Motivation / Empathy, Collaboration and Questioning

4.3.1 Lecturing / Formal Presentation

It is noteworthy that all the five lecturers presented their lecturing systematically with standard and effective communication skills. The lecture-discussion method employed by the male lecturers at VarsE and VarsA were in line with FIAC and UEW intern evaluation form IRB3. They were also in conformity with Gill's (2016) specified lecture technique. At VarsE where data gathering on the observation began, the male lecturer taught Oil and Gas Engineering. Apart from the systematic presentation, he consolidated his session with multimedia including slide and flip chart presentations, diagrams, video pictures thus reducing abstraction. He introduced the lecture by reviewing the previous lecture and spelling out the objectives. The lesson was presented to the whole class with no practical demonstration. Questioning by the students however, portrayed that the lecture was well understood. The female-lecturer observed at VarsE mainly used marker-board illustrations to derive some formula on Colour Processing 'in Biomedical

Engineering'. She also explained Colour Formation on the topic and about twenty minutes of her period was used for dictating notes to the students.

The second University for the observation was VarsA. Here, similar to VarsE, a male and a female-lecturer presented their lectures on Material Engineering and Technical Communication Presentation respectively. They also presented their lectures systematically, utilizing power-point presentations. During the session of the male-lecturer, he invited two male-students to use the projector to explain certain points about the content of the topic. The students were excellent; being able to use Power Point to present solutions to assignments given. As a result, they were spontaneously complimented with claps from both students and the lecturer – a real mark under FIAC's category under motivation. Only one out of the three females was punctual. When enquired into, the lecturer explained that the lateness was due to a field trip embarked on prior to the lecture. The female-lecturer at VarsA lectured Technical Communication Presentation instead of Agricultural Engineering (AE). The researcher became disappointed and this happened due to a miscommunication between the researcher and the class representative who was introduced by the observed female-lecturer to the researcher on the telephone to direct the observational exercise. Nonetheless, the topic taught was interactive with power-point presentation. It was an Interdisciplinary class of 80 members with females forming 25 percent. The AE students in the class were sampled for the post-observational interview.

At VarsB, only a male lecturer availed himself to be observed. He presented a lesson to a relatively large class of 72 members with females forming 22.2 percent of that number. Initially, the public address system failed to work so the presentation was inaudible.

Being the final lecture for the trimester, it was a revision-lesson of facts and concepts. This was in tune with FIAC's category five (5) that emphasizes lecturing by facts, concepts and procedures for experiments. The lecture was mainly presented with marker-board illustrations only. What probably was generally missing in the presentations in the light of FIAC's strategy was the acceptance of feeling/empathy as described next in the motivation stage.

4.3.2 Motivation / Empathy

Learners are generally expected to be motivated to learn for positive results in their future careers or endeavours. Most students at university level are intrinsically motivated but it has been observed that rewarding students for efforts made yields positive results. At VarsA, the students were highly praised even with claps for solving the assignments correctly. The only issue was that none of the female-students volunteered to solve a problem nor respond to questions.

At VarsE, both males and females responded to questions. For his part, the male-lecturer showed real empathy by reacting positively to students' questioning. He did this by calling the students by their names and complimenting them with words such as 'very good' and 'excellent' in response to their contributions. The female lecturer at VarsE however, was different. She did not show much empathy. She mainly used marker-board illustrations to derive some formula on Colour Processing in Biomedical Engineering after explaining Colour Formation on the topic. For the next twenty minutes of her period, she dictated notes to the students. There was thus, minimal interaction with the students. The size of the class was 33 with females forming 39.4 percent

4.3.3 Collaboration / Questioning

One of the principles in FIAC is that difficulties could be addressed with co-operative goodwill and coherent theoretical framework that clarifies human dynamics. In juxtaposing this with the observation, the male lecturer at VarsA collaborated with the students by inviting them to the board to solve the problems set as homework. He further extended the students' knowledge with additional information on the topic. Further clarification of the day's topic was done with the power-point presentations of electromagnetic chemical bonding.

At VarsB, collaboration was missing perhaps due to the lesson being mainly a revision one. Most of the females had their heads on their desks and this was shared by the participants during the post-observational interview. The students failed to ask questions for further clarification or explanation of the content.

At VarsE, the real objects in the form of rock and petroleum products as well as the video presentations infused into the lecture promoted reality that aroused the students' interests. Both male and female students asked questions during his session. Here, during the female-lecturer's presentation, again, the students failed to ask questions perhaps due to the explanation having been followed with lengthy dictated information. The marker-board was extensively used as an aid with sketches. Such a strategy and others might have preempted a notion of scientific disciplines and mathematics considered difficult.

4.3.4 Difficulty in Studying Science and Mathematics

ManE at VarsD shared his views about the prolonged studies associated with science disciplines. In his response to a question, he explained that the prolonged nature of the programmes in the sciences keeps female-students staying out of marriage for a lengthy period. In a similar vein, it emerged that the number of courses offered in the University per semester were too many therefore being non-commensurate with the duration. Perhaps it is the difficulty associated with the courses that makes them seem too many to be accomplished within a semester. Cephane, a female-participant at VarsE for instance, stated that:

> Only males should be allowed to do Technology or Engineering. Yes, because the engineering course is tight, very tight course. To cite an example of the tightness, [pausing for about four seconds and with a low tone, she said], hmmm! last semester, they offered us some 10 courses or 11 courses and being a woman or a lady who has started life progressing, at least you should have time for yourself to think about your social life or something … every time it's book, book, book. If you're not with your books you're at the workshop or lab and you can't even get small time for yourself. It's not good. For the men anything goes. They move about any time; come anytime they want so the course should be for men. (Interview Transcript 3: April, 2017).

Bimga and Wiltin (females) at VarsC also expressed their frustration at the additional courses and numerous topics that they have to pursue. Bimga stated that:

> Although this is a Christian Institution, Adventist per-se, I don't understand why I am doing ICT and I'm asked to study Earth Science, Principles and Practice of Christian Education and Music. I don't know where I am taking that to; and don't know where and when I'm going to dance (the other focus-group members burst into laughter) (Interview Transcript 2: April, 2017).

Wiltin also expressed her frustration at having to study about 500 topics with numerous slides before writing the end of semester examination. She stated that:

> I feel so exhausted. There are too many slides (about 500). They should tell us exactly what they want and go straight to the point. I am just

> tired. Stop wasting our time, stop wasting our reasoning! (Interview Transcript 2: April, 2017).

When the researcher attempted to explain the need to include other courses to broaden their knowledge and expertise, they in unison exclaimed that; "*but it must be related to the course!"*. Based on the same notion of difficulty, Thide, a female at VarsE (sharing her retrospective experience) discussed how her father discouraged her contrary to what had been shared by majority of the participants earlier. She stated: '*my dad asked me: 'Are you good in Maths?*' To Thide, the father ought to have rather encouraged and supported her to achieve her goals rather than ask discouraging questions which would stereotypically heighten the fear of Mathematics as a difficult discipline. This researcher thinks that although the father is exhibiting control over her child, he might not have the skills to guide Thide in Mathematics hence that questioning. The father was also being stereotypical about what the society considers about the sciences and Mathematics as being the preserve of males (social constructionism) and this really upset Thide.

Reminiscing, Boam, a female at VarsE made a reference to the attitude of parents in the olden days when most ladies ended up in the kitchen. She explained that some parents still think that Engineering is associated with hard-work (inferring difficulty) hence should be studied by males.

The parents, Boam further opined, think that the science courses being too demanding and tasking would not offer the ladies the opportunity to get involved in domestic chores. Neither would careers in them allow them enough time to spend with their families in their future married lives.

The duration as a matter of fact was a concern to the study of the sciences by the females. The parents prefer to see the females still in the vocational area by sewing cloths or

buying and selling. In these areas, they would have sufficient time for themselves to pick up culinary, washing or home making skills in order to have successful marriages and children. Parents, especially females, are more concerned with their daughters being good wives and mothers than being successful scientists. Afb, a female at VarsE supported the demanding and lengthy nature of studying the
sciences raised by Boam by stating that:

> Probably if you want to be a medical doctor, you have to go to a medical school and my sister who is in medical school is not easily seen. Sometimes you may see her once the whole twelve (12) months (Interview Transcript 3: April, 2017).

It is therefore observed that although parents influence their wards' choices of disciplines as analysed earlier, some participants narrated how they still feel unhappy about what they are studying since parents exerted some form of coercion on them to pursue the science course. Lyjune at VarsA said passionately that: "*I still find myself stressed up because I am battling with the course I did not want to pursue. I wanted to get into the languages"*. Thrif, Oval and Oaten (a male) at VarsB in effect, viewed that usually females leave the critical thinking and intuition to the males whilst they just listen. This the participants thought could be the reason why females are good in observation and verbal ability therefore well versed in language skills. Thus, the participants revisited the female/male dichotomy of brain lateralization analysed earlier. Oaten therefore said that:

> Okay, I think that when you are growing up, one thing is most of our teachers who teach us Mathematics are men. If it were to be women teaching it, the females will look at her and say, ah, I want to be like this Madam but, most of them are males so they feel like it is only

> males who can teach Mathematics. (Interview Transcript 5: November, 2017).

This quotation by Oaten really infers the importance of role modelling to people especially females. There was also a general consensus that the participants grew up to meet the societal norms and because of what they picked up from the initial stage with other children, that mentality of differentiated roles have been ingrained in them. Oval pointed out that to them, friends, parents, adults and those grown-ups just tell you that; "*you are a lady; Maths in general is not your field. It is for the guys so because of that you just grow up with that – fearing Mathematics*" (Interview Transcript 5: November, 2017). The participants continued that females get scared of mathematical concepts dealing with equations and complex formula but usually engage in debates and arguments. The participants explained again that this might confirm why people assume that females possess verbal ability as compared to spatial or mathematical and scientific ability. It was worth looking at some of the strategies employed in teaching mathematics.

4.3.5 Pedagogical strategies in Mathematics

A number of the participants attributed the difficulty in studying the core subjects such as Mathematics and Integrated Science to the strategies employed in teaching science-based subjects at basic and second-cycle levels. It was viewed that females are usually un-attracted to Mathematics because sometimes the tutors in the second-cycle level throw the questions to only the males thereby neglecting the females. Most of the female-participants in that regard reflected that the tutors think that the boys are less serious so they try to get them involved. They further discussed that the male-students in general were noted to attend lectures late and also, when lecturing is in progress, they continuously chat on their mobile phones so the lecturers try to secure their attention. By chatting, though not probed further, it is assumed that the males use their social media such as *WhatsApp* quite often during lectures so attempts are made to secure their attention by directing questions at them. OKA confirmed this with:

> In my class for instance, when we were in level 100, we had quite a number of females and there was a very good Structural Engineer who taught us Basic Structures and he throws questions across board whether male or female but, he realized that some of the boys were not pulling their weight and so decided to focus more on them. What is happening there is not that he feels this class is best suited for males but probably he's trying to get the boys to be involved. (Interview Transcript 1: April, 2017).

Elena, a female on One-to one interview at VarsA also shared that their enrollment in the first year was too large to be handled by the same number of lecturers. She stated that:

> When we came we were all engineering students. The first year we were all doing all the courses and over six hundred (600) because we were two batches that had come together. Previously we were about 200 then having gone up three times or so, we were a large number so the lecturers couldn't balance us as compared to the [previous] numbers. (Interview Transcript 4: April, 2017).

According to the participants, the Mathematics lecturer during the first year was Dr. Nasyib and he supported his teaching with power-point illustrations showing several examples of mathematical calculations on the slides. He however, did not move through the class perhaps due to their large numbers. The participants also complained that the slides were not visible enough so only those seated in front benefitted. Elena further stated that: "*We were packed in the class*" (Interview Transcript 4: April-2017). Since mathematics was considered very difficult, the next question sought opinions from participants on how they were able to sustain that discipline to progress to pursuing engineering programmes.

4.3.6 Sustenance of Interest in Mathematics and Science

Most of the participants, especially the females, admitted that the students who took the Mathematics course in the university performed creditably well though sometimes the style of teaching did not allow them to get the full grasp of the subject. Nevertheless, because they were science biased, even if the Mathematics is difficult, they preferred that to reading a whole lot in the reading courses. Reading for several hours, recalling and writing down the information becomes a burden to them. The participants acknowledged the fact that there is still a lot of reading in the sciences since science has its own literature too but, they usually have the problem with the reading courses. Elena, at VarsA on one-to-one interview submitted that:

> My interest went down in the Maths because I wasn't able to think. Most at times, I learn with visual lens so if I'm not able to picture from the formula and how it correlates to what I was supposed to do especially with the environment, I will not be able to understand it . I will be able to remember that formula more through correlation than just writing the formula on the board for memorization. It doesn't make me to learn but one thing is if I get it wrong, they don't have time to correct because we are a lot (Interview Transcript 4: April, 2017).

Jazz, a male at VarsE also expressed that he preferred Physics and Mathematics and his interest was sustained because he said: "*I don't like anything that is easy. I love difficult things*" (With that, all the participants burst into laughter with the exclamation eeeh!). Probing into what makes Physics difficult, Jazz added, "*Physics has a thousand plus* *formula which you put into your head, derive and all those things; and I hate reading*" (Interview Transcript 3: April, 2017). Jaet, a female at VarsD also shared that she preferred Biology and its sustenance was based on the things around. Thus, she has always been eager to learn more about things around the environment for instance '*the body'*. Camal also expressed that his favourite subject was Biology and his interest was sustained due to the way "*the tutor puts us into practical Biology for us to understand what Biology is*. *Thus, he taught the lesson practically for all to grasp the meaning of what is being taught"* (Interview Transcript 3: April, 2017). TunF, a female at VarsE said her interest was in Chemistry because of the way the teacher handled the subject thus, he went through it systematically at the second-cycle level. YaaT also explained how she acquired interest in technical education as early as in the junior high school (JHS) by visiting an uncle who owned a carpentry-workshop. He allowed her to practice how to saw thereby arousing interest in her. This again reaffirm influences wielded by relatives as discussed earlier.

Two females and a male foreign-participants at VarsE said they had no favourite subjects and were alright with all the subjects pursued. Their interests had been sustained for varying reasons. One of the two - Perp, shared that if she had to make a choice for a favourite subject at the second cycle and how it was sustained, then she would go for Food and Nutrition (F&N) and all the focus-group interviewees burst into laughter. She reasoned that F&N deals with food and she likes cooking. This implies that Perp may not be overly content with the engineering course being pursued. Dens, a male at VarsE said he preferred Geography because it was simple to understand due to the way the teacher taught it. Dens added that the way the teachers explain lead to the understanding or misunderstanding.

The responses by the participants under sustenance again exhibits the multiple functions performed by the teacher. Thus, apart from influencing the students in their subject choices, the teachers are again instrumental in sustaining the interests of the students based on the way they teach. Pedagogical skills play great pivotal roles in motivating students' studies.

4.3.7 Post-Observational Interview of Lecturers

Prior to the interviews of students, the lecturers who lectured for observation were interviewed. Asked about how he entered Sciences, the lecturer at VarsA explained that he was very good in drawing so wanted to get into Visual Arts. However, his father being an educationist, encouraged him into the sciences (influence of parents in subject choices). Asked whether he has held any regret for entering into science, he responded in the negative. Nevertheless, he admitted that there were lots of interferences including undertaking of extra classes to cope fully in his senior high school (SHS) studies. Asked how females could be encouraged into the sciences, he responded that they should be regularly praised for the least effort. He also mentioned the need for counselling and career guidance right from JHS through to SHS. Again, when the researcher asked whether females and males' brains are naturally structured for high ability in languages and mathematics respectively, he responded that he does not hold that view.

A similar post-observational interview session was held with the female counterpart. This was however cut short because she had to attend a meeting. According to her, she was also encouraged into the sciences by her parents and explained that females could be counselled to enter the sciences. She also viewed brain lateralization "*as mere fabrication by the society and that she believed that females could be encouraged through sensitization programmes*".

The post-observational interview with the male-lecturer at VarsA, concentrated on his background and what measures or kind of interventions being put in place to motivate females into technology-related programmes. He explained how VarsA has been involved in a quota system where females are privileged though undocumented. Asked how he was able to teach so competently, he explained that having gained professional knowledge at University of Cape Coast (UCC), he applies the teaching principles learnt there.

The post-observational interview with the female lecturer at VarsA also concentrated on how she entered engineering and of interventions that could be put in place by the institutions to encourage females into technology-related programmes. She gave responses similar to what the male gave. Additionally, she explained that VarsA has been assisting qualified females through unannounced or unpublicized efforts. After the interview, she invited a level-400 female Agricultural Engineering (AE) student (YaaT) to be interacted with. The researcher therefore conducted a One-to-one interview with her prior to the focus-group interview with the Material Engineering participants. The responses by YaaT has been woven into the analysis. Although YaaT was not sampled by the researcher, she gave very rich life experiences in her pursuance of science and the researcher has been thinking that perhaps the female-lecturer knew her performance and suspected that she might be able to respond to the questions successfully.

At VarsB, only a male lecturer was observed as noted earlier. The post-observational interview was postponed till the next day because the lecture was held in the evening followed by an end-of-trimester quiz. The male lecturer gave responses similar to that given by his colleague-lecturer-participants. The female lecturer who was supposed to have taught Mathematics at VarsB explained that she was no more handling Mathematics but rather Business Management.

4.3.8 Conclusion on Observation

In all the presentations, as expected of FIAC, there ought to have been verbal interaction initiated by the students but, this was missing. Students' participation in the sciences ought to be based on their inquisitiveness, how well their interests are piqued and how well they are motivated to explore both by explanations and practical demonstrations. So efforts must be made to pique their interest. The observation fell short in this. Practical demonstrations were lacking, and the students did not seem overly enthused. Generally, demonstration of practical work was replaced with the power-point presentations. Also, in considering the UEW's Intern Teaching Evaluation Form IRB3, one would not be wrong in concluding that the students in general were not engaged in critical thinking and problem-solving skills as expected of science students. Lecture-theatre or classroom management and communication skills however, were effectively done. The next analyses reveal the views of participants on their past and present experiences in terms of the most and least-preferred pedagogical skills

4.3.9 Interview Responses on Most Preferred Pedagogical Skills

At VarsE, the most preferred lecturers in terms of pedagogical skills were Mr. Tesax, Dr Labson and Mr. SSP who handle Physics, Geography/ Earth Science and Information Evaluation / Drilling Engineering respectively. Reasons assigned were that they approached the teaching sequentially. Notes given were self-explanatory and they were noted to group students and offer explanation to each group in detail. They also ensured that none of the students was left behind.

At VarsA, all the participants selected Dr Bodank (though no longer there) as the most preferred lecturer except two participants. They confirmed that they understood everything he taught them right from the scratch. To the participants, Dr Bodank was very knowledgeable in the subject matter and he explained every topic to the core. Doko, a male at VarsA for instance remarked:

> The first time I stood in his class, it was as if I have learnt it so many years and he was just brushing over it because he started from the basics. He assumed we knew nothing so there was nothing left (Interview Transcript 4, April, 2017).

DalenB, a female at VarsA also stated that:

> My best lecturer is the one he just talked about (Dr Bodank). He took us [in] Basic Structures and as I mentioned earlier my Physics was so bad in my secondary school so when I came here I didn't know anything. I had no idea about what I was doing. He made me to understand everything and told me to see his TA if I needed further help (Interview Transcript 4: April, 2017)

Prof Kokog was the second best lecturer preferred for he was noted to start his lecturing from the basics whether students have knowledge in the topic or not. He was also noted to make the session very practical and he explained the content in detail. Dr. Tuffag's lecturing was also preferred because he lectures with a power-point presentation with several examples and clear explanation to the power-point slides. He also makes the lecture a source of conversation and interactive by involving all the class members including the females.

On one-to-one interview, at VarsA, YaaT explained that her best tutor at the SHS was her core Mathematics tutor. She liked his teaching because *"he doesn't mind coming to sit with you explaining till you've understood. We were 61 in class but he made sure you all understand".* YaaT further shared that at the University level, Dr. Cherry was her best because he usually provided the lecture-materials they needed to study. Again, before Dr. Cherry assigns students work, he would offer guidelines as to how to go about the assignment. Furthermore, he would recommend a book for downloading from the internet but "*won't tell you to calculate anything but will just throw simple questions to you to know if you have read the book".*

At VarsB, the participants named Dr FitalOA as the best lecturer and confirmed that the way he explains everything in detail helps everyone in grasping the basis and everything. They maintained that irrespective of one's level of understanding, he tries to explain and support the lecturing with physical or concrete examples. They also indicated that Miss. Nijel who lectures Cell-Biochemistry was another favourite. According to Thrif, the woman makes them feel that the "*molecules being drawn are so close to them"*. Again, she is known to ask a few questions and though she expected certain kind of answers, if the answers given deviated from those expected, she treated that tactfully thereby reducing the embarrassment one feels in coming up with less accurate responses. She in effect probed and prompted students to come out with further responses instead of refuting wrong responses outright. The discussion led to the least preferred pedagogical strategies by lecturers.

Although no observation exercise took place at VarsC and VarsD, the participants were interviewed on their most preferred lecturer and the reasons for their preference. Not much was gathered about the names of their preferred lecturers at VarsC but the methodology of lecturing was discussed. Keyna, a male for instance stated that:

> Our lecturers ask us questions but one thing that is actually lacking is practical-work. We are in class doing theories and he doesn't even come. He comes once in every semester when we are about to write exams (referring to the demonstrator to take them through the practical component) (Interview Transcript 1: April, 2017).

At VarsD, the participants mentioned Sir Harles, Dr Asbby, Dr Barry, Mr. Seko and one Dean who is a professor (name unknown) who handles Mathematics. Some of the reasons assigned were that: "*he [Dean] knows how to manipulate figures, he takes his time but does not delay; and he uses audio-visual aids like tape-recordings and television"*. Dicta said this about Mr. Seko: "*He is best because he expands the topic and is able to finish the whole course. He tries to come to everyone's level although we're about fifty (50)"*. The researcher wonders if indeed the lecturer is able to appeal to all fifty members of that level. The participant might be exaggerating.

4.3.10 Interview Responses on Least Preferred Pedagogical Strategies

In giving their responses on the least preferred pedagogical skills, generally, the participants stealthily looked round to ensure that no person other than the participating group was around before responding. Most of the participants at VarsB revealed that Messrs. Telke and Ambor were the least preferred lecturers. They attributed their disinterest to lack of explanation during delivery of lectures. PEF a female for instance, stated that:

> When he [Mr. Telke] comes to class, he'll just sit down, dictates the whole notes and if you ask him you don't understand, he looks at his notes and dictates the same thing. He doesn't even give handouts. It's his notes. If we say, Sir, we don't still understand, he will say "go and read more". That's what he does. He just comes and sits down; dictates, dictates, dictates till he goes". He doesn't give handouts. It's his notes (Interview Transcript 3: April, 2017).

All the participants in that focus group said in unison that they had complained several times to no avail. To them, nothing has been done and it is always the same procedure. Further probing by the researcher revealed that as practiced in almost all tertiary institutions, there is usually staff-assessment by students at the end of every session be it trimester or semester but there is no change in the pedagogical treatment by the lecturer. ManEb (a male Nigerian) also stated:

> It's the same lecturer as explained by them but, my view is different. He keeps telling us that he wants us to write in our own understanding, but, if we do that he still fails us and it's a reading course and I don't like reading course and the course is bulky already so it makes it difficult to understand (Interview Transcript 3: April, 2017).

The participants belaboured this point wishing that they could find means to negotiate with this lecturer - Mr. Telke to adjust his attitude just like other lecturers by being considerate with award of marks. They assumed that if a student is left with only a mark to be successful, the lecturer should consider and pass the student but, he would fail the student. This would call for a re-writing of examination. ManEb continued with:

> Actually we love him [as a] person, no hatred but you can't move him for a student to go through successfully. He's too rigid, he's very, very, rigid, he's too strict. … That is one of the problems that we have and I don't know whether it's a problem or not (Interview Transcript 3: April, 2017).

The researcher finds it difficult to comprehend how the students came by the marking scheme to determine border-line cases. They based their arguments on the fact that other lecturers re-consider students' grades upon negotiation. Dens at VarsE also described a lecturer as:

> His name is Mr. Bryan Basin (B squared or 2B), Hmm! Wow! I think for years now the man has been a thorn to some students' flesh. Sometimes he talks some words that will threaten your emotions, sometimes as if you're so useless because of the way the man will talk to you. This man in question now, this is not the first or second time and his case has been reported to the school. Sometimes it looks as if he has to import some feelings from his house to the classroom to look for some students to punish, you understand? It is very bad, very, very bad (Interview Transcript 3: April, 2017).

Seeking views on how the practical teaching is carried out, Jaet a female at VarsD said; "*there is no practical; practical is totally theory. Practical 'dee' we don't do anything"*.

At VarsA, seeking opinions on the lecturer whose teaching is least preferred, most of the students mentioned one Dr. Moru who teaches Structural Engineering. To them, although the foundation had been laid solidly by Dr Bodank, at Level-100, most of them were not pleased with the continuity at Level-200 by Dr. Moru. They argued that though he is knowledgeable, his lecturing does not appeal to them because apart from usually not starting from the basics, he sometimes only reads prepared notes to them.

On one-to-one at VarsA, YaaT shared that her least preferred lecturer was Mr. Senate who handled Agricultural Engineering Material. Although YaaT grasped what he lectured, due to limited time for vivid explanation - thus lecturing all the time, she did not really like his class. She quickly stated that "*though per their titles[lecturers] lecturing is what they are supposed to do"* but she usually does not grasp what he lectures.

At VarsB, the -participants commented on the observation conducted by the researcher regarding the session by the male lecturer. They explained that the lecturer normally involves students in discussions but that day's lecture was not the best perhaps due to the initial failure of the public address system. Oval therefore stated that:

> For me, before he lectures, he tries to let everybody participate equally but, naturally girls, we don't like boring things, we like things that will make you laugh. We don't like things that will make you bored like seeing these on the board – equation - Ahaa… we like things that are very interactive that you talk, I talk, you talk, or debating; that's what ladies mostly like because we talk a lot. So if you come and you see only equation, you know that the ladies will become scared. (Interview Transcript 5: November, 2017).

On the preference of pedagogical skills in general, most of the participants at VarsB stated that their least preferred lecturer was the one who lectured Biology at Level-100 known as Mr. Jahel. To them, he is irregular to lectures and he makes the lecturing very boring because he reads the notes already given as handouts to the students to the class. The rest mentioned Dr. Damiel who handled Earth Science that most of the students who read that course had no foundation since they did not read Geography so they were making effort to pick up from the scratch but that was very difficult. Probing into the strategy adopted by the lecturer that dissatisfied them, Thrif stated that:

> When you ask him a question, he's automatically angry about the question you asked. Sometimes we are like Sir, we don't get what you are trying to say. He will say, I have gone beyond the earth I am standing on. He makes you feel like if you can't understand it then just leave it and it was a little embarrassing (Interview Transcript 5: November, 2017).

In actual fact, the researcher is of the opinion that the selection of candidates for particular disciplines must be guided by the foundational subjects. If one does not have a good mathematical background for instance, asking the student to pursue any area in engineering would become a daunting task. Geography, for instance, is the foundation for Earth Science and without it, too much pressure would be exerted on the lecturer who is to handle Earth Science. So also will the advance course work be difficult for the student without the basics. A male-participant Trempo also named one ManicA and described him as:

> He handled Maths in Level-100 and the guy, when he comes to class and is teaching, (and you know Maths is supposed to be calculation), …involving me to know this is what is going on but, the guy can mention a whole equation, the answers, the questions even the method with words. … It's Maths so I have to sit down and write the thing. By the time I finish, he would finish saying the things and my mind has already buckled to somewhere else. He teaches in a way that makes it look like if you don't get it, then you are the daftest person ever (Interview Transcript 5: November, 2017)

Dr. Zoman who handled Maths was also named as one of those whose teaching was least preferred. Tosh therefore expressed his view that:

> He will bring your spirit down. He will inform you that ooh we have a test tomorrow so go and prepare on this particular topic. Everybody will go and prepare it. Some will even have sleepless night, but the following day he will come and the question will be as if you have not done anything. After that he will discourage you and also insult you that you have to go back to JHS and study. He does this to both the girls and the boys. This even led to one of our ladies getting sacked '*koraa*'. The lady was my project group member and just because she didn't perform in one of the tests, instead of him [Dr. Zoman] to encourage such a person, he even made her sad. The lecturer's teaching style was okay but he was too fast because we can't all move at the same pace. Also, we don't all have the same thinking ability… With that discouragement that if you don't perform, you will fail, whenever you're even writing the exam, you have in your mind that this one has discouraged me already. You've got that kind of low esteem (Interview Transcript 5: November, 2017).

At VarsD, two main lecturers namely - Mr. Bodiz, a French lecturer and Pastor Mooret the Philosophy lecturer were least preferred. The French lecturer had been noted to insult students at the least provocation. Lyjune, a female expressed that: "*the area is not our language so the way he teaches is not the best*". The Pastor was also noted to talk very slowly hence EmlaC a female stated: "*he is dead boring – one-way teaching"!* Probing into the reason why that is the case, EmlaC continued: *"this is Philosophy and he reads the slides. He can also ask one or two questions in a whole lecture of one to two hours"*. ManE, the only male-participant in the VarsD focus-group since the other male could not be reached, remarked that the one whose lecture he disliked was Dr Bandish. ManE further expressed that the lecturer has adequate knowledge in the area of specialisation but, does not have the skills of communicating to the students. He stated that: "*Basically, he expects you to see things the way he sees it. Majority of the time, he reads and doesn't take his time to explain and even those trying to make efforts end up losing interest*". When probed further into the consequences of this on female technology-related studies, ManE responded that: "*discouragement is what females don't like at all. At least whatever a female does, try and find a way to polish that up".* According to the rest of the participants, they did not remember the last time that lecturer complimented or praised a member of the class. Toshb stated that: "*Most of my mates were not too happy because you have to come and rewrite his exam, come under that stress again*" (Interview Transcript 4: April, 2017).

4.3.11 Conclusion on Interview

From the responses, quite a number of issues have been put forward by the participants regarding most and least preferred pedagogical skills and also, pedagogical strategies by lecturers. These include: explanations to content of the subject matter, the use of audio/visual aids especially power-point presentations, need for practical activities and lecturers' reaction to students in response to questions and a need to reduce the reading of notes to students.

In summary, students prefer lecturers who explain the content vividly to them. All the reasons given for the least-preferred lectures hover on lack of explanation. The participants also expressed concerns about lecturers who insulted them when they asked questions.

Apart from the parents and other family members, teachers were the second largest influencers on students' choices of subjects. The teachers are therefore acting as parents and some of the students may be slow learners. It behooves the teachers to communicate to students that asking questions and making mistakes are part of the learning process. Therefore, no student should ever feel embarrassed to ask questions. Insulting students when they ask questions is unprofessional. Students are seeking knowledge, trying to get into applied sciences hence, the need for tolerance in dealing with their questions is absolute as reviewed in the literature. In point of fact, teachers can boost the self-esteem of many students by encouraging them, verbally or otherwise and showing interest in their academic work instead of hindering their progress in class with insults when they ask questions.

The use of audio/visual aids was commented by most of the participants. Surely, abstract concepts could be clarified with visual presentations. Students really learn from concrete to abstract, hence the use of audio/visual aids to stimulate their imagination and creativity is laudable.

The participants were also displeased with the lack of practical activities. Practical-work could promote active learning to ensure deeper understanding of the content of a subject. When students merely listen to lecture-notes dictated from handouts, the lecturing becomes boring leading to statements like; '*ladies do not like boring things'* made by some of the participants. Since engineering is practical-oriented, when students engage in activities practically whilst applying the scientific theoretical principles, they are motivated and therefore encouraged to resolve problems critically with higher order thinking. They are able to evaluate the merits and demerits of scientific data. As students carry out practical activities especially in groups, they learn how to integrate with each other and reach scientific consensus. This is how phenomena could be approved or disapproved scientifically. Not only do laboratory demonstrations help students grasp concepts but they also make it easy to remember. In the literature, Weber and Custer (2005) emphasised that females like collaborative learning. So, this must be enhanced in the universities. Students are able to grasp scientific concepts holistically without becoming didactic.

From the responses of the interviews, there is no doubt that leaders' behaviour could effect changes in negative behaviours. According to the participants, nothing is usually done about their complaints on the negative or weak pedagogical delivery. An instance was shared by Shino at VarsD where a lecturer was able to detect the handwriting of a student and started abusing that student arbitrary. When the researcher explained that the sheets are worked on by the quality control and are not distributed to the lecturers, the participants were a little bit apprehensive that the form got to the lecturer. It is therefore worth analysing the next theme on leadership.

In all, there were 383 students pursuing the engineering courses out of which 53 were sampled. Additionally, five (5) lecturers were sampled. Table 4.3.1 and Figure 4.2 below represent the details of enrolment of the Level-200 students. The statistical figures were completed by the staff who participated in the research in the demographic details at Appendix 10.

Table 4.3.1 Enrolment of Level-200 Students pursuing the sampled Courses

Date of Observation / Interview	University / Course	Department / Course	Males	Females	Total	%age of Female
4/4/17	VarsC Civil Engineering	Civil Engineering	15	2	17	11.8%
5/4/17	VarsE Oil & Gas	Petroleum Geology	19	2	21	9.5%
5/4/17	VarsE Biomedical Engineering	Digital Image Processing	20	13	33	39.4%
6/4/17	VarsD Computer Science	Computer Science	126	21	147	14.3%
19/4/17	VarsA Interdisciplinary	Technical Communication Presentation	60	20	80	25.0%
21/04/17	VarsA Material Engineering	Computational Material Modelling	9	4	13	30.8%
23/11/17	VarsB Biochemistry	Analytical Chemistry	56	16	72	22.2%
Total			305	78	383	20.4%

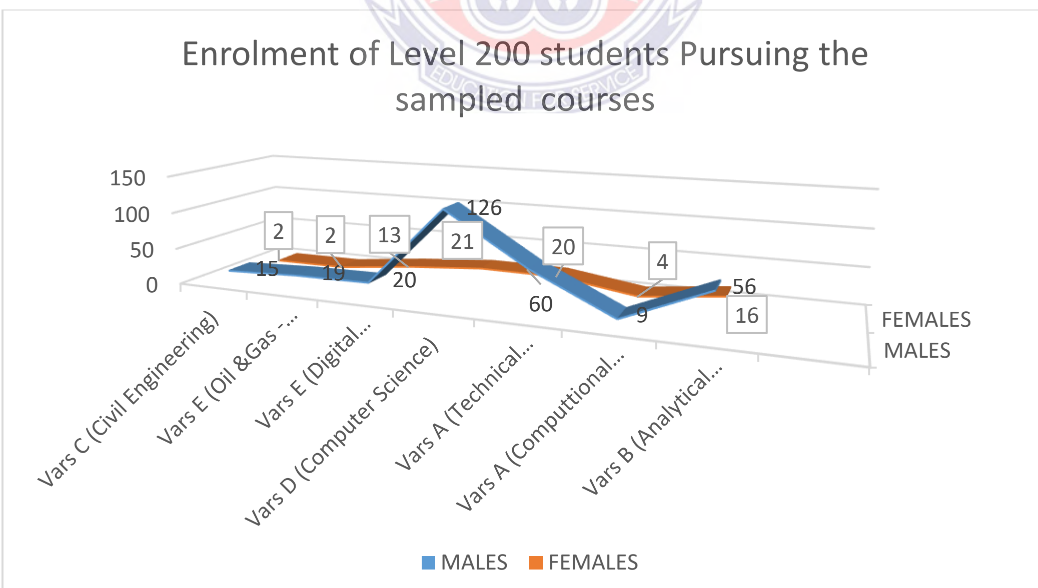

Fig. 4.2 A line chart of the total enrolment of students in the sampled courses

Research question four (4): ***How does leadership influence female participation in the study of technology-related programmes in the sampled universities?***

4.4 Leadership and its Influence on Females' Technology-related Studies.

It could be recalled from the literature reviewed how Burns (1978) explained that leadership leads to change and such changes redesign perceptions and values thereby changing the expectations of employees. Boateng (2012) also reported on the need for educational reforms to have an impact in terms of female technical or technology education to make technical education accessible and attractive to all including females. Most participants in this research expressed the need for parents as leaders to change their attitude towards females' technology-related studies.

4.4.1 Parents as Leaders

The home and school are places where females are expected to receive maximum encouragement to pursue their academic interests in the science-related programmes to the brim. From the responses given earlier on subject choices, it emerged that in a home where the leaders in this regard – mostly, the father and mother are scientific biased, the females equally as the males are motivated into the science and therefore technology-related programmes. The participants also expressed that the parents as leaders could encourage the females to change their mentality about the myth surrounding Mathematics and Science courses as difficult disciplines. This negative perception about such myths according to the participants leads to a "can't-do" attitude that in turn tunes the females off. This in effect prevents a concentration in studying the sciences. The participants expressed the need for parents to be sensitised in this direction. The participants further shared that parents and other close relatives ought to stop the "*favouritism syndrome*" because they are noted to make wrong choices by either choosing one person against the other or always paying much attention to their male wards at the expense of the females. Kamsok, a male at VarsE for instance stated that:

> I have an uncle who always thinks of investing in the sons and not the daughters because he believes that the ladies won't bring out anything profitable but at the end of the day, the ladies were doing better than the guys. So it's all about choices. (Interview Transcript 3: April, 2017).

4.4.2 Leadership in Institutions

Thrif at VarsB on focus-group interview shared that the leaders in the institutions should attempt to arouse females' interests in Science at an early stage such as the Junior High School (JHS). YaaT at VarsA expressed that it should start from the science class at the Senior High School (SHS). She further explained that as long as there is a negative mindset, the females are not going to take it serious hence the leaders should talk to the females early enough since choice of subjects commences at the JHS in Ghana. Probing into the naivety of JHS students for subject differentiation, YaaT said: *"They are not! From J.H.S you are going to choose a course in S.H.S which will lead to a course in the University or profession. It starts from J.H.S"*

Asking further whether any of the females had benefitted from a quota system or not, as carried out by leaders of the Institutions in countries such as Tanzania- University of Da-es-Salaam who have developed mechanisms to encourage females to enter engineering, YaaT said:

> It can also be done here but it looks as if our leaders don't care. Some of them are not sensitive but I think in some Universities here, they do that … I don't know about any such system that benefit girls but I have

heard a couple of guys talking about it that the same system has been introduced for girls (Interview Transcript 4: April, 2017).

The participants in general, explained that aside the system that should benefit females, they think that some of the teachers as leaders, need to be talked to. Thus, in some of their SHSs, their elective Mathematics tutors organized extra classes which were sometimes not fully participated by the females and in some instances, during the normal classes, the tutors would pose questions on the board based on what they have taught at extra classes to be solved by the students. The students' inability to solve such questions led to great humiliation by the tutors sometimes leading to failures in the terminal examination. This really posed a great challenge to most of the females as the participants continuously shared.

Sinarin, a female at VarsB supported the issue of teachers as leaders and influencers in subject choices and shared a view that her J.H.S head-teacher (male) who doubled as their core Mathematics and Science teacher knew everyone's capabilities and therefore encouraged most of the students into the sciences. When it got to the time of choosing schools and the courses, "*he just tells you - this is where you are good at, so just choose those courses"*. The teacher encouraged her (Sinarin) to enter the science programme. Another female, Shawut, went through the same process since they attended the same JHS known as Great Victory Academy in Bolgatanga. EmlaB at VarsC also shared that lecturers are leaders who could play vital roles in the progression of females in the technology-related studies. She however blamed them for demotivating the females in science due to limited explanation given to the content of what they teach. She in effect stated that; "*They only like the best girls, but, the others should be able to go to the* *lecturers but this does not happen*". (Interview Transcript 1: April, 2017). All the participants across the sampled universities were optimistic that with time, there would be a change and more females would enter the science-related programmes if only the teachers would pull their weight and the girls too would change their mentality.

Probing into what the leadership in the government could engage in to encourage females into Engineering disciplines, quite a number of the participants expressed that the government and institutions for science and technology could establish rules governing the study of the sciences. About what the Heads of Institutions such as the Vice-Chancellors and the heads of department could do, Joanat shared a similar view with YaaT who suggested that the study of the sciences should start from the basic level because from primary through to the secondary school, the lives of individuals are shaped permanently. They cited a subject Basic Design and Technology (BDT) studied at the JHS as an area that critically needs females' encouragement. Again, they suggested that the best girl in technical subjects in the JHS and secondary or technical schools could be awarded with incentives and scholarships. They further suggested that the best male student from the Home Economics could also be awarded to whip up the male students' interest in the female-dominated areas too. Again, they emphasised that the award does not necessarily have to be too expensive thus; it could be money in an envelope or a certificate and ought to be given in front of the whole school to show that the awardees performed creditably and the Institution or University was proud of them. To the participants, that could serve as encouragement to other females to enroll in Technical subjects and vice versa for boys in the female-dominated disciplines. Other participants from VarsD such as Lyjune and Bimga both females studying Computer Science expressed similar sentiments and concluded that this suggestion could promote a gender-balance instead of the gender-skewed specialisation. The discussion led to whether there should be a policy framework to govern the study of sciences since science forms the bedrock of technology or engineering.

Research question five (5) - ***What are some of the policies formulated at national (macro), institutional (meso) and departmental (micro) levels for access, entry and retention towards participation of females into / in technology-related studies?***

4.5 Policy Formulation

A policy is a deliberate system of principles to guide decisions and achieve rational outcomes. Policies as addressed by Althaus, Bridgman and Davis (2007) are generally adopted by governing bodies of an organisation. When the issue of whether a policy or rule should be enacted towards the study of the sciences at various levels thus – at national level (macro) and at meso or micro levels thus in the institutions and departmental levels respectively, the participants expressed that it is not a formulation of any policy but that the institutions for science and technology should be well established. They observed that currently, the low participation of females in the sciences is dawning on the authorities in the institutions so the lecturers have been trying to arouse the interest of the females in the sciences. One challenge at VarsA for instance was on their initial enrolment in Chemistry with non-spacious laboratory which has been addressed. The laboratory instruments too were not accessed flexibly by the students. The instruments were over-protected by the lecturers. Tosh, a male at VarsB on one-to-one interview expressed that some time ago, the laboratory was nothing to write home about hence he said that:

> It looked as if it (laboratory) was for the lecturers because they over-protected the practical equipment. They don't really want anything to break. They want to keep that place safe so since we were like three hundred (300) in number, they could not take all of us at once so there are three (3) tables so a hundred (100) students per table or sometimes fifty (50). So we didn't do the practical. The Teaching Assistants (TAs) do it for you to see it but there are a lot of people at the table so you stand on your chair and you still can't see. You strive to fight to try and be close to the set up (Interview Transcript 4: April, 2017).

On what could be done, Joanat at VarsA said the situation has improved because another laboratory has been built so that has eased the congestion. Other instruments too have been purchased but nonetheless, they emphasised that the infrastructural facility still ought to be improved. They do not consider that policy-formulation is necessary. The rest such as Elena, Tablec, Tianar (females) and Seataj (a male) at VarsA explained that one cannot urge the government to put up more infrastructures since there are financial constraints in every sector. Joanat again continued that:

> Most of our hopes are dashed because we have not realised our hopes. Quite a number of us leave for greener pastures elsewhere because those with the intention of living in Ghana though with nothing to encourage females, want to carry out the engineering activities because they are determined to make an impact in the nation.

Tianar further added that:

> I don't really think the government, even if he puts an interest in the education, will consider the tertiary level because they consider it as okay for the time being. So, you have to do your best and graduate and go and get a job. So in the end it's like all the science you have learnt is

> for nothing. The generation of the interest is not enough for me. (Interview Transcript 4: April, 2017).

Oval at VarsB also stated that:

> Once we are thinking about staying [in Ghana], we are the ones thinking about going on but, the facilities are not there in the schools. The instruments are not adequate but I know that when the budgets are made, although they give money for education, they focus on the primary and the secondary education, so they encourage people to go to school. (Interview Transcript 5: November, 2017).

ManE at VarsD pointed out that the studies in Africa would never change anytime soon thus, if one wants to get into a comfort zone then one should not study sciences because studying the sciences is stressful for females. He explained how Ghana started with Ordinary and Advanced level of education but the Americans brought the high school system but then they (Americans) are still running the Ordinary and Advanced Level structure. Thus, someone completes SHS and is less knowledgeable compared to the previous years. He complained about the current trend of students reading so many courses at each semester which make the education too stressful for females. To him, males are able to handle stress hence the engineering would always be skewed towards males. With that discouraging view expressed, the discussion moved to the final theme.

Research Question six (6): ***What are some measures or interventions that could be put in place to boost enrolment of females in technology-related disciplines in Ghana?***

4.6 Interventions towards Enhanced Enrolment

In the literature, some of the measures noted to have been adopted in Ghana to encourage females in the sciences were the inception of national annual programme such as the Science, Technology and Mathematics Education (STME) 'Clinics' and automatic scholarships to females who enroll in Institutions such as the Hyundai- KOICA Technical Institute. Continentally, it was also reported by Lihamba *et al* (2006) that in countries such as Tanzania, affirmative action (AA) programmes have been taken whereby females are offered preferential admission criteria. Similarly, the participants for this research expressed the need for interventions through seminars and award systems, formation of Associations / Clubs amongst other suggestions already made.

4.6.1 Seminars and Awards

The participants considered the need to sensitise more females into science through seminars as topmost priority in boosting enrolment in the sciences. Training more female lecturers in the teaching of science-related courses to ensure their involvement in the teaching of these areas was also suggested. Awareness creation was therefore highly discussed. Jazz, a male at VarsE for instance stressed the need to go for talk-shows and also award scholarships. On how the scholarships should be awarded most of the participants suggested that the authorities should target the females who are likely to shift to other courses due to financial constraints. On the procedure, the participants stressed that such females could be identified through the records kept by the schools since the secondary schools keep the records of the students. The talk shows were similar to the suggestion made about formation of Associations and Clubs.

4.6.2 Formation of Associations / Clubs

Dens, at VarsE on the issue of awareness disclosed that there is an Association in their University called Structural Petroleum Engineer and the members have taken upon themselves to visit secondary schools *"to fish them young*". In effect, they give information about the Oil and Gas field because the mentality is on job opportunity and how they would be able to fit into it. They normally educate the community on the modern technology of the use of software and the minimization of physical activity like the carrying of metal components. According to the participants at VarsE, this is done annually to encourage the females because they are not pleased with the fifty (50) males to three (3) female-enrolment on the field. Sometimes, as explained further by them, the populace within the nation considers the Oil and Gas sector as a field for carrying only iron rods and fixing buckets so the participants think that everything borders on awareness on how the field is operating. If the females are sensitised that there are so many females at VarsE pursuing Oil and Gas Engineering, maybe it could create awareness.

At VarsD, the participants shared similar views on the need for the establishment of an *All Girls Science Club*. They considered that this ought to be made compulsory for all females at JHS and SSS level and it should be an '*After-School'* Club to get all the females involved. Role modelling was also suggested as a very useful interceptive strategy.

4.6.3 Role Modelling

The participants raised issues pointing to the importance of role modelling and mentorship in sensitizing females into the science-oriented programmes. Cephane, a female at VarsE recounted and cited scientific gurus like the Physicist Marie Currie as a lady who excelled than men. Cephane explained that there might be lots of women like her who are also in sciences. Females, she thinks can also do it because she said: *in modern times, almost every single thing in this world that men are doing, the ladies are also doing it*".

Oaten, a male at VarsB stressed the need to encourage more females into the teaching of technology or sciences in general because what he has observed is that since most of their teachers are males, there is no female to point at. To him, if it were to be females teaching the sciences, a girl may look at one and say, "*aha, I want to be like this Madam but, most of them are males so they feel like it is only males who can teach Mathematics.*"

Trempo, a male also at VarsB narrated how a female-lecturer handled Mathematics temporarily when their male Mathematics lecturer took a short trip. He shared how she asked the male-students to go outside the room for a short period during a session specifically to ensure that only the females remained in the room. Although the males got agitated, they later realised that she wanted the female-students to be involved actively and this was realised when she posed the questions to the females. In the absence of the males they responded. Trempo therefore continued that:

> It's already in their [females] heads that every time a man is around, he should take charge. So when she [the female lecturer] did that; in most of the subsequent classes, the ladies were also participating in it. So, it is not always about seminars but the hard fact that nobody is going to get the job done for the ladies.

Oval, a female at VarsB stressed that role modelling begins at home. She explained that her friend's mum's profession as a Mathematics tutor led to all the children (boys and girls) reading Mathematics at higher levels. Her friend's sister she further shared, does not like reading but rather likes doing things that involves Mathematics for instance, playing the game "Chess" and another game played by solving problems on a cubical cage or so. The others on the focus group agreed that the home makes the mathematician. Benedicta at VarsD expressed a similar idea that:

> I see it that in the home, when you want the ladies to be interested, when the dad does something and then the mother is also around, let the mother be seen as a star doing it also, so that the ladies can also see that oh, mummy is doing this so I can also do the same (Interview Transcript 2: April, 2017).

To Dicta a female at VarsD, the mothers should also get involved in the so-called male-dominated areas of specialisation – they should be fixing the cabinets to show that "*if mummy can do it, why can't I do it?*" Considering the working field or occupations in general, LyjuneB at VarsD, concluded that: "*the role models in the communities seem to be very busy and hardly could they avail themselves to other women in their fields of specialization*". Harone, a female also at VarsD expressed that the current generation could be educated to serve as role models to the up-and–coming generation. Other suggestions emerged from the participants.

4.6.4 Other Suggestions

Suggesting varying thoughts about the situation, most of the participants expressed the need for females to have access to books. Thus, when they close from school, the domestic chores ought to be minimized so as to enable them read and assimilate what they read. In view of this, to them, parents ought to be educated to gain knowledge that the science field is not the preserve of males and that females could also excel. The participants added that some premonitions sometimes lead to the parents' behaviour. Tianar for instance stated that: "*maybe, 'asemasi's' daughter went into engineering circle and she did not do well so the conclusion is that my daughter too might not do well*". The participants optimistically shared that a transformation in such a mentality could lead to an improvement.

Dens, Jaet and TunR (females at VarsE) shared common ideas of the need to sensitise parents through 'Parents' Teachers' Association (PTA) at the junior and senior high levels. The participants also stressed that the science in this world is moving fast and females should be sensitised also to study more of the sciences to move with the world. If the females are encouraged, they will be willing to do it. TunR therefore added that:

> Whatever you tell a lady to do, when she is willing, she does it perfectly". Women are more careful so if they're able to get into the industries, they will be able to manage resources in industries. Men don't care how much they waste but women are more resourceful. Talking about manufacturing and invention, the first refrigerator was made in the 18th century but, a lady called Florence Piper made a modern refrigerator that we're enjoying today. So, though a man made it initially, a lady improved it (perhaps because it dealt mainly with keeping food) with females' inclination towards Home Econs, creativity in that side sets in. (Interview Transcript 3: April, 2017).

LyjuneB at VarsD expressed the need to put females at the forefront of advertisement. She observed that it is normally the males that appear when one refers to Engineering or even Medicine and females appear when it gets to adverts regarding food (the participants burst into laughter). Sinarin at VarsB shared her views on how Mathematics should be made friendly to females by stating that: "*it should not be about solve, solve, solve and solve. Mathematics is about everything done like the steps taken in walking, cooking and sweeping. Females should strategise with these to solve questions in the books but not giving them the questions in the book directly. If we get that mentality, our Mathematics teachers can teach us Mathematics once in a while in that category* [trajectory]. *I think it will be the best way*". This seems like making Mathematics realistic by linking it to real life experience thereby perhaps, demystifying the aura behind Mathematics.

Thrif at VarsB had a similar view as Sinarin's and therefore stressed the need for leaders to educate females that Mathematics in itself is fun. Thus, making Maths into games would be helpful. She explained a typical game-like competition captioned '*A Critical thinking'* which took place in her SHS whereby sequence of questions in the form of a game was solved. In that game, in a row, the respondent's answer is used to solve the next question. It was named 'marathon' but subsequently changed to 'Mathletics' (thus, athletics in Mathematics). It was introduced and sponsored by one South African University. Thrif again shared her view on another game captioned 'the game of 24' which was also considered as 'fun'.

Veepo, a male, was skeptical about the issue of fun and therefore stressed that everything boils down to the perception of the societies. To him, encouraging the females into Mathematics through fun is still an attempt to bring things that are perceived as women-like into the Mathematics. He thinks that since there is no difference between how the brains of the males and females function, it would be ideal to stop the interest-segregation. He stated that:

> Ladies getting into things which are fun before you can let them like Mathematics must stop. So, I think, right from the start, you have to let them understand that whatever they want to do, there's no difference actually between what both sexes can do (Interview Transcript 5: November, 2017).

This could imply that the females have to learn the hard way equally like the males. Oval, a female also shared that the problem could be solved with their current parents because they say, '*charity begins at home'*. Thus, if the parents are educated on the importance of females having deep knowledge in Mathematics, they would be able to get into the engineering careers. To Oval, it is a matter of informing the parents that the world is moving forward, so, one should not stagnate. One should leave the old world behind and move forward.

Harone, a female had a contrary view that it is the next generation that ought to be targeted and not the current in what is being strategized because their current parents were not educated along these lines so most of them do not know the value of females' engineering education. She thinks that getting to the parents would be a real problem so the participants should serve as role models for their up-and-coming children. Harone again expressed that it would be easier educating their children (females) to achieve equal targets as the males for these children to also serve as role models for their offspring or the next generations but not the current parents. Others were still optimistic that the crusade should start by motivating the current generation now.

PEF a female, expressed her view that: "*women have managerial skills. They are creative, they're good in bringing up ideas but the best of all is the commitment*". Commitment as discussed by the other participants, is key in performing creditably well in the sciences especially in Mathematics. With a newspaper article titled 'What a Shark' by Bonney (14th October, 2017), the father of the female who enrolled at age fourteen (14) in Mathematics at KNUST was considered a role model. This really happened because of the father's encouragement. Based on the responses, a final sub-theme emerged serendipitously on whipping up the interest of females in science and technology-related programmes.

4.6.5 Whipping up the Interest of Females in the Sciences

As already discussed at the intervention, about 80 percent of the participants in all the sampling units reached a consensus that; seminars organized at basic and secondary schools would sensitise and motivate the females. The seminars to them, must be extended to the society especially on the importance of girls' engineering education. Scholarships, attitudinal change and making technology-related programmes prestigious were all shared. Boarding facilities in schools to relieve females of domestic chores were also raised. Those responses given at the intervention stage were repeated hence the discussion led to whether the society considers the study of technology-related programmes by females important. The participants shared their views that the society sees the importance in it but the participants did not outline any reason when probed.

OKA however cautioned that the women activists in Ghana ought to be careful so that the tables do not turn against boys whereby only the girls would become engineers and scientists at the expense of the boys. This was further argued and the participants drew a conclusion that it might be impossible based on the enrolment pattern of the two sexes in the scientific and technological areas of specialisation. Since qualitative research quite often is a mutual research, the researcher drew the participants' attention to the enrolment trend across the sampled universities and highlighted that if an attempt is not made to curb the trend of serious lopsidedness, a time would come when there would be no female in the engineering field. A Nigerian female participant offering Oil and Gas Engineering at VarsE suggested that females are more careful so all efforts should be made to encourage them into the sciences.

OKA further shared that most girls including his own sister are not making the effort because he initially wanted to read medicine but when he was applying, he made a background research and found out that he wanted to go into semi-conductors so he had to go into the field of engineering. This was possible because of his good performance in Mathematics and Physics. His interest was further sustained through consistent reading and researching. He has also adopted the culture of practicing whatever was taught. If there is lack of understanding in a subject, he shares ideas with his friend. He emphasised that he does not delay because he realised he was a slow learner. His sister does not emulate his example, he explained bitterly.

On how best to help the females to learn effectively well, the participants reiterated the importance of boarding facilities OKA stated that: "*but we don't have boarding accommodation so we have to still go home*". He further cautioned that:

> the boarding facility is very important because the home is considered as the ignition point and according to our culture, if you try to limit them [females] from their house chores then in the aspects of marriage, they would have problems so I think there has to be a blend. The time factor has to be shared equally at home (Interview Transcript 1: April, 2017).

The participants expressed the need for females to draw personal time-tables which ought to be discussed with parents or guardians. If the discussion becomes challenging, then the participants considered a consultation with the spiritual leaders or teachers who would come home and sit with the parents. Probing into the issue of organizing special programmes for females in schools as advocated by feminists such as Zuga (1999), the participants admitted that that would be difficult since they must all follow a common course structure.

The final issue expressed by the participants was the need to accord the highest prestige to the study of technology-related programmes. LyjuneB expressed the importance of females' inclusion in advertisements covering engineering as already shared under interventions. The participants considered this as prestige boosting. Under prestige again, during the focus-group discussion in the piloting at COLTEK, the male participant explained that he thought in Ghana, certain courses are relegated to the males of certain ethnic group citing an example as Voltarians for Carpentry and Joinery. During the main research too, a male from VarsB made a similar comment that butchers are noted to hail from the Northern part of Ghana. This generated into laughter which was decently checked by the researcher.

On the whole, from the responses by the participants, it could be concluded that the influencers interconnect to influence females' choices of scientific and technological studies as diagrammatically represented in Figure 4.3.

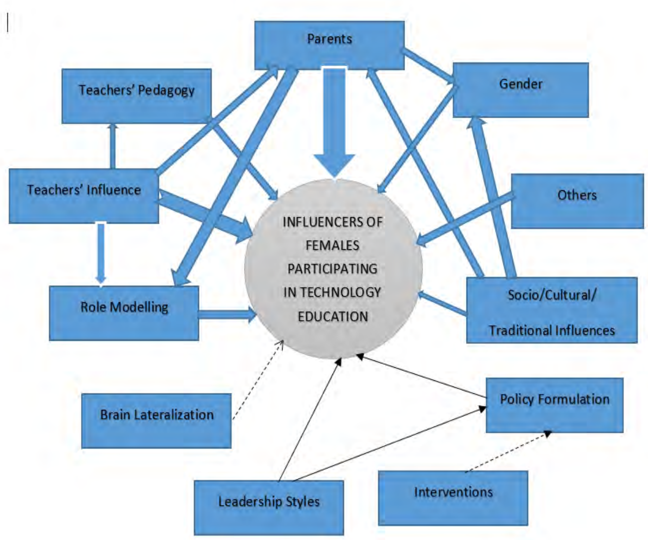

Fig. 4.3

Interconnectivity of Influencers for females Participating in Technology Education

4.6.6 Interconnectivity of Females Pursuing Technology-related Education

In the interaction with the participants, parents were seen as the greatest influencers of females and males' subject-choices alike. The parents were found to serve as role models. Some of the participants remarked that when the mothers for instance take up roles seemingly reserved for the males (fathers), the girls would be motivated to do same. Success could be achieved from the experiences gained from the home so when the mothers also start fixing the cabinets, the females would learn that those jobs are not the preserve of males. The parents were also influenced by societal perceptions in terms of social/cultural/traditional issues. In effect, the parents segregated gender roles by overburdening females with domestic chores based on traditional roles passed on from generation to generation. This thwarted females' studies in subjects such as Mathematics which is placed early on the time-table of the schools' curricula. The participants also expressed that the parents as leaders could encourage the females to change their mentality about the myth surrounding Mathematics and Science courses as difficult disciplines. The negative perception about such myths leads to a "cannot-do" attitude that in turn tunes the females off. This then prevents a concentration in studying the sciences, the participants viewed.

Socio/cultural issues such as marriage was seen as premium for parents which dissuaded their female wards from pursuing courses that may be prolonged thus delaying their marital status. Yes, the issue of marriage as a concern cannot be devalued but, policies could be formulated to reduce the number of courses within particular disciplines if some courses are less beneficial to the area of specialisation. By mounting appropriate courses, those courses that are quite disconnected from the main areas of specialisation could be dismounted. As could be recalled, a female-participant recounted that she sees no connection between ICT and Music hence considering such combination a waste of time and students' energy. Policies could also be formulated to easily allow young mothers to continue their education at a slower pace and at the same time give them the opportunity to manage their families too.

Teachers were the second influencers to the subject choices. As shown in the web diagram at Figure 4.3, teachers interconnect with other elements such as pedagogy to bring out the best in students. It emerged from the responses of the participants that when teachers utilize appropriate pedagogy, exhibit positive interpersonal relationship with students, this leads to comprehension by students. In turn, this fosters a sense of self-worth that improves acquisition of practical and theoretical skills. Teachers or lecturers' restrictions on the use of facilities however thwarted students' studies. Female students may not feel at ease standing on benches to observe practical lab demonstration in case of overcrowding as emerged in some universities. Again, although the use of power-point illustrations showing several examples of mathematical calculations on the slides were considered very helpful by the participants, because of the large class size, the slides were not visible enough. In that case, the purpose of using the support materials (the slides), would be defeated or lost. This had the potency of minimizing the attraction for practical-oriented disciplines as found in technology-related studies. With a very good inter-personal relationship, the students found the teachers affable leading to the teachers guiding them towards the subjects to be chosen. The teachers again, served as role models especially if there were female science and technology teachers. As expressed by a male participant, if the females find out that their science teachers are females, that motivates them to take scientific disciplines seriously. The teachers guided the students towards their best capabilities. The interconnectivity of teachers just like the parents to other social elements as illustrated in the diagram at Figure 4.3 is indispensable

There are other members that put together also influenced students' participation in this study either positively or negatively. Positively, one male remarked that the grandfather decreed that they all have to study the sciences and since the grandpa was a scientist, all the children obeyed and towed that line. One female also shared that her uncle introduced her to technical skills as early as the JHS level. Some of the female-participants also towed the paths of their peers. Contrary to these, the negative behaviour of a male classmate nearly influenced a female-participant to relax in the study of Elective Mathematics.

From the responses of the participants, again, it could be adduced that people's gendered perceptions about the female preempt certain automatic behaviours from the females. Why should females get stressed about the content of certain curricula and not males? Why should females be prevented from interconnect with the parents' decisions.

There were minimal influences raised on the part of leadership in institutions and the government. The participants did not consider brain lateralization as an influence on both male and female studies but considered a need for a change of the mindset of females. There is a need to promote enabling environment with flexibility in the use of instruments and equipment, ensuring involvement in practical activities by students, formulating policies to ensure a gender friendly atmosphere for students. Inadequate gender and science policies by the government as expressed by especially the females impact negatively on their scientific and technological education; sometimes influencing the graduates to seek greener pastures outside the country.

Thus, in general, if the gendered situations are reversed, thus, parents especially mothers serving as role models, the society refining their perceptions towards gender roles, teachers creating enabling environment with the appropriate pedagogy, mounting appropriate courses, refraining from humiliating students with insults, females might be imbued with the 'can-do' spirit and therefore would be encouraged to learn. Furthermore, if the government would also create enabling environment by providing adequate infrastructure, adequate science and technology facilities and equipment, formulating appropriate policies, scrutinizing and modifying outmoded culture, intervening with appropriate incentives, females would be motivated into science and technology-related programmes for successive generations.

4.7 Conclusion

This chapter has reported the major findings of the research conducted. It was categorized under themes or concepts corresponding to the six main objectives and the research questions framed for the instruments. The interviews concentrated on the observation of teaching, pedagogical strategies and participants' retrospective views on science-related programmes.

On the scientific belief of brain lateralization, almost all the participants admitted that there is no reality in this assertion but rather the attitude towards the study of these subjects brings about the differences. A few were paradoxically unsure about the reality of brain lateralization. Under culture, one peculiar issue that emerged was the fact that females were not allowed to hold certain technological tools in certain woodwork shops whilst embarking on their Community Service. Some participants complained about the demanding and stressful nature of engineering coursework. Parents were therefore noted to be apprehensive in encouraging their female-wards into the engineering courses due to the likelihood of delayed marriage.

No practical activity was undertaken in the observation sessions under pedagogical strategies but in one particular university, both male and female-students were working on their individual practical projects. Both male and female-participants complained about lack of practical experience they longed for. Some of the participants also complained about the restricted use of laboratory equipment by lecturers for fear of damage.

On leadership, the participants' directions were diverted from political to mainly parental leadership. There were also a few, though, who expressed loss of hope in the government since their successive budgets hardly ever make provision for the universities. A few participants narrated how they still feel unhappy about what they are studying since their parents exerted some form of coercion on them to pursue the science courses. At the same time, most of them were found to be intrinsically motivated for their parents guiding them into the science-oriented programmes. Teachers were also instrumental in influencing participants into the sciences. On interventions, seminars, award of scholarships, females at forefronts of engineering advertisements and formation of clubs dictated the pace.

Generally, from both sexes who participated, it has been observed that attitude of females and the society need to be changed. Females ought to adapt the culture of pursuing the science or technology-related programmes effectively by changing their 'cannot-do' attitude to the 'can-do'. On the whole the influencers interconnect to impact on females' scientific and technological choices of disciplines. The next chapter further analysed and interpreted the Findings of the research.

CHAPTER FIVE

DISCUSSION AND INTERPRETATION OF DATA

5.0 Introduction

Information gathered in the previous chapter was collated in line with Neuman's (2007) steps and Kvale's (1996) model of conducting research and interviews respectively. In all the five universities sampled, there was under-enrolment of females pursuing technology-related programmes. Female-lecturers were also few. Generally, participants submitted that parents play very significant roles in the choice of subjects by students at the second-cycle level. This was followed by teachers. Mathematics still seems to be a barrier to the study of technology-related programmes. Cultural beliefs also prevented or killed females' interest in the sciences. For instance, in some areas, without any real explanation, females were restricted from touching technological or work tools, including ones as simple as a saw. It is reportedly seen as a taboo. Clearly, this is a serious inhibition to females' interest, choice or their enthusiastic participation in science and technology-related studies.

This chapter further analyses the critical issues raised in the findings. It further discusses and interprets the data in relation with the literature, theoretical, conceptual frameworks and the methodological paradigms utilised in the study.

5.1.1 Demography: Gender Enrolment and Geographical Background

Although this research was focussed on females, a justification was made towards inclusion of males which undoubtedly enriched it. Out of the fifty-eight (58) sample size, thirty-six (36) were females, two (2) of them were lecturers. This represented 62.1 percent of the sample size. Male participants were twenty-two (22) with three (3) being lecturers. Sampling from both public and private universities also became a useful exercise since this led to the participation of both local and foreign participants precisely from Nigeria. As explained in the previous chapter, the Nigerians outnumbered each ethnic group with eleven (11) females and four (4) males representing approximately 19 and 7 percent respectively of the entire sample size. A blend of foreign and local inputs in terms of ideas enriched the data since the data that emerged portrayed similar and unique cultural experiences about females studying science and technology-related programmes within the sub-Saharan Region of Africa. It was found out that the location of a University does not necessarily depict the dominant ethnic group in that locality but rather, the type of programme offered is significant for student-enrolment.

5.1.2 Areas of High and Low Patronage in the Study of Technology-related Programmes

It was found out that apart from the Nigerian female participants who outnumbered all the other ethnic groups in the female category, six participants each representing 10.3 percent of the sample size were from the Eastern and Volta Regions of Ghana. No male student-participant hailed from the Northern, Upper East and Upper West regions. It is really very difficult explaining why none of the participants from the lecturers who were observed or the male student-participants hailed from the three regions in the northern part of Ghana. Sampling was by non-random snowballing technique across the universities.

Discussing the issues on why the Nigerian students dominate the student population in most of the private Universities especially in the Oil and Gas Engineering during the post-observation interview, it was disclosed by the lecturers who taught for observation at VarsE that there is a special agreement with Nigerian counterparts who advertise for that programme in Nigeria for the institution and that goes with remuneration. This was confirmed by the Head of Department (HOD) who also added that the female students from Nigeria as compared to those in Ghana are very brave or daring in pursuing what is regarded as male-dominated area so long as the programme comes with higher chances of securing career on the job market with higher salary. It is therefore reasonable to say that the course such as Oil & Gas Engineering is tailored to suit the industrial expertise required for the booming oil industry in their country (Nigeria). As per the enrolment statistics shown in the previous chapter, both males and females were fairly represented for, out of the 28.3 percent Nigerian students, 20.6 percent were female-students who participated.

The transition through second cycle to the Universities was also of great importance and it was realised that only two participants (a male and female) attended pre-tertiary Technical Schools out of the 53 student-participants. A larger proportion of participants attended general Senior High Schools (SHS - 96.23%) as was shown in Table 4.3.4 in the fourth chapter. Only two Level-200 male and female students pursuing Agricultural Engineering and Biochemical Analysis at VarsA and VarsB respectively attended Senior Secondary Technical (SST). This could imply that the pure technical students hardly attend Universities. Until the year 2017, the College of Technology Education, Kumasi (COLTEK) of UEW which was used as the piloting institution in this research was the only University Campus that offered greater opportunity to technical students to further gain practical and theoretical expertise in their fields of specialisation. The establishment of technical universities is therefore very significant to the upgrading of technical students to the tertiary level in Ghana. This could attract a greater percentage of female students who prefer to enter SST thereby ensuring higher enrollment by females in technology-related programmes in the near future. Having analysed the demographic characteristics, the first theme under gender and brain lateralization follows.

Research question one (1): ***What are the biological characteristics that influence subject choices for female and male students?***

5.1.3 Biological Characteristics

Analysing from both the male and female participants, brain lateralization was considered as a mere perception – thus, about 70 percent of the participants fully disclaimed the issue of brain laterilization. Brain lateralization refers to spatial tasks and mathematical ability whereby males are claimed to outperform females and females also claimed to outperform males in verbal ability due to a dichotomy of the brain which has already been argued in the literature by researchers such as Kimura (1996) in Mohler (2008), and Diamond (2003). The participants of this research expressed that there is no differentiation between the male and female brains in processing mathematical and verbal cognition. They however, alluded to the fact that it is the perception and attitudes of the society that bring about the differences.

The participants' disagreement with this scientific perception was in line with Diamond (2003), a scientific analyst of brain lateralization who pointed out in the literature review that up to date, no live human being (male or females) has donated brain tissues to be used in conducting an experiment on the differences. To her similarities and differences between male and female brains presents a "considerable challenge in the decades ahead" (Diamond, 2003 p.6). Nicholson (1993), Fausto-Sterling (2000) and Sabbatini (2007) however expressed that biologically, hormones have been explored to have direct and indirect effect on the development of the brains.

The participants expressed that this perception that has lived with us from generation to generation would change. They think that a change of attitude would reverse the situation to put females also on the pedestal of mathematical wheel, thereby entering into technology-related programmes appreciably. The participants especially the males further expressed the need for females to sit up and adopt the 'can-do' spirit. It could be argued that although there are differences in physical strength and the reproductive system where females reproduce young ones unlike males, brain lateralization is inconclusive since no scientific evidence is available as expressed by Diamond (2003) earlier. Oakley, cited in Haralambos et al (2004), has also pointed out that; "if there are biological tendencies for men and women to behave in different ways, these can be overridden by cultural factors" (p.100). Oakley considered the high premium placed on marriage as one of the barriers to the study of science and technological-related programmes by females. Again, biologically as addressed in the literature, a lot of research projects conducted on the development of spatial skills indicated that people can improve their spatial skills with training. Spatial skills are not inherent and thus, children could be introduced to language that describes the spatial world mostly with words like circle, octagon and curvy surfaces at early stages in life. Parents therefore ought to be educated to motivate their children especially the females along these lines as early as possible. Pruden et al (2011) reported that toddlers and babies who heard and used a lot of spatial words scored higher on spatial skills when they were pre-schooling.

In conclusion, since cultural practice could take quite a long time to change, domestic chores could be harmonized or blended with spatial skills' language during activities with the use of descriptions such as *round saucepans* and *square dishes* at home. This could facilitate spatial development but should not be restricted to only females.

Research Question two (2): ***Who/ What in the society influenced your participation in the technology-related disciplines?***

5.2.1 Parents as Influencers

Socially, parents were noted to play significant roles in the choice of subjects by students. From Table 4.2.1 and Figure 4.2 in the fourth chapter, about 62.2 percent of influencers of subject-choices were parents. Most of such parents had appreciable or high literacy level with majority being teachers in the science and mathematics-based disciplines. A challenge is that most of these female-students living with other relatives or serving as house-helps without educated biological parents may face difficulties during such decision-making exercise. If they are the shy type, they may find it difficult approaching their teachers who were considered as the next influencers with a percentage of 20.8 as found in the same Table 4.2.1 of the fourth chapter. The tendency for the females might be to follow the peers which might not lead to the most appropriate choices.

Beside these shortcomings, participants also discussed engagement of females only in most domestic chores as a great disincentive to the study of science-based subjects. This is because they are not left with much time to study as opposed to their brothers.

5.2.2 Domestic Chores

In discussing issues on domestic chores, a male participant (Tosh at VarsA) on one-to-one interview shared his views on the services rendered at home by his sister and himself. Her sister being a non-residential second-cycle student on return from school had to go and fetch water and if even the males take part in this errand, she (the sister) would additionally prepare meals whilst the males performed no additional chore. Sometimes, the females are asked to care for their younger siblings too. Cooking and performing other domestic chores take time and place extra burden on the females that leads to exhaustion. This minimizes the ease with which further studies could be done after school. Restraining the females from the chores too would lead to a shortcoming in their roles and responsibilities during marriage. They may not pick up the female skills like cooking, cleaning and other skills needed in their future marriages based on societal expectations. Taking turns on their domestic chores with their husbands too may be culturally unaccepted by the husbands' parents or the husbands themselves. With time, such ideas might be acceptable since the idea of ensuring that each member of the house gets engaged in a routine in the house was expressed by the participants as a welcome idea. A very practical analysis made and supported by the participants on the focus-group discussion at VarsB was that boys in the single-sex boarding schools get chores like sweeping done yet, survive so this behaviour ought to be replicated at home. If this practice is transferred into the traditional and cultural arena, the burden of females would be reduced. They would be mentally emancipated to believe in themselves that if their brothers survive doing house chores, they too could survive delving in courses otherwise reserved for boys only. If one has to analyse the daily routine of a teenage female in a rural or semi-urban area for instance, the day starts with going outside the home to fetch water, cleaning the compound of the house, cleaning the hen coop if there is one, washing the cooking utensils / saucepans and serving bowls, scrubbing the bathroom, cleaning the earthenware cooker or switch stove and setting fire for heating water and preparing breakfast, bathing, dressing and taking breakfast before attending school. A male teenager on the other hand sweeps the living-room and dusts the furniture, takes the bath, takes breakfast and leaves for school. Comparing the two sexes, the female would reach school often very exhausted and sometimes getting to school late. Quite often, she would be punished corporally by the teacher. This could lead to playing of truancy by the females or, they could be physically present in the class but mentally or emotionally absent.

As noted from most time-tables in schools, Mathematics as a subject is scheduled at the early part of the morning so the female who arrives late may either miss the lesson or feel so exhausted to assimilate whatever is taught. Long hours of domestic chores therefore hamper females' education particularly the study of Mathematics which happens to be the basis for science and technology-related programmes. If females are unsuccessful in Mathematics in the second-cycle schools just like the males, they are restricted from pursuing science and technology-related programmes since most universities' entry requirements demand a pass in the core subjects. This situation is however curtailed if both males and females are offered boarding facility in the second cycle schools since supporting staff undertake most of the chores for the students. In that sense, both male and female-students enjoy the same amount of time.

From the ongoing analysis, it goes without doubt that distribution of domestic chores at home which ensures division of labour, underpinned by egalitarian principles could relieve the females of some of the chores. Egalitarianism is a belief that all people are equally important and should have the same rights and opportunities in life. Thus, politically, socially and economically, all people must have the same right irrespective of gender, race and religion and must be treated equally. Apart from the constraints with domestic chores, the participants also expressed the issue of exhaustion due to the demanding nature of engineering courses. Although this is a curriculum issue, the participants raised it as socio/cultural issue. Actually, students in the sciences often discuss class assignments. It is not unusual to find students studying together far into the night when they are preparing for their examinations. This presents a challenge to a female student if she has no colleague/s in her dormitories. If at home, on vacation, she is most certainly not going to be allowed to study together with a non-relative male colleague.

5.2.3 Demanding Nature of Courses / Frustration

It could be recalled how a female-participant at VarsE complained bitterly about the demanding and tasking nature of technology-related programmes. At VarsD, another stated that:

> Although this is a Christian Institution, Adventist per-se, I don't understand why I am doing ICA and I'm asked to study Earth Science, Principles and Practice of Christian Education … you're doing Music and I don't know where I am taking that to; and don't know where and when I'm going to dance.

Tay at VarsD also expressed her frustration at having to study so many topics with numerous slides (about 500) before writing the end of semester examination. There is no doubt that the demanding nature and duration of science-related courses need not be compromised since science and technological innovations need precision and practising which cannot be attained overnight. The number of courses could however be reduced since students would definitely learn on the job and gain experience when they complete their programmes and secure careers for themselves. Five-hundred slides seem to be exaggerated, so there is a need to check confidentially from the VarsD to ascertain the veracity of the claim.

A point worth noting is that students might not see the need for studying certain courses in addition to their own elective areas. It is appropriate that frequent orientation is given out to them to broaden their horizon on why certain courses are studied. Students should be educated on the importance of educating and developing individuals wholly but not partially. Lecturers ought to discuss the real life application of topics treated to arouse students' interests. If feasible, the educational institutions could also put into practice a structure where students could extend the duration for a programme based on their own pace and ability by allowing them to take fewer courses per each academic year. It is quite clear that the formal structure is not scheduled for extension to suit students' pace and ability in the context of the study but rather the informal sector. Nonetheless, a transformation could be anticipated. On the other hand, the ramifications that come with the extension ought to be discussed. In this regard, longer time to graduation would mean additional fees by students. What rate would course loads reduced be charged? This would also lead to reduced graduation rate and possibly congestion in the dormitories as students would take longer time to graduate. Most students would put extra financial constraints on their parents. One may wonder how parents would handle this, and how the institutions too would handle the increased occupancy.

The act of extension of duration however, should be given a serious thought to curb the exhaustion expressed by the participants. Exhaustion is defined in most dictionaries as a serious weakening that leads to extreme fatigue or overexposure to something leading to fatigue, loss of strength and energy resulting from hard physical and mental work. Such fatigue could arise out of insufficient sleep over the work to be done. Exhaustion could also affect the quality of work and could lead to stress and depression which could have detrimental effect on the body - both physically and mentally. This could be a reason while one female-participant expressed the need for reduction of courses.

In another vein too, females and parents could be encouraged to use variety of electrical appliances, gadgets and devices that ease the difficulties associated with learning and domestic chores to enhance learning. This would minimise the fatigue associated with the lengthy procedural practices or operations. Again, as expressed by the student-participants, there is a need for the female-students to shed off the 'cannot-do' attitude and adopt the '*can-do'* spirit,

5.2.4 Achieving the 'Can-do Spirit'

Developing positive attitude towards the achievement of a particular feat is a great step in achieving a 'can-do' spirit. If one sees a situation with an optimistic view, great opportunities are opened. With liveliness or enthusiasm, one would be motivated to tackle issues in engineering. In nearly all the universities sampled, the fear of the sciences especially Mathematics being very difficult which leads to a 'cannot-do' attitude was raised. AnP a female-participant at VarsC for instance stated that: *"For girls we think we can't do it all because we are girls. I have brothers and they don't like Maths but my father just encouraged me that I can do it and by God's grace I have been able to do it*".

Yes, Mathematics as a course and the other science-based programmes demand concentration and systematic procedure in calculating or carrying out the operation of certain processes. If a step is missed, the rest get affected so one could easily become frustrated without intrinsic motivation, but, 'practice makes perfect'! There is a need to commit certain formulae and principles into memory; failure of which leads to flaws in solving problems. This is why in response to the various courses preferred, Emla at VarsA expressed that: "*Physics has a thousand plus formula which you put into your head, derive and all those things; and I hate reading*". This could be one of the reasons why YaaT in her response to whether females are different from males in terms of verbal and spatial ability expressed that: '*there is no difference but, there is a need for females to sit up since the courses are demanding'*. As expressed in her quote, YaaT thinks there is a need to practice and go over the presentation by the lecturer after the lecturing. If the lecturer adopts a pure lecture technique, one cannot assimilate everything within the spate of the lecture period. Oval also emphasised that the females grow up with the fear of mathematics because, friends, parents, adults and those in the societies put that fear in the females. They therefore grow up fearing and disliking Mathematics.

Oaten a male at VarsB explained that it is just by nature because females always want the easy way out. Oaten's statement of females' easy way cannot fully be accepted in the sense that females have taken up the gender roles accepted by society with due diligence. They get up at dawn to set off to the markets to operate their businesses. Career women quite often see to the upkeep of the children at home before setting off to their various offices. Very often too, whilst at the office they check on their families. From the discussions on the daily routine of domestic chores analysed earlier, females could work for twenty-four hours a day.

TunR, a foreign female-participant attributed the disinterest in Mathematics to the perception by the society. She expressed that the society has a role to play because when they are about to choose their subjects, their girl-friends will say; "*I can't do Maths, Maths is for the guys, it's very hard. So only a lady who has put her mind to it that this is what I want to do will do it"*. The quotation by TunR undoubtedly, confirms the indoctrination of these beliefs and practices by the society. It is however worth noting that with determination and perseverance, the *can-do spirit* could be achieved as further expressed by TunR. At the teenage stage however, only few females are able to make informed decisions on their own without assistance from parents or teachers as emerged under the theme of choice of subjects discussed. All these stakeholders must therefore be sensitised to stop the maxim of '*oh you are a girl and Mathematics is for the guys*" as expressed by the participants. It is more rewarding to view an experience through a more positive or optimistic lens since this can help fire or fuel the 'can-do' attitude. This could be achieved by practicing and perseverance. Achieving the '*can-do'* attitude might reduce the exhaustion. One may not even be frustrated with the number of topics treated which would curb a statement made that: "*They should tell us exactly what they want. They should go straight to the point. I am just tired. Stop wasting our time, …"*! From the quotation, the impression could be created that topics are piled up on students to serve as punishment. There is no doubt that the demanding nature and duration of science-related courses need not be compromised since science and technological innovations need precision and practising which cannot be attained overnight. It would however be worthy to examine or review the content of the course outlines critically to analyse the relevance and redundancy of some of the topics. Topics ought to suit modern trends of industrial development. In reviewing the courses, the methodology employed for lecturing or teaching ought to be evaluated.

Parental attitudes really limit girls and therefore females' advancement through higher education which in a way includes pursuance of technology-related programmes. With custom and traditions being very well upheld in Africa in general, parents generally have been noted to be apprehensive about the status quo of their female-children getting altered thereby changing the females' traditional practices and roles within society. Kwesiga **(2002)** in Uganda undoubtedly was justified in stating that: "parental attitudes are the biggest determinant, very distinct from other obstacles which might include division of labour … and customary practice" (p.167). Marriage for instance seems a premium in the Ghanaian society than most institutions.

5.2.5 Marriage and the Study of Science and Technology-related Programmes

Perceptions of parents emerged from the participants that science courses are too demanding and strenuous which would not offer the females the opportunity to get involved in domestic chores as well as enough time to spend with their families when they marry. A male-participant at VarsD – ManE for instance shared a similar view about marriage being a barrier to females' study of the sciences in general. To him, studying the sciences demands prolonged studies and most parents are impatient to see their female wards staying out of marriage for a long time. They want their female-children marrying early. They have the unexpressed fear that the longer they stayed in school the greater the chance of their marrying someone different or even having a baby before marrying, thereby failing to attain the educational goal. Oaten, another male-participant from VarsB stated that: "*as a woman, she just has to grow up and somebody will come and marry her so they don't want to use the minds to the full potential*". With these expressions, most females concentrate on the social/gender roles at the expense of the courses that are considered to be demanding and prolonged. Marriage, culturally, seems to be the ultimate goal in life especially in the developing world. If she is going to be a housewife, why rack her brains in school? This could be the case, since most parents seem to rely on their children in their old age. Structures have not yet been developed to cater for the aged by the government and non-governmental organisations compared to the developed world hence, parents look up to their children for such aid. Sometimes, the pressure put on young women by parents and the society become forces too much to bear. No wonder a participant expressed that the technology-related courses are suitable for only males as analysed in the previous chapter.

Thus, with a limitation of the females' leisure, utilising their free hours for theoretical academic and workshop practical activities, a delay in their socialisation and courtship, marriage and childbirth are also delayed. There might be the fear of losing potential or suitable partners. Parents might also fear that their female children might engage in cohabitation whereby they live with male partners without getting married legally. They might also anticipate pre-marital practices which might end up with contraction of diseases or without consummation into marriage. According to Haralambos et al (2004), General Household Survey by HMSO in 2002 reported that between the year 1979 and 2001, the proportion of people between the age of 18 and 49 who cohabited increased from 11 percent to 32 percent in Britain. The statistics may be a little lower here yet, it is of much concern. Parents also fear that their children might be engaged in single-person household whereby they live on their own if their marriage is delayed.

Although there is legalisation of females attending school when pregnant in most countries including Ghana, parents are usually against premarital relationship which could lead to premarital pregnancies. Premarital relationship could lead to premature motherhood which could have negative impact in terms of missing classes for attendance to antenatal clinics. Again, since there is usually a change in health status during pregnancy, sometimes the females may feel lazy in attending lectures. If child bearing sets in, taking care of them coupled with other chores become daunting. YaaT admitted that she does not know about a specific culture that puts impediment in females' pursuance of technology-related programmes apart from marriage. To her, females pursuing engineering do not want to engage in early marriages and she argued this with the demanding nature of the courses as already discussed.

Throughout the discussions, it has been observed that parents fear that their female children would not get husbands if they prolong their studies. A male participant at VarsD (ManE) shared a view about marriage being a barrier to females' study of the sciences in general. He stated that: "*studying the sciences demands prolonged studies and most parents are impatient to see their female wards staying out of marriage for a long time"*. In addition, the pool of suitable candidates shrinks for females as they go further in their academic pursuits. It is much easier for a highly educated man to find a wife than for a highly educated woman to find a husband. It looks like men find it a bit challenging to propose to women with educational attainments much higher than their own. Possibly, highly educated women may not also want to submit to a man with lower education.

It could also be recalled in the literature reviewed, how some mothers feel that they might lose 'assisters' in the house thereby tending out all the domestic chores alone if they overlook traditional norms. It was for instance explored that the Sub-Saharan African (SSA) society expected all females to marry and play roles expected of wives. On that issue, the reasoning of the society was that women needed just enough education to see them through marriage successfully, therefore, when given the option and under limited resources, the fees of a boy in the family would be paid first. This was revealed in a research conducted by Kwesiga (2002). Some participants also expressed views on religious, cultural and traditional practices that affect science and technology-related studies worth discussing further.

5.2.6 Religion as a Cultural Barrier

During data-gathering some participants expressed views on cultural practices in terms of female genital mutilation and Trokosi system which have no direct bearing on this research. They however considered gender segregation of activities such as restrictions placed on females from mounting the pulpit to preach equally as the males in some churches. This was considered as a reducer of confidence in females. Such religious inactivity by females according to the participants inhibits most females' potential to research and disseminate information. Again, the participants consider science to deal with dissemination of research findings by expressing for instance that: "*I saw this; I think this should be done"!* The participants supported that this leads to a subservient stance whereby the females consider it normal to be passive in public speaking. It was further raised that religiously, males are supposed to be the heads whilst females assume subordinate status hence, sometimes leading to males' refusal to accord females the necessary acknowledgement and regard. This also leads to the withdrawal of females in social set-up and lowering the drive to take initiatives.

A chat by this researcher with a Catholic priest on the passiveness of females in preaching revealed that the Christian Catholic Faith does not permit females to mount the pulpit justifying with Biblical quotation found in the First Book of Corinthians chapter 14 verses 34 and 35 which express that women are to be silent in the church. One cannot fathom the number of female engineers produced from other churches such as the Methodist that permits females to preach the sermon unless a research is conducted on this. Similarly, in a conversation with one of the female-heads of an Islamic Senior High School in Ghana, it emerged that females are not allowed to touch and hold the Koran when they are in their menstrual cycle. They are also disallowed to preach in a congregation which includes adult males. No reason was offered except that the laid down principles must be followed. All these restrictions might have indirect impact on females since it portrays inequality in the system. One may consider the impact as insignificant since in schools where academic and scientific insights are gained, no such restrictions are placed but people assimilate what they observe from their environments - a social constructionist's perspective. Growing up in a society under such restrictions as expressed by some of the participants in this research, induces inactivity in the females which in turn inhibits their potential to disseminate information and to flourish even where sometimes men easily do.

The literature also describes Orthodox Judaism's practice of allowing only males to take a full part in ceremonies. In other Islamic religion in some regions too, report by Holm (1994) reveals in Haralambos et al (2004) that women are not allowed to enter mosques for worship. Christianity has also been male-dominated and, many of the influential ideas were worked out by (celibate) men in the first/five centuries of the Church's history. The significant developments of the medieval Church and Reformation were also shaped by men. Holm (1994) further explains that women's second-class status is related to sexuality thus, menstruation and childbirth are regarded as polluting, so, Hindu females are prohibited from approaching family shrines when pregnant or menstruating.

Such religious beliefs and practices have been detected to be reduced. Research, however, needs to be conducted on this to find out the degree of impact on scientific insights and technological innovations by females experiencing these segregations worldwide. It is quite difficult to conclude that there are no females of the Catholic or Islamic faith who are engineers. These religious differences could be based on the culture adopted by the particular religion. One of the four definitions of culture is: "the whole way of life of a people" (Haralambos et al., 2004 p.791**)**. This definition was further refined by the same source to: "The culture of a society is the way of life of its members; the collection of ideas and habits which they learn, share and transmit from generation to generation" (p.791).

All these religious practices could be regarded as patriarchal (being created, dominated and ruled by males). They are socially constructed by men and regarded as acceptable by females in the various societies. This variety of sub-cultures or cultural pluralism inherited by the society from the forefathers might have gone unquestioned. Females not allowed to preach and likely to have an influence on their research and dissemination of information as suggested by the participants definitely cannot be conclusive because of its universal application. This is because there are quite a number of females in religious denominations who are allowed to deliver sermons who might not be in engineering and those in other countries who may be in Islamic religion only but are engineers. People carve their identities based mainly on the differences within their societies especially what they witness as being done by the parents, peers and other members. The church is just a microcosm of the larger macrocosm so it is doubtful whether lack of sermon delivery could have an impact on females' scientific and technological studies. It therefore calls for research.

Another sensitive issue that emerged during the interviewing was the case whereby female students pursuing engineering courses on Community Service (CS) were not allowed by the workers to touch the carpentry tools. The carpenters whom the students were to understudy for practical insights refused to permit the females to hold the carpentry tools in a particular region of Ghana as noted in the fourth chapter of the Findings. CS which falls under various universities' curricula is similar to Industrial

Attachment (IA) where students pursuing practical-oriented programmes get the opportunity to link the theoretical insights gained in the lecture theatres with the practical activities on the field. At the end of such service, students present reports on the skills and knowledge attained for grading towards the attainment of the degree. A female-participant expressed the reason for the behaviour of the carpenters in her region that**:**

> The notion that ladies are not allowed to hold carpentry tools is on the basis that men do the hard work. Most of the hard work should be done by the men. The ladies are mostly to be in the kitchen or just the house, doing the house chores"

This is therefore based on culture and tradition. Culture as already defined, is generally the way of life and living of a particular society. The cultural system of most developing countries seems to be patriarchal in nature. Patriarchy involves a description of inequalities between men and women. It mainly describes males' control over females' labour power (Haralambos et al., 2004). Reasons as to why males control females have not been explained critically by these writers but this could be adopted by the society due to the religious beliefs (e.g. Christianity) imbibed by most members of the Ghanaian society. Though Skelton et al (2006) explained how segregation is exhibited almost everywhere in schools in terms of arrangement of names in the register, seating arrangement in the classroom, and play patterns, the issue of females' restriction to touching certain tools or using them has never been raised in the literature. These students were to learn practically from the more experienced workers outside the formal sector and the females were denied access to the tools whereas the males were allowed to touch and use them. This could be considered as clear segregation due to power and authority wielded again by the male artisan workers. Perhaps, this stems from superstition and definitely likely to put fears in the female-students. This in turn, is likely to be considered an abomination to the entire community (touching of carpentry's tools by females). The female-students attempted to find out why that phenomenon exists but they were cautioned by the elderly women with the statement that '... *"when they say, don't do this, don't do it*". This inhibits the creative knowledge of the students. Female-students ought to be assertive enough so questioning the reasons for the restriction was in order but, this might have been in existence from generation to generation. A positive response to their questions is likely to improve their scientific knowledge in the sense that the enquiry would guide them to gain insight or acquire deeper knowledge which might lead to a deeper thinking or reasoning of the world – in this case, a developing country as compared to other developed countries. This would generate further discourse that might lead to the unraveling of this phenomenon that has been socially constructed by males or perhaps by females. Females' confidence would be least boosted with such negative behaviours portrayed outside the university's walls. This pronouncement by the carpenters is likely to put and cut off females from the practical-oriented courses. With contemporary changes in development or current universal transformational growth, if the males who are the experts in manipulative skills are still holding on to this mentality thereby debarring the females from the acquisition of practical skills, then there is a need for measures to insist that they (males) compulsorily oblige. Perhaps, the authorities in the universities could redirect students on such CS but by taking that stance too, this problem can never be resolved in the society. All these portray real occurrences in the day to day activities shaped by people in the world thus typifying social constructionists' phenomena.

The participants also complained about lack of infrastructural facilities. Infrastructural deficit leads to discouragement since there would be minimal practicing on campuses' workshops and laboratories. A female-participant (CT) on the piloting for instance responded that: *In the ICT [Information Communication Technology] laboratory, you see the computers there but not like the Mechanical Technology Education (MTE) workshop.* She concluded that whilst applying for the mechanical programme, they had limited knowledge about the ICT else they would have opted for that. They were however reminded by the researcher that the entry requirements might have perhaps denied their admission.

The importance of appropriate infrastructure and provision of adequate facilities in the development of a practical-oriented discipline cannot be over-emphasised. All the internal processes that take place in a learner may be influenced by external factors such as the teacher's comments and the use of resource materials. In this regard, if the females lack the manipulative skills and are again denied the use of tools towards acquisition by those they are to acquire further skills and competences from, then both intrinsic and extrinsic motivation fade. These restrictions need to be worked on to promote equality in praxis which might ensure a balance in science and technology-related studies and careers. The command issued by the carpenters also confirmed the role of language as a social constructionist's phenomenon.

5.2.7 The Role of Language and Social Change

Language according to Burr (2015) is a way of expressing our internal states such as thoughts and feelings to other people. The female-student who shared ideas on the CS said with fear that:

Since it wasn't our community and we have been told that when they say, don't do this, don't do it, so we came back and we were like why [should] women not touch this thing?"

People use language in everyday interaction, that is, their 'discourse' with each other and these linguistic skills are used in building specific accounts of events which may have implications on those they interact with. Consequently, one would not be far from expressing that the command of not touching the tools may have ripple effect because the students will communicate that it is an abomination to touch such tools. The implications may go beyond the immediate social situation and the consequences may not be the intentions of the speakers or carpenters themselves but what has been imbibed from generation to generation. Words matter very much! Language really has the power to bring about change in the thinking of people and this greatly lies in the hands of those who want to effect change (Burr, 2015). So, how this should be reversed needs serious research since other females have touched carpenters' tools without any embarrassment or accidents. An instance is YaaT who acquired basic technical skills very early because an uncle permitted her to use the tools in his carpentry's workshop continuously. This culminated in her pursuing technology-related programme which would successfully carry her through to technological career. Authorities instituting CS or IA must ensure universalism that is the "*value that ensures that all people are treated similarly and that there is no favouritism based on family/friendship connection, or payment*" (Haralambos et al., 2004 p.307). It is of no doubt that in a pluralised world with diverse cultures, one cannot dictate to a particular culture but, so long as the CS is found on the curricula of the university, it behoves the authorities insist that students are issued with questionnaires that would spell out all requirements before embarking on the CS.

Those sole-proprietors or master-craftsmen on the private sector are likely to formulate their own rules and theories as against those in the public professional industries. If an individual is unwilling to adapt to modern trends of ensuring that females are equally treated as the males, that individual ought to be ignored. Students should be educated to complete questionnaires just like how informed consent is initially sought prior to embarking on a research. It is necessary that preliminary studies are made before the students are granted permission to attach themselves to various workers or practitioners since people are usually unaware of the consequences of their spoken words and actions.

5.2.8 Other Discouraging Social, Economic Barriers to Females' Science-related Studies.

Another social issue that puts females off the study of the science and technology-related programmes that emerged was the immoral behaviour of young staff or tutors who wanted to use the females as sex-predators. It was reported that a National Service (NS) person posted to a second-cycle school to assist the tutors sometimes sexually harass the female-students. Reports by Mensah Prah in Appiah and Cusack (1999) on a study conducted nationally on violence meted out to females in Ghana showed that quite a number of females experienced threats from teachers to fail them or influence their schooling if they failed to yield to their sexual demands

In this study, a female-participant expressed how she got discouraged in studying Chemistry due to the behaviour of one NS person. She wanted to be a doctor but the NS Chemistry tutor repeatedly failed her because she would not yield to his sexual advances. Nearly all the tutors and lecturers handling the science-related programmes in the second-cycle and University levels are usually males. This is even confirmed in the number of lecturers sampled for this thesis. Most female-students would be resistant to mention such sexual intimidation, abuse or violence. It may not be easy for them to find a male senior or lecturer to confide in. This behaviour has negative ramification on female students who yield to the tutors' demands since their grades in the end would not reflect their true academic performance. It is also possible that these men may have multiple sexual partners thereby endangering the lives of those that fall prey to their harassments. The females could contract diseases in engaging in such promiscuous lives or could be put in the family way. Desperation may lead to an attempt by the female students to terminate the foetus at the peril of their lives.

Sometimes parents whose children report such sexual abuse to them fail to report to the authorities for fear of victimisation or labelling in the society. Also, quite often, such females are shunned by their peers making their lives miserable within the educational communities. At times too, they may be nicknamed and even bullied by other male friends. Their own female peers may tease them on the grounds that they are anti-sociable or timid. This could affect their performance with the possibility of their dropping out of the school. Appiah and Cusack (1999 p.160) for instance state that women:

> Fear their daughters will never find husbands to marry them if [they] report such things (rape). If a woman cares about the future of her children, she will never report the man, even if he tries to kill her.

Thus, based on such fears, female-students might be abused continuously without reporting. It is really important that such female-students are given the encouragement to report such cases. If sanctions are applied to the defaulting service personnel, this diabolic behaviour could be minimised or curtailed entirely. It is important that the students who are bold to report such incidence at the second-cycle stage are relocated to other schools for fear of indecent acts or further assaults by relatives of the sanctioned teachers. Leaving the girls unprotected cannot quench the fears in the female-students. This was however not experienced in the universities sampled. Apart from these socio/cultural inhibitions discussed, pedagogical strategies were found as key issues hampering females' studies.

Research Question three (3): ***How do identified pedagogical strategies influence the interest and choice of technology-related disciplines by females?***

5.3.1 Observational Criteria

The analysis for this section focussed on the observation of lecturers and a discussion on the most preferred and least preferred lecturers in terms of pedagogical skills. An attempt was made to be non-prejudicial; thus, commenting on the processes observed and not necessarily what ought to be done based on the researcher's own professional practices. The FIAC's observational checklist designed by the researcher was structured towards an observation of either lecturer or student-centred approach of teaching.

The observation of the lecturers' teaching was analysed alongside five (5) out of the ten FIAC's schedule in the fourth chapter. The five (5) included: accepting feelings (empathy), praising and encouraging (motivation), accepting or using the ideas of pupils (collaboration), asking questions (questioning) and lecturing (formal presentation). Additionally, it was worth interpreting further the observation with two main phases of teaching analysed by Cohen and Manion (1993) which corroborate with FIAC's schedule and these were: Motivation and the Style of presentation or Application phases of strategy

5.3.2 Motivational Phase

In consonance with the FIAC's schedule under motivation (Appendix 3.3), the researcher checked whether the lecturer stated the purpose or objectives for the session, checked for compliments offered (whether negative or positive), checked for resource / support materials used in terms of the use of real objects, models, charts or other incidentals. Again, the lecture theatre or hall's management - whether the lecturer respected diversity and showed positive rapport towards both male and female students and above all, whether gender sensitiveness was portrayed in the course of distribution of questions and reactions to questions. It was also meant to check how the closure was effected; whether done through questioning, a summary of salient points or just a wish of the best for the day. These criteria as also noted in the third chapter were adapted from the University of Education's Centre for Teacher Development's teaching practice Evaluation (IRB3) Form.

Commenting on this motivating stage, apart from the male lecturer at VarsA, the other lecturers hardly complimented the students' effort in responding to questions. Clapping was meted out to two male students for the great effort made by them in solving the home-work. Cohen and Manion (1993) greatly commend this form of reward as a follow up to a piece of homework. To them, such an effort could go with praise and encouragement such as "You tackled a difficult task very creditably, well done!" (p.138). The two guys were the only students who solved the problem. A critical analysis of the reaction by the lecturer could have been to question why majority of the students had not solved the take-home assignment. One cannot determine whether they could not understand the question hence lack of solution or sheer laziness which is not usually checked.

A female student asked a question undertone and the male lecturer prompted her to speak aloud to the hearing of all which was a mark of a very good teacher or lecturer since the question was meant for the entire class. The question was also thrown back to the class by the lecturer for the students' response before the lecturer's additional comments and explanation. That was considered as a very professional practice since that would ensure alertness by all the students. On the other hand, the lecturer could have also complimented or praised the female student for asking the question if the question was worthwhile. Praises are known to be rewards that really encourage further performance. The lack of praise at that period confirms the observation by Elwood and Comber (1996) in the literature that teachers' praises to girls were less enthusiastic and less meaningful than that directed to boys. In this case, there was no compliment at all except a quest for speaking aloud. On compliments, in responding to a question on the least preferred lecturer in terms of pedagogical skills, ManE at VarsD expressed that: *Discouragement is what females don't like at all. At least whatever a female does, try and find a way to polish that up. I don't remember the last time he [the lecturer] complimented a member of the class.* Quantitatively, Skelton et al's (2006) research's report found boys to receive more attention than girls in both teacher and student-initiated interactions across a wide age range even 20 years in a research conducted in the UK, USA and Australia.

5.3.3 Style of Presentation / Application Phase

In the presentational strategies, generally, by observing in situ, a more comprehensive view of the setting was achieved. The hybrid or blended and democratic styles seemed to have dominated the other styles of teaching for the lecturers except one. There was no physical or psychomotor practical demonstration of teaching but two lecturers supported their delivery with an overhead projector (OHP). On commencing, the lecturers either gave the lessons' outlines or overview which could be synonymous to the statement of the objectives of the lesson or lecture. Cohen and Manion (1993) express that there are many ways of arousing students' interest at the beginning of a lesson after their attention have been secured. This phase may depend amongst other factors on the subject being taught, the teacher's insight and the nature of the class.

At VarsE, the male lecturer commenced with the outline of the course with charts on an OHP. The female lecturer used mainly board marker illustrations. At VarsA, the male lecturer used the feedback phase of the previous lecture by asking for those students who solved the take-home assignment. The two male students who solved the assignments were complimented with claps for solving the assignment in front of the class as mentioned under the motivational phase. The female lecturer at VarsA set off by reviewing the previous lecture whilst the male lecturer at VarsB gave the highlights of what was to be done spelling out specifically that since it was the last-but-one lecture, the third trimester's work would be reviewed.

In line with FIAC, the male lecturer at VarsE asked series of questions, used real objects like pieces of rocks or stones and adopted the lecture-discussion method amidst variety of power point and flip-chart presentations. Quite a number of the male and female-students asked questions and an attempt by one male student to dominate the interaction with repeated questions was ignored by the lecturer – a mark of proficiency since the student could conduct further research after the lecture. Constant questioning by one student could derail the progress of the lecture. Variety of visual aids in terms of real objects used enhanced the lecturing. Thus, throughout the presentations, students' attention was secured and sustained perhaps due to the numerous support materials including flow charts on the power point presentation.

Contrary, the female lecturer at VarsE used board illustration amidst explanation followed by dictation for about twenty minutes. The dictated lecture could be classified under autocratic mode of imparting knowledge since no student asked a question within that period and after. There was lack of empathy as expressed by FIAC in the sense that the students did not ask questions to check whether the lecturer would sympathise with them, accept their feelings and clarify the points or not. The lecture ended at the end of the dictation so one cannot determine whether the dictated part was meant for closure. The main points of the lecture were initially presented with board illustrations in terms of sketches, notes and explanation. The female-lecturer could have checked students' comprehension by inviting questions since there was still time left for the teaching / lecturing. Thus, FIAC's stages of response or initiation by students were all lacking.

The post-observational interview could not cover the dictated aspect since, ethically, this was a research observation not meant for assessment as carried out as part of the professional duties of the researcher on students. Besides, no matter the liberality of the approach taken, it could have embarrassed the lecturer. The issue of further professional studies with the female lecturer was discussed and from the hearty responses and questioning about where and how to enroll, a positive discussion could be deduced.

The lecturing by the male lecturer at VarsA as discussed earlier at the motivational stage as well as in Chapter Four (4) was fairly interactive. The female-students' contribution was minimal though. Only one out of the three females was punctual to class and it was explained by the lecturer that they embarked on a field trip prior to the lecture. The presentation on the "Bonding Process" by the male lecturer using overhead projector just like the male at VarsE, was proficiently and systematically presented and all the students were very attentive. Definitely, as explained during the post-observational interview with him (male-lecturer at VarsA), he exhibited the expertise of a professional teacher.

Not much was gleaned from the female lecturer at VarsA since the focus of this research was on science-related programmes but she lectured 'Technical Communication Presentation'. There was a miscommunication between the researcher and the Class Representative who was introduced by the observed female-lecturer to the researcher on the telephone to direct the observational exercise. It was unfortunate that all phone-calls to the female-lecturer for clarification proved futile since there was no response. She nonetheless, presented her lecture with modern technology; thus with power-point presentation likely to appeal to both sexes of students. It was a large Interdisciplinary class of 80 members with twenty (20) females (forming 25 percent) of the class.

The male-lecturer at VarsB had the public address system failing therefore initially presenting poor sound quality for the lesson. He however presented the review for the trimester with board illustration. The class was initially dull with some of the females having their heads on their desks, least mindful of the visitor (researcher) seated right behind them.

In all, there was neither group work nor individual practical teaching to recount how the female students would be kept actively involved equally as the males. Females have been noted to collaborate effectively well in group work on practical activities (Weber & Custer, 2005). It was also impossible to determine whether individual attention would be paid to any of the students since although this is a higher institution, it is still a mixed ability group with some of very high ability, others average and some slightly below average. This could be possible since during the post-observational interview session, some of the students admitted that they were coerced by their parents to study Engineering (Material Engineering). It would have been interesting to observe how the lecturers behave towards such category of, especially, female-students who were gradually picking up.

Confirming or verifying females' most preferred style of teaching/ learning regarding the issue raised by researchers including Chapman (2000) in Weber and Custer (2005) became difficult. Females are noted to prefer collaborative work as against individual competitive exercise (contrasting YaaT's style though). Chapman (2000) also expressed that contemporary curricula work is shifting towards small group work (co-operative learning strategy). Perhaps this might not be applicable to higher institutions since from experience, without supervision, a number of students do not take active part in the science-related project work when assigned on small group basis. Some even influence other members to get their portions done for them. They just connive with the group leader to include their names in the group list. Without proper supervision too, some students just present purchased items from the markets. Since most technology-related classes have lower enrolment as realised from the enrolment patterns for the various sampled courses in this research, students be it females or males, ought to be encouraged to carry out individual assignments but, collective or group discussion could be encouraged prior to the solution. Students' acquisition of skills leads to proficiency in the practical field which in turn boosts their morale and confidence during their professional career.

No student seemed to be bored during the entire observation apart from a few at the VarsB where the lecture was held in the evening from 3.30pm with an initial poor sound quality. During the female lecturer's presentation at VarsA, the atmosphere was quite noisy although she presented with a well-developed power point details. It was a large class (80 in number) and the students attended the lectures in a more flexible manner with more than 50 percent using their laptops. Questions were asked by the female lecturer and a few students. At a point, a female-student seated in the front row put up the hand in an attempt to either respond to or ask a question but she was ignored. Another female-student seated close to the lecturer also in the front row was called though. From the eye-zone of the lecturer, both females caught her attention but reasons as to why the first was not called cannot be adduced. Perhaps, that student normally gives irrelevant contributions or is a mere extroverted type of student. Extroversion is however, one of the greatest traits for proficiency in the study of science-based programmes (Yukl, 2010). Interaction generally between the lecturer and students was somehow minimal and since the females were far lower in enrolment than the males, it would have been expected that all those who made attempts to contribute be given the opportunity.

A point worth noting was that during the observation of the lecturers, no insults were hailed at the students as experienced by some of the participants at Level-100 during the interviewing. A negative point however, was about a dictated lesson as shared by some of the participants. PEF at VarsB for instance expressed that:

> When he [least-preferred lecturer by PEF] comes to class, he'll just sit down, dictates the whole notes and if you ask him you don't understand, he looks at his notes and dictates the same thing. He doesn't even give handouts. It's his notes. If we say, Sir, we don't still understand, he will say go and read more. …He just comes and sits down; dictates, dictates, dictates till he goes". (Interview Transcript 3: April, 2017).

Having analysed the observation of lecturers, the next issue was the participants' opinion on their preferred and least preferred lecturers in terms of pedagogical skills. According to the participants, the most dominant criterion that made a lecturer's presentation preferred was explanation that is given to the information or content of the topic. YaaT explained that her favourite tutor at the SHS was her core Mathematics tutor because, *"he doesn't mind coming to sit with you explaining till you've understood"*. What is the importance of explanation in teaching or lecturing?

5.3.4 Explanation of Content

Most of the participants expressed views about the importance of explanation to the content of a lecture. The literature also notes some elements or factors that contribute to effective explanation which include: continuity, simplicity, and explicitness (Cohen & Manion, 1993). Explanation could therefore connote a principle underlying the teacher-centred situation because it is a method in which the teacher speaks and the students listen. Oeser in Cohen and Manion (2003) illustrated that such a relationship leads to the interaction "confined to listening, perceiving and assimilating; and there is no interaction amongst the pupils themselves" (p. 169). The writers again express that in a talk or lecture, there is a sharp distinction which makes the teacher or lecturer's role become more "authoritarian, exhortatory and directive" (p. 169). Such a social structure they explain is found in its pure form in a radio or television broadcast. To these writers, such a style is more appropriate for the introduction of a new lesson, demonstration of a skill in the course of the lecturing or at closure of a lesson when the lecturer or teacher sums up what has transpired.

In the case of the lecturer at VarsB who reviewed the trimester's work, this method could be considered appropriate because the students were preparing for an examination. In the view of this researcher however, in a lecture hall or classroom exchanges, the teacher must not monopolize the talk by explaining solely but step it up with discussion; be it a review or main lecturing. Active learning is the one in which the teacher allows discussion and mutual help between the students. Such mode of learning is known to work well by practical work in the sciences where the teacher becomes a facilitator or an expert advisor. This could be considered as student-centred lesson especially where they are grouped and made to solve their task by discussing their difficulties and agreeing on solutions. One participant said: "*you talk, I talk*" which connotes a two-way conversational interaction. This is not to support the status-quo of females' preference for linguistic skills but from the responses of the participants, a view is held that with the already domestic practical expertise by females (constructed by the society in terms of gender roles) coupled with the linguistic skills, if the practical component of courses for instance are well explained and vividly discussed with females' input, acquisition of the psychomotor or practical skills would become flexible which would lead to easy and proficient application of the theory by females. Quite often, with limited discussion, comprehension becomes difficult hence transfer of such knowledge becomes abstract. If females are assisted, they could form mnemonics with these scientific and technological procedures for easy assimilation and therefore transfer of theoretical knowledge to practical skills.

This is why a dictated lesson may not be appropriate at the higher educational level. It is important for the students to make their own notes after the lecture by researching and extending the knowledge gained in the lecture. Lack of discussion was also expressed as the main reason why some female-participants dislike some pedagogical strategies of some of the lecturers. At best, the lecturers could supplement their lecturing by preparing and distributing instructional materials termed as Information Sheets. The teaching or lecturing should also traverse beyond discussion to demonstration since Engineering is a practical-oriented programme. Regrettably, it emerged that no practical activities were performed. Keyna at VarsC for instance stated that: *Our lecturers ask us questions but one thing that is actually lacking is practicals. We are also in class doing theories and he doesn't even come. He comes once in every semester when we are about to write exams (Interview Transcript 1: April, 2017).*

The situation was noted by Joanat to have improved with the construction of another laboratory. This ensures demonstration as well with the lecturer or demonstrator intermittently asking questions, explaining and discussing the various stages with the students. Students should also be given the opportunity to participate in the demonstration else, merely observing would not lead to proficiency in the acquisition of skills. With the overcrowding shared by the participants too, some of the students are likely to be behind the demonstrator therefore unlikely to view what is being demonstrated. A semi-elliptical or semi-oval shape opposite the lecturer is considered the best arrangement for viewing what is being demonstrated. As expressed in the last quote, the students strived to secure a space closer to the demonstrator and most females being shy unlike the aggressive gene possessed by the males, would not struggle for the space. They are therefore likely to ignore the demonstration. Practical activity is very important for the engineering industry. Students should be equipped with manipulative skills to produce simple devices that could help develop the mechanical, automotive, electrical, food and clothing, agricultural industries for the country to be independent of simple items that would appeal to both females and males. Students should be guided to produce agricultural implements, food appliances, cast engines, fabricate and assemble vehicles and many more. A concentration ought to be placed on the study of practical aspects of learning and not only the verbal acquisition of knowledge. Both female and male-participants expressed lack of practical activities. Jaet, a female-participant at VarsE also stated that: *"there is no practical; practical is totally theory. Practical 'dee' we don't do anything".* Without practical activities, students would not be conversant with the practical components. There is a need to blend the theoretical and practical components to improve the system. There was also no practical demonstration with real objects during the observation exercise. Some of the students pursuing Material Engineering however carried out practical activities outside, on the terrace and not in a workshop or laboratory.

At VarsB, although no practical activities took place, it was deduced from the responses of the participants that practical project work was carried out. Tosh, a male-participant for instance expressed how a female-student who happened to be his project group member was dismissed due to low performance and non-compromising nature of a lecturer whose pedagogical skills was detested by him. Other reasons for the least preference of pedagogical skills stemmed from insensitivity or lack of flexibility through to overtasking, boredom or lifelessness.

5.3.5 Insensitivity and Lack of Flexibility to Students

Some of the participants shared critical issues on how some students mainly females could not successfully go through the engineering programme due to the insensitive nature of some lecturers. According to the participants, some lecturers patiently call students who may be nearer to the borderline of grading and allow them to re-write before the final grading is recorded but other lecturers are so insensitive (rigid used by participants) that they would not yield to any negotiation but just go ahead and record the initial failing mark.

Actually, one of the duties of lecturers or teachers is to impart knowledge for students to assimilate and later engage in the right careers for self-empowerment as well as national development. In the learning process, there are slow as well as fast learners based on factors such as previous background and environmental issues. Assessment happens to be the means of evaluating performance of students. Within the numerous evaluation criteria is the continuous assessment. Continuous assessment is defined by Hudson (1973) in Cohen and Manion (1993) as “a constant ‘updating of teachers’ judgements about their pupils which permits cumulative judgements about their performance to be made” (p. 286). The teacher or lecturer therefore has to monitor the performance throughout the course (process) of how the students master certain tasks especially in science and technology-related programmes than to “pass judgement upon the final product of their efforts” (Cohen and Manion, 1993 p.287). This is applicable in all the educational sectors and this actually lessens the burden of the student who might not be emotionally sound to write the final examinations perhaps due to bereavement, ailment or any other negative issue. In support of this, in assessing specific skills in a practical-oriented course such as Engineering, continuous assessment could be considered most appropriate and effective.

Other lecturers too were noted by the participants to be unfriendly. Students ought to be accorded that emotional comfort and stability to learn effectively. Most females are likely to be less stressful when the atmosphere is friendly. Making students feel useless as the above quotation shows, might be de-motivative especially to females whose mathematical prowess is noted to be less encouraging. Students are the future of the society and every effort ought to be done to ensure their progress especially in the effort to encourage them into technology-related programmes. Teaching or lecturing without responding favourably to students’ questions and offering sarcastic responses like ‘going beyond the earth upon which one stands’ is unprofessional. At least, questions asked could be thrown back to the class for others to react to. Lecturers ought to be more tolerant and sensitive to the plight of students since this could lead to inferiority complex on the part of the female-students and subsequently dropping out of the system. The students may even lose confidence in the lecturer. They are also likely to lose confidence in the study of engineering when embarrassed with sarcastic remarks. In reading a particular programme which is science and technology-related, confidence is noted to be a key predictor of success by females (Edzie, 2014). Females may also broadcast to the outside world or the social media that would eventually repel other females from enrolling in the technology-related programmes. As already highlighted by the participants, females like talking.

5.3.6 Overburdening of Students

The female-participants supported the issue of numerous courses undertaken during a semester in two of the focus group discussions. Some of the topics they think, lack relevance to their areas of specialisation and therefore getting them frustrated and waning their appetites for studies. A clear case was what Bimga, a female at VarsD expressed about her programme of study (ICT) and Music. To her, such courses have no linkage and bearing and just frustrate them. Undoubtedly, if the purpose or objectives for the courses or topics were spelt out, students would realise the real life application and therefore the benefits of what they pursue. Emotions may therefore get mesmerized and students would willingly read the courses with passion. By explaining the purpose of the course and spelling out the specific objectives of the topics to be treated to the class and linking to real life situation and how these affect students' future expertise and careers, students' morale would be boosted and their appetites whetted up. In support of the Objective Model for teaching by Cohen and Manion (1993), the cyclical nature of the model ought to be considered from societal and individual needs to evaluation and feedback. There is a need for teachers and lecturers to inform students of the outcomes of their efforts and check these outcomes against the original aims and objectives in order to assess the extent of students' achievement. After spelling out the objectives, the strategies for achieving the objectives for example adoption of demonstration, must be explained and employed. Definitely, if the appropriate strategy is adopted, students would not feel bored and unappreciative which inevitably leads to a consideration of some of the topics or courses read as irrelevant.

Based on such complaints and similar sentiments expressed, there is a need for occasional workshops on counselling and review of courses but this depends on leadership of every institution. The next session for further discussion is therefore on leadership that would ensure gender-sensitive programmes. The question that drove this is:

Research question four (4): ***How does leadership influence female participation in the study of technology-related programmes in the sampled universities?***

5.4.1 Teachers/Tutors/Lecturers as Leaders to Students.

Seeking participants' views under this direction, whereas some participants raised the need for leaders in the educational institutions to arouse females' interests early in the Science programmes by enforcing compulsory science studies as early as the junior high school level (JHS), others held the view that it should start from the senior high school (SHS). The behaviours of the SHS tutors who handle the science subjects and the Elective Mathematics were shared by the participants. Some of the tutors were noted to reserve the difficult aspect of the content to their extra classes and during normal classes those who refused to enroll on their fee-paying extra classes were targeted to solve such problems; their inability to solve the problems correctly led to them being humiliated. This could be related to the research findings by VanBelle-Prouty (1991) from Francophone Central Africa which revealed that some teachers normally called the least capable female student to the board to solve very difficult mathematical problems and when unsuccessfully completed, called the most able-male student to assist. This would definitely reinforce the supremacy of male-students' mathematical ability. Kwesiga (2002) found out that such attitudinal behaviour of teachers was ranked least amongst the barriers to females' technological studies though found to be a major factor to students' education be it low or high level. This indicates that most people take such attitudes for granted.

Teachers are considered by the participants as leaders especially being second in influencing students in choosing their subjects as already analysed. Some of these teachers however, seem to be commercializing their profession to the detriment of students. The behaviours of some of the tutors who handle the sciences and the Elective Mathematics reserving the difficult aspect of the content to their extra classes and embarrassing those who fail to attend classes with questions solved during the fee-paying extra classes should be condemned. A contributory factor to the failure of otherwise well-meaning educational programmes is the absence of teachers' commitment and apathy. It is not every student who can afford extra classes hence imposing one's authority with extra classes could be considered unprofessional. Such tutors as leaders are exhibiting poor leadership qualities. Students are already saddled with a number of subjects and most of them at second-cycle level are non-boarders hence have to fend for themselves after school hours. They may become so exhausted that additional material cannot be absorbed. Apart from the unaffordability, the brain needs to relax to get refreshed for the following day's activities. It emerged from this research that females are emotionally very sensitive hence such humiliations of asking questions whose solutions have not been learnt, pull them away from serious studies of the subject. Those who attend the extra classes are likely to respond to questions correctly. There should not be any sort of coercion to get students enrolled unto extra classes. This did not emerge within the university sector during the interviewing but, disciplines read in universities are trajectories of JHS and SHSs and embarrassing females intentionally would repel most of them from choosing STEM courses.

EmlaB at VarsC also expressed that lecturers are leaders who could play vital roles in the progression of females in the technology-related studies but, regretfully, she stated that they only like the best girls. Sometimes the lecturers direct students to their Teaching Assistants (TAs)] but the students especially the females find the teaching challenging. Lecturers are leaders and academic counsellors appointed to students. There should therefore not be any discrimination since there are varying abilities within individuals pursuing various programmes. As leaders, lecturers ought to listen to their students keenly, reflect and offer counselling towards all students' progression but not just concentrating on the most intelligent females. Empathizing with all students could boost the morale of especially the average students. Responses to students' questions ought to be cordial, fair, consistent and portray ethical values. Recounting what a female-participant at VarsB expressed, the Engineering course might draw students away. Thrif therefore said: When you ask him [the least preferred lecturer] a question, he's automatically angry about the question you asked. When one questions further, the lecturer will say, I have gone beyond the earth I am standing.

Such sarcastic comments do not portray ethical leadership. When lecturers relate to students very well, it shows great esprit de corps that ensures individual's progression. Lecturers are supposed to play leadership roles by serving as role models and mentors to students. Mentoring as realised from the literature, helps to address the feelings of isolation and marginalization that females in academic settings especially in engineering often report. Mentoring is noted as crucial for females in STEM because without it "they might not be privy to the "good old boys' club or behind the scenes conversations that are crucial to fitting in the department and to getting tenure" (Trower, 2010 p.71). Females are likely to learn how to 'tinker' or play with the tins and cans when they interact with the males who are familiar with all the tinkering strategies. Such activities are very useful for the acquisition of engineering skills.

Besides the lecturers' attributes as leaders, the participants further shared issues on lack of infrastructural facilities inhibiting the study of their disciplines. In the piloting for instance, a female participant expressed how they see the computers at the Information Technology Communication (ITC) laboratory unlike the Mechanical Technology workshop with very fewer machines. She added how they would have opted for ITC had they known earlier. Some other participants were however quick to indicate how the central government has other sectors of the educational hierarchy to cater for therefore perhaps ignoring the University level. It is true that developments entail a lot in terms of funding hence, in explaining a point about high spending on INSET, a senior Chief Inspector reported that: *there are no cheap high quality routes into teaching.* There is a need to develop both the human and material resources for effective school climate. Workshops for carrying out practical activities ought to be equipped adequately by the leaders to avoid congestion. Expressing disappointment at the chemistry lab, Tosh said that: *we were like three hundred (300) in number with three (3) tables so a hundred (100)* *students per table or sometimes fifty (50). ... So we didn't do the practical. It is really impossible to get any meaningful practical demonstration carried out in such a situation.*

Fortunately, another laboratory was built therefore easing the congestion. In like manner, the leaders of institutions ought to devise means of ensuring that students make maximum use of the limited infrastructural and stationery facilities judiciously. Educational institutional leaders should exercise their powers and authority creditably well for all students particularly females to be attracted to the science-based disciplines that would surely lead to majority enrolling in technology-related programmes. Yukl (2010) dilates on the difference between power and authority of leaders and it is worth relating it to views expressed by participants in this research.

5.4.2 Power and Authority

Power, as a concept, according to Yukl (2010 p.199), "involves the capacity of one party (the agent) to influence another party (the target)". Yukl further explains that sometimes the agent could influence one person, a multiple target, attitude, events or behaviour. Power is also described as dynamic that changes as conditions change. The heads of institutions (micro level), departments (meso) and the nation (macro) as agents and definitely influential, have the power to change the status quo of institutions in this case the students who are the targets. If even policies are not formulated (as expressed by the participants) to coerce students to read certain programmes, such agents or heads could guide the targets (students) through their charismatic approach to see the potential and importance of certain courses to the two sexes of students. In that vein, through dialogues, they could influence the behaviours and attitudes of students. A leader's authority includes the right to make particular types of decisions for the organisation.

'Authority' is the "rights, prerogatives, obligations and duties associated with particular positions in an organisation or social system" (Yukl, 2010 p.199). Leaders therefore have authority and managerial control over financial and material resources. Fund-raising techniques could yield and support such resources. As the participants shared, there is a need to boost up infrastructural development for students to have first-hand practices with the machinery and equipment. If students are restricted, confidence would wane and they would be deficient on the job market. It is important that Universities check the vision and mission establishing the units and work towards their achievement bearing in mind both sexes of the student-population. Nations dubbed 'First World' such as Britain and the United States of America have been making strides by formulating educational policies for most of their countries with the aim of turning out each year technology-literate boys and girls who to a large extent constitute the future work-force (Danso, 1996). It is worth making conscious effort to emulate such nations to ensure a fair balance in the technological educational system.

As analysed later under the next theme, policies could be formulated to ensure that Universities are equipped with adequate facilities to attract the students to enrol especially females in the science and technology-related programmes. When the issue of quota system or preferential admission criteria (PAC) to females who qualify to enrol in engineering was raised as carried out by leaders of Institutions in Tanzania specifically in the University of Da-es-Salaam, the participants were not familiar with that. YaaT for instance expressed that she does not know of any such system but she has heard the boys speculate on that issue. She in effect stated that: *It can also be done here but it looks as if our leaders don't care. Some of them are not sensitive but I think in some Universities* *here, they do that* … None of the participants seemed to have benefitted from any such quota system. This signaled that the admission is solely based on merit between females and males and it is only those who can afford the fees and other requirements who enrol. Given the option between enlisting males and females in a financially constrained family, only the male would be given the opportunity to enrol in a school as found in the literature. The male lecturer at VarsA who was observed however hinted that something similar about the quota system is underway but it seems to be silent. The importance of females getting identified and offered special consideration in tertiary institution (quota system) in STEM subjects or disciplines is long overdue. As indicated by the participants, there ought to be scholarship incentives targeting only females who want to study technology-related programmes as already argued out. Leadership of schools' government or Council must advertise to make the citizens aware of the females in technology-related programmes and the incentives thereof. Industries must also be sensitised to accept females who undertake technology-based programmes after school. This might erase issues expressed by Joanat that: "*Most of our hopes are dashed because we have not realised our hopes. Quite a number of us leave for greener pastures elsewhere because those with the intention of living in Ghana though with nothing to encourage females, want to … impact in the nation*".

The participants suggested the importance of improvement in the infrastructural facility to motivate females specially to ensure proficiency in the practical activities for a good stance in their future careers. The leaders of universities should be able to assess their goals and adjust to suit current trends of development by focussing on females' engineering education. As expressed again by the participants, talk-shows must be frequent to inspire, motivate and arouse the interest of stakeholders such as parents who are found to be the main influencers of subject choices.

The social media could be sensitised to advertise these programmes on air. Quite a lot of programmes are unknown to the populace. Advertisements through the media such as press releases, radios, articles, television teaching as done regularly in other subjects should be encouraged. Lyjune at VarsD for instance responded that: *You talk of engineering, a man pops out; you talk of medicine, a man pops out. Put women at the forefront of advertisements!* The leaders of institutions could formulate award-winning proposals for refurbishing the workshops and laboratories. Leaders ought to exhibit the five exemplary practices reported by Kouzes and Posner (2007) which are: Modelling the Way, Inspiring a Shared Vision, Challenging the Process, Enabling Others to Act and Encouraging the Heart as reviewed in the literature. Leaders must place premium or value on female technology-related studies; share these values with stakeholders and give priority to females to prove their worth in engineering practices. Under-funding affects the management of programmes in terms of acquisition of human and material resources. Funding and equipment of workshops and laboratories ought to be given a serious consideration to refute the statement made earlier by YaaT that it *looks as if our leaders don't care.*

Leadership as described by Edwards (2009) is "the practice that leads to positive influence, growth, and development of both individual and groups for a collective purpose" (p.25). From this perspective, leadership could transform the situation based on values held. As reported by Kwesiga (2002) in the literature, at Makerere University in Uganda, enrolment grew rapidly from 23 % in 1989 to 35 % in 1999 and reached 41 % in

2002 due to affirmative action (AA) strategies employed to promote women's studies. The leadership devised a strategy by offering a bonus of 1.5 points since 1990/91 academic year to women who qualified to enter public universities. Association for the Development of Education in Africa (ADEA, 2006) also reported how Makerere University again, employed AA to boost enrolment for females in the Agricultural Engineering studies.

Similarly, in Tanzania as the literature reviewed indicated, Lihamba et al (2006) reported how similar AA programmes instituted at the UDSM have yielded positive results thus leading to increase in females' enrolment generally and specifically in traditionally male-dominated specializations such as Engineering. From 1996 through 2003/04, AA saw enrolment increases from 16% to 27% in the sciences and 7% to 13% in the Engineering (Lihamba et al, 2006 p.583). Pojman (1998) in that regard explained that the AA was politically masterminded to actively dismantle institutionalized or informal cultural norms and systems that had been ascribed to certain groups leading to their disadvantages, hence inequalities. This is a real transformational practice of leadership as explained by Kouzes and Posner (2007) in the report of their 25-year research project. They researched into a number of leadership styles as reported in the literature review (Chapter two) and one style pertinent to the number of styles is the transformational leadership. Such leadership style makes extraordinary things happen in any organization. Ideas on how leaders perform excellently well by Challenging the Processes were also explained.

In conclusion, from the data gathered from the research tools and literature, leaders in Universities should emulate transformational leadership style which is in conformity with what Pojman (1998) explained about the leadership practice displayed at UDSM in Tanzania and Makerere in Uganda. Such positive discrimination AAs boosted enrolment in the technology-related programmes for females. There could be challenges in attempting to influence the stereotyped populace into adopting a particular culture which some might consider alien to theirs but, with well-articulated goals, motivational speeches and other interceptive actions outlined later, all these could be attainable. The transformational leader could succeed in encouraging an appreciable number of females to be enrolled in the engineering sector. Further attempts to enhance enrolment viewed by the participants unfolded as the next theme is analysed.

Research question five (5) - ***What are some of the policies that are formulated at national (macro), institutional (meso) and departmental (micro) levels for access, entry and retention towards participation of females into / in technology-related studies?***

5.5.1 Policy Formulation

When the issue of whether a policy or rule should be enacted towards the study of the sciences at various levels thus – at national level (macro), at meso (institutional) or micro (departmental) level, the participants expressed that it is not a formulation of any policy but that the institutions for science and technology should rather be well established. They expressed views that with adequacy of laboratory instruments, workshop equipment and flexibility of use by students, policy formulation would not be necessary. Although some participants especially those at VarsA admitted that the non-spacious laboratory for Chemistry has been addressed, sometimes they were restricted from using the instruments if even available for fear of getting damaged. Some participants also seemed to be frustrated but still thought policies might not work.

On the number of courses pursued within a semester or trimester where applicable, it could be recalled how ManE complained about the numerous courses offered' he outlined a trajectory of the educational structure in Ghana from the Ordinary and Advanced Level through to the current SHS Level. Definitely, the review in the educational structure leads to changes in the number of courses pursued. ManE therefore expressed that the numerous science courses taken per each semester makes the studying of the sciences too stressful for females. To him, males are able to handle stress hence the engineering would always be skewed towards males. He however could not think of any policy that could relieve female-students out of the stress in order to attract other females into the technology-related programmes.

Considering all the responses by the participants, a question that could be pondered on is - how could the inadequacy of facilities, numerous courses and the infrastructural deficit be addressed at macro, meso and micro level? What policies could be formulated to ensure gender-sensitiveness?

Policies could be formulated to ensure the acquisition of facilities through internally generated funds by the institutions, faculties and departments. There is a need for the preparation of budget and implementation based on the strategic plan of the university, faculty or department. Loans could also be sourced for developmental projects. The leaders of these sections particularly departmental heads or individual members of staff could also search the internet for sponsorship. There are sponsors and their areas defined for sponsorship. If the criteria are met by the units or institutions, then proposals are formulated for sponsorship. There could also be a policy on how to generate funds internally as observed at Obafemi Awolowo University where a well-established bakery fetches the university high sums of money. This was observed during a Carnegie-sponsored Conference attended in that University in the year 2008. Additionally, portions of their land have been used for piggery and poultry farms for commercial purposes.

Similarly, at micro level, in any Engineering Department, mass production unit could be established whereby employees would be involved in the manufacture of components such as bolts and nuts, crank-shafts of vehicles, vacuum-forming plastic bowls and injecting moulding of plastic bottles for drinks. Since universities are higher places of learning, policies could be formulated for the establishment of a practical workshop or laboratory to serve as resource centre, production unit and students' practical-acquisition centre. If this is done, the workshops would always be resourced adequately to appeal to both males and females. This would also ease congestion since expansion of infrastructural facilities could also be achieved.

With the restriction on instruments as indicated by some participants, it is important that at micro level again, the workshops are resourced with high as well as medium or low quality instruments that could be used appropriately by beginners and semi-experts. An instance could be the furnishing of low-tungsten flexible bi-metallic blades to be fixed in hacksaw frames for beginners or level-100 students whereas the semi-experts or continuing students could use the 'All-hard High Speed Steel blades which snap easily. This is because the fresh students are less experienced and if provided with the All-Hard blades which are quite expensive, the workshop might get depleted of the blades in no time. The purchase of tools and equipment must therefore be done by categorization to suit all levels to ensure longevity.

At micro level again, students should be allowed to use the instruments instead of restricting them for fear of damage. Students must be taught safety and maintenance of tools, machinery and equipment instead of restricting them against the use of the instruments. It is more appropriate to teach them safety precautions and safe handling of tools, equipment, devices and machinery. There is no need for carelessness in the science laboratory or workshop because a moment of carelessness can result in an accident which can affect one for the rest of his/her life. Krar and Oswald (1990 p.21) expressed the need to "THINK SAFE, WORK SAFE, and BE SAFE" since a loss of eyesight due to not wearing safety glasses or a loss of limb due to loose clothing caught in a machine" can affect one's career in the machine industry**.** Uniform rules and regulations on safety in terms of the workers or operators (students) and use of machines, tools, instruments and equipment ought to be pasted at vantage points in all workshops and laboratories. Students could also be charged a minimal fee for use of the laboratories. Such fees could be used for replacing broken equipment.

Each academic year, all engineering students could be charged a workshop or lab minimal fee. The amount so generated could be used to replace damaged equipment or probably to buy additional ones. Damaged equipment usually results in personal injuries. The necessary housekeeping or safety and maintenance issues like using a wire-brush to clearing the metal chips left on the surface of the table, meticulously cleaning oily floors and oiling machine joints must be adhered to. There is also a need to work under strict safety conditions such as understanding the mechanisms and operations of machines in terms of being conversant with how to start and stop a machine especially under emergency to prevent injuries. In some cases, a particular accident occurring in a factory or industry might lead to a person becoming maimed for life and a burden to the society or the family in which the accident occurred. The industry might not have been insured too thereby worsening the situation of the injured. All laboratories and workshops ought to be insured as a policy before accreditation or re-accreditation is ensured. Most females as emerged from this research as well as from experience are noted to be less confident hence taking precautionary measures would encourage them into technology-related fields of specialisation. In most developing countries as, most people believe that accidents are caused by some hidden forces and magical actions but these cannot be scientifically proven. All these accidents put fears in females therefore preventing entry into technology-related programmes. An adage goes that: “a stitch in time saves nine” so there is a need for all instructors including lecturers to emphasise safety precautions including practices that would prevent fire outbreak. There is a need to carry out preventive maintenance of the machines and accessories regularly by servicing them according to the procedure laid down in the manufacturers’ manual. Precautionary and preventive policies ought to be formulated to govern laboratory and workshop activities. This is to prevent or stop major damages or breakdowns. Minimizing accidents mitigates fears when operating machines.

Policy-formulation is also important at macro or national level especially to the up-and-coming private universities. There ought to be a benchmark for operation of these science-related programmes since they are practical-oriented. Policies should be formulated on the number of machinery, tools and equipment to acquire prior to the mounting or establishment of a science or technological-based programme. Plans and strategies for refurbishing existing workshops, replacing worn-out instruments, tools, equipment and machinery and procedures for maintaining the facilities must be succinctly outlined before accreditation granted to the programme.

Students must not be made to feel stressed up and frustrated due to limited infrastructural status. They ought to be given the freedom and flexibility to acquire the skills to proficiently equip them for the job market. A few participants expressed great disappointments leading to how some leave for greener pastures elsewhere. Those who have decided to stay in Ghana despite the predicament must be complimented. Industries should be established to cater for their engineering careers.

At meso or institutional level, the participants expressed their displeasure about the numerous courses studied per semester currently expressing how that makes the education too stressful for females. In the previous years of ‘O’ and ‘A’ Level programme, the courses were not many and the students could cope with the duration of the programmes. ManE further stated that: *“males are able to handle stress hence the engineering would always be skewed towards males”.* As discussed earlier, a number of the female participants have expressed their frustration about the numerous topics and courses studied under the engineering programme.

At macro level, one cannot suggest a formulation of another policy towards the educational structure since another one has just been implemented under the ‘Tracking System’ currently which offers the opportunity for every pupil to enter the second-cycle school free of charge. This would improve the literacy rate of the country. The number of subjects to be treated should also be streamlined by the authorities concerned to ensure gender-sensitive, stress-free curricula especially in the sciences and Mathematics.

On infrastructural deficit and inadequate facilities which restrict practical work thereby dashing hopes of studying engineering, it was really appreciative that participants acknowledged the financial constraints in the various sectors of the educational ministry. It would however not be out of place for participants to be educated on the need to maximize the use of the limited facilities and resources. On a conference in South Africa in September 2004, an excursion to the University of Stellenbosch saw students grouped into streams and time-tabled for the use of computers. Each group was offered duration of about one-and-a-half hours to get an assignment completed. The computers were also in excellent functional condition. In the year 1995, whilst the researcher was pursuing her second degree in Britain, she had the opportunity to interview a primary school female teacher (Mrs. Down) on how all the basic school teachers acquired the computer literacy skills and it was revealed that on the introduction of computers, each primary school teacher was furnished with a computer and directorate like Mavis Beacon by the educational authorities. These were used for three weeks in turn. The schools were not fully equipped with the computers but two teachers in every school kept the computers for three weeks and passed them on to other teachers until all the teachers were equipped with the skills.

On pedagogical skills, besides the issues already discussed about the lecturers whose skills were unappealing to the students, a few others need to be commented on for formulation of policies. Quite a number of the participants attributed their loss of interest in the sciences to lack of explanation during delivery of lectures as well as the posture or attitudes of lecturers. As expressed by YaaT at VarsA, *per the title 'lecturer', it is assumed that the imparters of knowledge and skills at the university level just have to* *lecture throughout but, there is lack of explanation during the lecturing*. Students do not have the same cognitive capability so when they are not offered the moral support, there would be mass failure. With the pronouncement of failure, one is threatened and may panic during examination. Lecturers need to draw students' attention to the fact that they do not necessarily learn solely for examination but the examination becomes a booster for learning. They learn to acquire knowledge for competency in their future careers and endeavours. Students' self-esteem gets lowered when discouraged by the person whose role is to lift them up. Engineering courses have been considered to be difficult hence a need to encourage the students. The female-students need to concentrate though as already discussed.

On the issue of dictation of notes during lectures as disclosed by the participants and also witnessed during one of the observation exercises, the act ought to be condemned. Staff should be counselled by the leaders of institutions to desist from such teaching methodology and explain or discuss as already analysed. Setting questions for quizzes outside the objectives set for the courses, insulting students at the least provocation ought to cease. Definitely, policies cannot be formulated on these but, since universities are the highest places of learning, students no matter their age ought to be treated with the greatest degree of respect and dignity. There has to be a written code of conduct for teachers and students. Violators must be disciplined. Leaders ought to plan monitoring and evaluation services to be implemented by independent authorities apart from the Accreditation Board to evaluate course outlines that ought to be commensurate with set questions.

Ignoring students' complaints especially on student/staff appraisal forms ought to be curtailed. From the participants, nothing is usually done about their complaints on the negative or weak pedagogical delivery. An instance was shared by Shino at VarsD where a lecturer was able to detect the handwriting of a student on the appraisal form and started abusing that student arbitrary. When the researcher explained that the sheets are worked on by the quality control and are not distributed to the lecturers, the participants were a little bit apprehensive that the form got to the lecturer. This researcher thinks that policies ought to be formulated towards strict adherence to the completion of student/staff consultative appraisal form which must be accorded the strictest confidentiality that it deserves. Comments lecturers ought to be detailed and analysed and forwarded to them individually through the Deans of faculties. Lecturers ought to be given in-service training on the professional methods of imparting knowledge and skills. Although in the academia, the terminology 'lecturer' is a parlance for the teacher in the university, thorough tutorials ought to be given to the lecturing staff for insight into the various forms of methodologies applied in imparting skill-oriented programmes.

Research Question six (6): ***What are some measures or interventions that could be put in place to boost enrolment of females in technology-related disciplines in Ghana?***

In the quest to find out the most suitable interventive measures to boost females' enrolment, apart from the policy interventions analysed earlier, quite a number of measures were outlined by the participants and they included: organisation of seminars, institution of award systems, formation of Associations and Clubs, minimization of domestic chores, role modelling and mentorship.

5.6.1 Organisation of Seminars and Award Systems

Seminars are usually organized to gain extra knowledge about a particular subject. Unlike the classroom or lecture hall presentations, seminars are usually flexible with discussions. Discussions offer a greater opportunity for students to acquire a greater wealth of knowledge as compared to other teaching methods like lecturing. In all the focus group discussions, suggestions of the conduct of seminars superseded all the interventive measures that arose. The participants expressed the need for leaders to make mathematics fun if ladies should get into it. Organizing seminars should not necessarily be strictly about solving complex problems which seem to have no bearing on the courses being pursued. Thrif explained how the game *mathletics* meaning athletics in Mathematics was framed in her second-cycle school in game-like manner. Others have coined it gamification.

Mathematics happens to be the basis of all disciplines particularly scientific subjects. The building contractor cannot progress without accurate dimensions of the profiles of components for the building. Similarly, the pharmacist cannot progress without accurate measurements of herbal ingredients. The nutritionist or chef cannot also produce sumptuous meals without correct proportions of ingredients just to mention a few examples. Mathematics is also connected with everyday life hence it is necessary that the pedagogy is carefully built to connect with the human mind. Questions framed ought to be formulated using familiar objects or circumstances. If Mathematics is taught as a game, it would really be fun and appeal to most females whose mathematical prowess seem to be weak. Games are exciting hence, the teaching must be connected with games exposing exciting, interesting, concrete ideas unlike the abstractness with which

Mathematics is usually associated with. Nobody gets bored when playing games hence, teachers could be trained to prepare their lesson plans in game-like format to make their lessons interesting and appealing. As there are not enough teachers and tutors who are conversant with the modern technological computer game-approach to the handling of Mathematics in that game-like manner, those with such skills ought to be detached from the classrooms and made to go round giving In-service teaching to the JSS/SSS teachers all over the country. Students' interests in the subjects are influenced by the methodology as expressed by Sinarin at VarsB earlier in a quotation that; *if maths is discussed, it wouldn't be too difficult; it wouldn't look like it is out of space:*

From 1987, some of the measures adopted in Ghana to encourage females in the sciences were the inception of national annual programme such as the Science, Technology and Mathematics Education (STME) 'Clinics', which were in the form of seminars or Educational Fares. The programme was termed 'Clinic' synonymous to the hospital where the girls were considered sick after diagnosing by the doctors (the teachers) and therefore needed to be healed or remedied. In the *clinics*, the participating girls were guided to make food and clothing products like jams from local crop fruit known as *'prekese'* and batiks from grey-baft respectively. They were also guided by resource persons such as this researcher to make simple mechanical / electronic components such as mini-cell fans and alarm systems which whipped up their interest. The STME programmes seem to have stopped in Ghana but one crucial observation is that despite those items showcased, many of the girls were not mature to grasp the importance of understudying the designing and making of those artifacts. It would be worth evaluating the outcome of the STME *Clinics* to check its impact on females' scientific and technological education.

Although there is dearth of research into females in engineering, it is with no doubt that most of the females often aim at entering Nursing because they see majority of women as nurses. Besides, not as much mathematics is required as in Engineering. Aside this, seeing other females in that field gives them the confidence that they too can successfully pursue that course. Such stereotypes as explained by ADEA (2006) stand in the way of perceptions of reality and social change. People tend to internalize stereotypes as standards of behaviour and as such refuse to go beyond the traditional roles. For this reason, the females that successfully complete technology programs must be given some district, regional, national or public recognition. Such females could be role models, encouraging other females as well.

5.6.2 Dealing with Stereotypical Attitudes

In the educational set up as emerged in this research, certain fields have been stereotypically reserved for certain groups of people within certain geographical backgrounds. People from the Volta region were noted for expertise in Carpentry and Joinery artisanry work. None of the participants according to the demographic profile for this research hail from the three northern regions of Ghana even though sampling was purposively done by snowballing. The researcher had no knowledge of participants' background prior to the research. An interview held with the head of technical department at Yeji Senior High Technical School during an Internship Supervision in October, 2018 by this researcher disclosed that the students from the three Northern

Regions of Ghana prefer to study Agricultural Science or Electrical Science stating reasons that; if they study Mechanical Engineering for instance, upon completion they would be no industry on the job market to absorb them. By studying Agricultural Science, on completion of their programme, they could apply it on their vast land even in the absence of white-colour job. Similarly, by studying Electrical Science, they could be engaged in electrical wiring of the buildings under construction in their areas. Such students seem to be considering their future career in their developmental phases.

Unfortunately, whereas the males might be anticipating the choice of Agriculture as their possible future career, the females in the Upper West regions have been indoctrinated not to hold implements like the hoe since according to another elderly interviewee in Wa (Upper Western Regional Capital), they (females) could become barren if not adhered to this indoctrination. Other females as emerged from the participants at VarsB are not supposed to hold carpentry tools. Attempt to intervene in such situations practically become a real challenge. Such cultural stereotypes whereby females want to produce patterns of behaviour that conform to societal expectations inhibit females' potential of becoming technologists or engineers. These issues have no scientific basis and it needs real research and effort to turn things around.

Although seminars and workshops as suggested by the participants could be organized, it may take the intervention of practitioners moving along with physical female human resource to demonstrate how to use these tools for the observance of those who have imbibed these stereotypical rules. Those students who have been indoctrinated against females holding the carpentry and joinery tools may have a change of mindset upon seeing the females of their age using the tools without harm.

5.6.3 Formation of Associations and Clubs

Besides the suggestions of seminars, the formation of clubs and associations as interventive strategies to address the marginal representation of females in the technology-related programmes was also suggested. At VarsE, the Oil and Gas students were noted to be making strides in reaching the young ones especially females with an Association called Structural Petroleum Engineer. The members (students) move round the secondary schools within their vicinity annually with the aim "*to fish them young*" as expressed by Dens - a foreign male-participant. This had the aim of awareness creation and that Association visits secondary schools annually to give information about the Oil and Gas field because the mentality is on job opportunity and how they would be able to fit into it. They normally sensitise the populace on the modern technology and the use of software as well as the minimization of physical activity like the carrying of metal. The participants expressed that everything borders on awareness about how the field is operating. At VarsD, they shared similar views on the need for the establishment of an *All Girls Science Club*. This they discussed ought to be made compulsory by all females at JHS and SSS level and should be an '*After-School'* Club to get all the females involved.

Apart from the formation of clubs and Associations, other participants expressed views on the need to go for *talk-shows* and also award scholarships. On how the scholarships should be awarded, the participants emphasised that the authorities should target the females who are likely to shift to other courses which are non-science based due to financial constraints. Jazz, a male at VarsE for instance, stressed that: *females could be identified through the records kept by the schools – in this case, it could start from the* *secondary schools since such schools keep the records of the students.* Such trend of selection was not too clear since it connotes that the leaders would have to move from second-cycle school to school to track students' records for science and technology-related programmes in the universities. An adage however goes that; *where there is a will, there is a way'*, so there could also be positive discrimination whereby all females who enrol on the engineering programmes could be awarded scholarships. This is feasible since as noted from the enrolment-ratio of the participants of this research, there is low participation for all the females. It could be advertised in the social media but this does not mean an entry with low grade which is likely to promote mediocrity as could be thought of. Females would be admitted on their attained grades and qualification though under quota system. A quota system could be indicated in the advertisement and when this achieves positive results, more females would be attracted into technology-related programmes. This would be similar to the practices of Makerere University in Uganda and UDSM in Tanzania where Lihamba et al *(*2006) reported that AA programmes have been taken whereby females are offered preferential admission criteria (PAC) as analysed earlier. Awarding scholarships has been noted to be very effective towards female enrolment as found out in the automatic scholarships granted to females who enrolled in Institutions such as the Hyundai- Korea International Cooperation Agency (KOICA) Technical Institute in Ghana. This Institute is found in Koforidua in the Eastern Region and Ansah (2018) unfortunately has reported of its near collapse due to its non-inclusion in the free senior high school policy. The Principal of the school (Isaac Osei Mensah) as reported by Starr News indicated that only 24 students enrolled instead of the annual average admission of 90 students. Students are no more posted and international donors have stopped their sponsorship because of the free senior high school policy. The collapse of such an Institute would be a big blow since females were noted as beneficiaries of scholarships for the study (Ghana/Starrfmonline.com/103.5FM2018/10/trade-ministrys-technical-institute).

Besides these interventive strategies, this researcher is also of the view that formation of 'what-do-you-know' clubs which could be captioned attractively like 'the engineering hubs', 'engineering diamonds' or the 'Golden gems' could appeal to females in the second-cycle institutions where subject choices and specializations are carried out. This should lead to the best female engineer and it should be made attractive just like competitions in sporting activities run on gender basis. This could also be run under *All Females* and *All Males* and it is likely to raise the efficacy of the practical components. It is also likely to boost students' morale just like how the science competitions have attracted students and sponsors. There is a need to source for sponsors just like how Carnegie and CIDA have supported female programmes from time immemorial. If award systems are made attractive and recognition given to the participants just like how Brillant Science best brains or National Science and Mathematics Quiz are organized nation-wide, the technical sector would become appealing to females. The participants of this research also suggested some interventive strategies to deal with the societal gender roles on domestic chores.

5.6.4 Dealing with Domestic Chores, Marital and Curricula Issues

Culturally, domestic chores and marital issues emerged greatly in the literature and the fieldwork. Mikell (1997 p.278) for instance emphasised that 'in Nigeria, women's responsibilities include cooking, farming, and taking care of the house and the children – a social constructionist's mentality or essentialist's views. In such a case, unless educated against this, the current generation could hardly change their perception about science and technology programmes that seemingly lead to a prolonged study. Females may have the need, motive or desire to pursue engineering but with marriage competing with their professional ambitions, there is a need for evaluation of the curricula to ensure that only the essential topics that could equip students adequately are included. This could shorten the duration of such courses and this was a concern for quite a number of the participants. The curricula could therefore be revised to ensure that only the relevant topics are included in the course outline.

In the lecturing or teaching methodology, instructors ought to learn to teach from the principles or concept of "known to unknown, simple to complex, concrete to abstract, less difficult to most difficult" to ensure clarity. Females' lack of confidence also emerged in the responses by participants so to encourage them into this useful venture of entering engineering one cannot do away with positive discrimination at first. When the interest is acquired, then the difficult ones are brought in into the course structure. The foundation of teaching or pedagogical skills too needs to be researched into. A number of the participants expressed the need for subject choice to begin at the basic level. Interest acquired in the Mathematics and sciences at an early stage would definitely lead to greater feat in the future studies of engineering for not only males but females too.

On the other hand too, as expressed by both male and female-participants, females ought to sit up and study hard in order to achieve their aims and objectives. Science and technology-related programmes cannot be studied mainly by lying down and reading. There is a need to enhance females' traits. Trait according to Yukl (2010) refers to a variety of individual attributes including aspect of personality, temperament, needs, motives and values. There is a need for females to enhance their personality traits which are considered as stable disposition to behave in a particular way for examples ensuring self-confidence and emotional maturity. The females who achieved scientific success such as the Physicist Marie Currie (role model) as expressed by the participants worked tirelessly and also got married. Marie Currie as history reveals also had a physicist parent and this is synonymous to many of those participants who are studying engineering. They were basically influenced by their parents who were in science-based, engineering or mathematics programmes. All parents even without scientific background ought to be sensitised to look for the potential in their wards and guide them appropriately but not be stereotyped or prejudiced as raised by the participants. A participant expressed how some parents get easily put off by hearing that a female could not successfully pursue an engineering programme opted for. Parents and guardians should be encouraged to pep their wards up as characterised by the Agricultural Engineering student (YaaT) whose father encouraged her by saying: *"you could register and get the paper [re-written] … thus, so long as you have gained admission, it means you can do it"*. Pepping up females with the 'can-do' spirit was stressed by the participants. Role modelling was also suggested as a very useful interventive strategy.

5.6.5 Role Modelling as Intervention

Lack of role modelling emerged as disincentive to the female students. Regarding this, there was a general consensus that the people including the participants grew up to meet the societal norms and because of what they picked up from the initial stage with other children, that mentality of differentiated roles have been ingrained in them. It needs effort from institutions to encourage and train more female engineers to serve as role models. Oaten, a male-participant at VarsB for instance expressed that: *Okay, when you are growing up, one thing is, most of our teachers who teach Mathematics are males. If it were to be females teaching it, the females will look at her and say, ah, I want to be like this madam but, most of them are males so they feel like it is only males who can teach Mathematics.* (Interview Transcript 5: November, 2017).

With this quote, apart from citing the Physicist Marie Currie, the participants also mentioned some of the few female engineers lecturing them such as Dr Mrs Peace Amoatey at VarsA and explained there might be lots of women like them for females to look up to. They therefore suggested the training of more females in the engineering sector. They further expressed that with incentives, ladies might be ready to pursue engineering.

The role models in the communities too were noted by the participants to be hardly approached. LyjuneB at VarsD for instance stated that: *the role models in the communities seem to be very busy and hardly could they avail themselves to other women in their fields of specialization"*. In view of this, strategies ought to be mapped out to invite the role models in the science and technology-related fields to the schools. Video documentaries could also be put together showcasing these role models and their activities to students in the second-cycle schools where they cannot be physically reached. A disadvantage would be that questions cannot be asked. Modern technology such as teleconferencing or discussion by SKYPE could however be carried out with such role-models to spare them the time of travelling. LyjuneB together with those in the focus-group at VarsD further expressed the need to put females at the forefront of advertisement. She therefore stated as expressed earlier how males appear when one refers to Engineering or even Medicine and females appear when it gets to adverts regarding food.

The importance of advertisements in influencing people cannot be overlooked. If done visually on television for instance, it is able to appeal to a greater number of people. Most people especially children perceive everything advertised as true and prestigious. Females are usually seen as models in beauty pageants and not in engineering. If engineering studies are given similar attention, it could grab the attention of audience and appeal to the up-and-coming generation. Advertisement should have correct balance. As LyjuneB expressed, when it deals with food, females are portrayed but in case of engineering or medicine, it turns out to be males. Females should be advertised operating the vehicles, fixing the engines and wheels equally as the males. This might change the mindset of the stereotyped citizenry. Oval explained that role modelling begins at home and stated that: *My friend's mum's profession as a Mathematics tutor led to all the children (boys and girls) reading Mathematics at higher levels*. To the participants, the mothers should also get involved in the so-called male-dominated areas of specialisation

– they should be fixing the cabinets to show that "*if mummy can do it, why can't I do it*"? If activities and labour are well blended and divided at home and the illustrations in the advertisements well-constructed in the media with females equally represented, the 'can-do spirit' would be uplifted and mindsets transformed.

It is worth considering how females could be educated massively to take up the teaching in the science-related programmes. There is the need for the curricula developers and teachers to be more innovative in choosing projects in schools that could be considered gender-free or neutral to attract both males and females. Selecting a project such as 'gari-processing' machine might be a bit complex and also gender-skewed for beginners. If simple neutral projects such as 'alarm systems, door-bells and merry-go-round recreational facilities are planned and fabricated, both males and females would be attracted to such projects. These would not frighten the females. Clear instructions ought to be outlined towards the planning and preparation of projects to be followed by all. In planning the schemes for classroom and workshops' activities, teachers must take the gender-mixed-ability into consideration. It must have the aim of boosting the image of females equally as males to attract them into the engineering sector to secure many female role models.

5.6.6 Ensuring Prestige and taking Affirmative Action in Technical Programmes

It is of the view of this researcher that the government and leaders of institutions should strive to raise the value of technical education since values are known to influence a person's choice of preferences, perception of problems and choice of behaviour. Values again are described as internalized attitudes about what is right and wrong, ethical and unethical, moral and immoral. If the education leading to the choice of engineering programmes is valued by exhibiting equivalent status, fairness and excellent recognition as the general second-cycle schools, its attraction would be upheld by many in the society. Acquiring skills that is the ability to do something in an effective manner known to be jointly determined by traits and heredity (Yukl, 2010) would not be beyond the capability of females so long as recognition and high premium are placed on the value of programmes leading to technology-related disciplines. Conscious effort ought to be made by the education service to train females in that sector either by offering special incentive packages like lap-top computers programmed substantially with engineering programmes to entice them. Including females in the technology-oriented adverts as expressed by female-participants earlier is a way of raising the value of females in the performance in that sector.

At UDSM, interventions dubbed Institutional Transformation Programme (ITP) a six-week pre-entry remedial course to assist females to enrol in engineering could be adopted or replicated in Ghanaian universities. It can be modified by separating the groups by their aptitudes, instead of putting the mixed-ability group under one banner. This ensures proper targeting of those who under-perform, mainly the females as shared in the research. Since the development of every country depends primarily on both males and females, conscious efforts ought to be made to educate both genders technologically for all to equally contribute their quotas and equally benefit from the nation's growth.

Heads of departments ought to be vigilant with any staff member who sexually harasses any student. Appropriate sanctions, including dismissals, ought to be meted out to them. Females should be encouraged to report such perpetrators. They must be assured too that while their complaints will be thoroughly investigated, their cases will be treated with utmost confidentiality. Appiah and Cusack (1999) reported that most women in the case of sexual harassment typically rape case, fail to report for the fear of their daughters not finding husbands to marry. Females too are noted not to report because of the stigma attached to such females as being spoilt children. Thus, the society as Burr's (2015) social constructionist's theory stipulates, shields irresponsibility.

5.7 Conclusion

After analysing the major issues, one is led to conclude that a lot of issues have been socially constructed and socially maintained which could make changes in females' pursuance of technology-related programs very challenging. Issues under brain lateralization were not conclusive as Diamond (2003), pointed out in the literature review that up to date, no live human being (male or females) has donated brain tissues to be used in conducting an experiment on the differences. Societal attitudes and perceptions create the seemingly brain laterilization.

Pedagogical issues in terms of preferences for skills and interaction with the students have been analysed. Cultural inhibition, leadership issues and policies have all been analysed. Interventions that could be taken to address female-students' participation in technology-related studies have also been analysed. The next chapter (final) of the research summarizes the findings and draws conclusions, recommendations and suggestions for further research.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This is the concluding chapter of the study and it presents a synopsis of the research, makes some recommendations and suggests areas for further research. The main purpose was to examine the most effective means of motivating females into technology-related programmes in order to enhance their participation in technology-related careers.

6.1 Summary of Major Findings

The research was substantively situated in the Social Constructionist's Theory (Burr, 2015). It was conducted in two (2) selected public and three (3) private autonomous Universities (Appendix 5) in Ghana with a focus on Level 100 to 300 females in technology-related programmes. Fifty-eight (58) participants comprising five (5) lecturers and fifty-three (53) students were non-randomly sampled by snowballing. The lecturers were mainly sampled for the observation exercise as compared to the students who were interviewed. The piloting was carried out at the College of Technology

Education, Kumasi (COLTEK) a satellite campus of the University of Education, Winneba (UEW) now known as Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED). Although the focus of the study was on females, for broader divergent perspectives and comparative purposes, the sampling was extended to males in the same sampling units.

The summary concentrated on biological characteristics in terms of brain lateralization, stereotypical socio/cultural attitudes under domestic chores, marital issues and religious discrimination. Additionally, subject choices, pedagogical skills' preferences, leadership, policies and interventions to ensure an enhancement in the enrolment of females in technology-related programmes were included.

The first theme sought the perceptions of student-participants on brain lateralization within biological characteristics and it emerged that the human's female brain is not different from the male's in processing linguistic and mathematical or spatial information. Thus, none of the participants held the view that the disparity between the enrolment of females and males in technology-related programmes especially in terms of abilities and interests in Mathematics and language has been biologically-driven. The participants expressed the view that females usually excel in languages because they spend much time reading whereas males concentrate on calculation hence their spatial acumen. They further explained that both sexes could excel in either disciplines especially the females in Mathematics if there is a change of mindset. The issue of genetic inclination on brain lateralization has therefore been unresolved in line with researchers such as Diamond (2003) in the literature who have expounded that till now, no live brain has been offered to dissect and analyse brain lateralization. From this analysis, females were admonished by the participants to adopt a 'can-do' spirit or attitude in approaching mathematical and scientific issues.

On the second theme which studied the main socio/cultural attitudes that discourage females from pursuing the technology-related programmes, the participants discussed amongst others that long hours of domestic chores hamper females' education particularly in Mathematics which is scheduled early on the time-table in most second-cycle schools. This affects especially students without boarding facilities. In residencies where domestic chores are mainly carried out by females, exhaustion and dormancy in class occur. The participants therefore highlighted the need for boys to be engaged in domestic chores since in the single-sex boarding schools, they engage in such chores like sweeping and yet survive. The males assisting the females may ease the extra burden placed on the females thereby offering the latter the opportunity to learn studiously at home in the case of non-residential female students. This is underpinned by egalitarian principles whereby distribution of domestic chores at home ensures division of labour.

Marriage according to the participants was also of grave concern to parents. The participants expressed how the demanding nature of their courses warranted greater proportion of their time thus, always studying which keep them out of social life and a delay in their marital status.

Another barrier that emerged was the inhibition placed on the usage of tools and equipment in some parts of the Upper Eastern Region of Ghana. Female-students who embarked on the Community Service (CS) in one of the local carpentry's workshop were not allowed to touch the carpentry-tools. They therefore did not acquire the requisite skills as compared to their male-peers who were allowed to use the tools. This automatically cut the females off engineering practices. In the same region, it was found out that females are not allowed to hold farming implements like the hoe.

Again, on the use of tools, since there are limited infrastructural facilities in most of the Universities, females have to carry some of their tools and equipment from their homes or halls of residency to the lecture theatres. The females therefore expressed that socially, they feel embarrassed carrying these engineering drawing boards and Tee-squares about especially, when boarding 'trotros' (local name for mini commercial buses).

On ethical or moral issues and in retrospect, the immoral behaviour of young staff or tutors who wanted to use a female-student as sex-predator in the second-cycle institutions was also shared. The staff's failure to succeed in that direction led to the victimisation of the female-student. The student re-wrote Chemistry at second-cycle level thrice to no avail because she was unyielding to the advances of that young National Service (NS) Chemistry Tutor. In situations of that nature, it was found out from the literature that some female-students would be resistant to mention such sexual intimidation, abuse or violence due to the social consequences associated with such actions.

Some religious practices were also revealed as hindrances to females' study of technology-related programmes. It emerged that restrictions placed on some females such as disallowing them from mounting the pulpit to preach the sermon equally as the males in some religious denominations put fears in them and reduces their confidence. Some of the participants considered this to be the case because to them, science is known to be built on research and dissemination of information so by surfing the religious books and noting the findings and preaching the religious data to the congregants, their confidence in researching and disseminating information is usually boosted. This enhances their ability to read and analyse issues.

Studying the most effective pedagogical strategies, the third theme found some female student-participants revealing that the number of courses offered in some of the Universities per semester were too many if one has to consider the duration. This demanding nature also sprang from the fact that there are too many slides and seemingly non-relevant courses to be studied which leads to frustration and stress. Such complaints, were however, counteracted by some of the participants that it is the mindset of females that create the negative impression that they are unable to cope. It was therefore discussed at length that females ought to change their mind-set and adopt the 'can-do' spirit towards solving especially mathematical problems. In the schools, since Mathematics is found to be the foundation of all the technology-based programmes, the participants expressed the need for the quality of its teaching to be improved by ensuring detailed explanation to the subject matter. Apart from the explanation, they preferred the use of audio-visual support-materials like tape-recordings and power point presentation with clear examples on the slides in handling all disciplines. An additional comment made by the researcher was the need for the instructors to step up the explanation to discussion, which is found to be a two-way interactive method. The participants raised the need to design the syllabi and course outlines in a game-like manner with formulation of word-problems during solution of mathematical problems instead of just writing the equations on the board. To the participants, it becomes abstract and meaningless.

For early acquisition of mathematical and engineering concepts, the researcher raised the need to sensitise parents to use mathematical language at home with terminologies like 'pie-dish', 'concave cake dishes', 'round or oval table' since concepts built early in life are not easily forgotten. With such grasp of geometrical terminologies, transferring the knowledge and skills orthographically (two-dimensional representations of objects) and pictorially in fabricating engineering products would not be a very challenging and abstract task. This is very significant since parents were noted to play prime roles in influencing females on choices of subjects or disciplines which lead to future scientific and technological developments. The participants therefore expressed the need to extend the sensitization of programme choices not only to students in the second-cycle but basic schools as well as parents and guardians. A limitation however, would be where all parents or guardians are found to be illiterates. Nonetheless, with a national literacy-rate of 69 and 74 for females and males respectively, there is a glimmer of hope for this suggestion.

On the pedagogical skills, the participants detested lecturers who would not keep their words, are too inflexible with students' grades especially on decisions to rewriting a paper before entering the grades. They also expressed a dislike for lecturers who belittle them by hailing insults at them at the least provocation. Complaints were made by the participants that student/staff appraisal forms completed by the students to appraise the lecturers' pedagogical competencies did not meet the strictest confidentiality that they deserve. This was the case because a lecturer at a point called out a student's name and insulted her for remarking negatively about him (lecturer).

The fourth theme on leadership's influences on females saw majority of the participants regarding parents as their leaders who could encourage the females to change their mentality about the myth surrounding Mathematics and Science courses as difficult disciplines. They expressed that the negative perception leads to the "can't-do" spirit or attitude that in turn tunes the females off. They emphasised the need for parents as leaders to be sensitised against "*favouritism*" they engaged in. This was a situation whereby parents usually make wrong choices by either choosing one person against the other or always paying much attention to their male wards. In leadership parlance, parents could be seen as serving as transformational leaders for their wards.

Considering leadership in the institutions, the participants expressed the need for the authorities to arouse females' interests at an early stage by making Science compulsory from JHS or the SHS. The former was the researcher's preference because although this might seem so autocratic in leadership-style, majorities are likely to opt for the applied sciences at the senior high stage thereby enhancing participation at the university level. As leaders in the universities, besides the limited explanation given to the content of subject matter as expressed earlier, some of the participants blamed the lecturers for discriminating against the intellectually-weaker females. Under political leadership, the participants expressed concern about the limited infrastructural facilities which inhibit the study of the technology-related disciplines. It could be recalled how a participant expressed that she would have opted for ITC Education if she had the insight into that course because they (students) see the laboratories well equipped with computers. It was detected that the influencers interconnect to influence females' choices of scientific and technological studies.

On the fifth theme on policy-formulation, some of the participants expressed that with adequacy of laboratory instruments, workshop equipment and flexibility of their usage by students, policy-formulation would be unnecessary. Some female-participants seemed to be frustrated about the limited infrastructural and industrial facilities in the universities hence some of them after graduation seek greener pastures outside the country. Others expressed that despite these limitations, thus discouraging them from getting employed in Ghana, they are bent on staying in the country after graduation to help their motherland. Though the participants could not suggest any policy-formulation, for progression of the science-related disciplines, it is considered that certain policy framework must be put in place to entice females into the area. First, policies on the number of machinery, tools and equipment to be acquired prior to the mounting of any technological-based programme should be formulated. Plans and strategies for refurbishing existing workshops, replacing worn-out instruments, tools, equipment and machinery as well as procedure for maintaining the facilities must be succinctly outlined by every institutional management board before accreditation is granted to the establishment of any programme.

All laboratories and workshops ought to be insured as a policy before accreditation or re-accreditation is granted. Most females as emerged from this research as well as from experience are noted to be less confident hence precautionary and preventive policies ought to be formulated by the management board of every institution to govern laboratory and workshop activities. Studios for drawing or drafting ought to be set up with well-furnished equipment to prevent students especially females carrying their tools and large equipment about.

On the sixth theme on interventions, besides the minimization of domestic chores the participants shared views on the importance of organizing seminars by the educational authorities such as Ghana Education Services to redesign and present Mathematics in a game-like manner similar to the game titled Mathletics' meaning athletics in

Mathematics to appeal to females. The formation of Clubs and Associations such as a compulsory 'All Girls Science Club' and another similar to the one called 'Structural Petroleum Engineer' whereby the members (students) move round the secondary schools annually with the aim "*to fish them young*" were also considered instrumental as interventive strategies. The participants further expressed views on the need to award scholarships by identifying the females through the records kept by the secondary schools. Such an award system was similar to the affirmative action (AA) implemented in some of the South-Eastern African Universities (Lihamba et al, 2006) and Hyundai-Korea International Cooperation Agency (KOICA) Technical Institute in Koforidua, Ghana reported by Ansah (2018).

Role modelling was considered significant as intervention to boosting enrolment by females but the participants expressed that the role-models are very scarce to be reached. In view of this, the educational directors should make the effort and move along with physical female human beings or resource persons who will demonstrate how to use engineering tools for the observation by female-students. In such a circumstance, the stereotype threats exhibited by societies would be minimized. Aside this, modern communication strategies like video documentaries of practical activities by the models could be telecast by technology-related lecturers and tutors for the students. An anticipated fear would be that questions could not be asked with these documentaries but this could be forestalled with the employ of teleconferencing like Skypes and Zooms.

6.3 Conclusions

From the discussion, it could be inferred that people's background and environment very often exert a great influence upon them throughout their lives especially during schooling age (social constructionism: SC). This is so because choices of subjects at the second-cycle which led to the possibility of getting into technology-related or applied science programmes were mostly influenced by the participants' parents. No wonder, SC, the main theoretical framework upon which this research is situated, holds fast to females' technological-related studies.

It has further been induced from this research that the brains of the female and male human beings in terms of mathematical and verbal cognition are not different. To achieve any purposeful development by females in engineering, females were encouraged to step up their 'can-do' attitude or spirit and change their 'mindset' towards scientific studies. There is also the need for reduction of some of the courses to minimize the stress and frustration if investigations prove positive about what some of the participants expressed about the number of slides. This is not to promote mediocrity in the studies because acquisition of skills and knowledge can be improved progressively on the job after graduation when the students secure careers for themselves. The students must be educated by the lecturers on the rationale or the real life applications for studying the number of courses or the topics treated to arouse students' interests.

The approach of teaching scientific disciplines especially Mathematics in a game-like manner to promote 'fun' and interest must guide Lesson Plan preparation by instructors including teachers, tutors and lecturers. Females also ought to be educated to overcome societal stereotypical attitudes in addition to their personal conviction of the merits of technology-related studies.

Females could have imitated role models in engineering but a gross limitation of this research was the unavailability of such models especially female lecturers. Given the present situation where other female role models too were found to be too busy to be approached, apart from documentaries and teleconferencing, it would be appropriate to encourage more males to serve as role models and mentors for the females whilst encouraging those females in the science and technology-related programmes with incentives like scholarship packages for sustenance.

During the focus group discussion in the pilot-study, one male-participant explained that he thought in Ghana, certain courses are reserved for the males of certain ethnic group. When similar qualitative research projects are embarked on, the males would gain interest and insight in such gender sensitization issues. Nearly all the participants suggested the use of 'talk shows' and 'seminars' to sensitise the society on the need for females' technological education. Such interventions and advertisement focusing on the females must be intensified by the educational authorities and students.

Given the present situation where engineering is still struggling to establish itself clearly in the annals of females' education, based on the low enrolment of seventy-eight (78), which is approximately 20,4% out of a total of three-hundred and eighty-three (383) student-population for this research), it is very difficult to imagine how the recommendations or suggestions made could materialize or be adopted but, as realised from the literature and also noted by the participants, any change would be gradual. The participants admitted that the change could start with their generation if such sensitization research continues. The Ghanaian Mirror (15th June 2019), states that; 'it will take some time for mankind to try to make reasonable, safe and unproblematic change of nature' (pp. 11 & 17). Relating it with the Sustainable Development Goals (SDG) Gender Equality Index in the World Affairs, the Ghanaian Newspaper 'The Mirror' noted that no country has achieved gender equality in the world. Again, it noted that the right of women to drive vehicles in the Saudi Arabian Kingdom was given quite recently after "long years of agitation and imprisonment" (15th June 2019: p.17). Synonymously, although there is freedom of selection of programmes of study or disciplines by both sexes in the Ghanaian second-cycle and tertiary education, the motivation that would be offered by the society for a greater proportion of females to pursue technology-related programmes would be gradual.

It is a reality that as individuals immersed in culture, "myths, variety of stories and narratives of ordinary lives played out in TV and film from the time of our birth and stories circulating in our culture" (Burr, 2015 p.166), the achievement of a near-gender parity in enrolment is likely to be gradual. It is difficult to change these cultural and gender-related stereotypes, but it is possible that with carefully selected and well developed pedagogical strategies employed by lecturers and tutors, females' interest in engineering courses which hitherto might have least attracted them, could be stimulated.

The value of technological courses or technical courses must be raised by organizing competitions with substantial awards to send signal to the stakeholders of the importance of the science and technology-related programmes. The image of the subjects and careers that emanate out of these would be elevated and become so prestigious just like how Blackwell was able to raise the image of Medicine which has attracted quite a number of females into it. Though females were not enrolled on the medical school, her 13th application at age 28 in January, 1849 saw Elizabeth Blackwell enlisted on Geneva

Medical College in New York as the first woman in America to be awarded a medical degree. She created the opportunity for females to be enrolled in the medical profession - a feat that was hitherto accomplished by only males (Biography.com Editors, 2014). The current generation may not persevere for that number of years in seeking admission as done by Blackwell but, implementing policies progressively by leaders of institutions, guiding female-students towards interaction with role models and providing boarding facilities with scholarships to prospective female-students to insulate them from gender-stereotyped chores would make inroads into the pursuance of technology-related programmes. the various influencers of subject choices and therefore participation of females in technology-related programmes were found to be interconnected with each other.

6.4 Recommendations

As revealed in the responses, brain lateralization is not supported by majority of the participants but, it is the attitude of males and females that brings about the differences. On the curricula for instance, Mathematics is the main discipline upon which science-related programmes are pivoted yet, participants were not pleased with its teaching and lecturing at even the University level. The following recommendations are couched out of the findings of the research:

1. Firstly, it is recommended that teachers, tutors and lecturers must endeavour to incorporate educational games into the activities or topics in the teaching in all sectors of education for Mathematics to make its study fun and stimulating to all especially female students. The preparation of schemes of work and lesson plans

at the basic and second-cycle levels must take a game-like format. In considering this suggestion, the content ought to challenge the high ability group and motivate the low ability and yet not to bore the males whose stronger points have been known from the literature to be spatial acumen. The participants suggested a game called 'Mathletics' thus, athletics in Mathematics. This recommendation should be based on problem-solving framework or approach. In such a framework, females would be interacting with their peers which would lead to gaining of knowledge or insight from one another. Sharing ideas with peers psychologically usually sink down effectively well than learning from teachers or lecturers alone. As revealed by the participants, females have been noted to be talkative hence, adopting collaborative and problem-solving approach in pursuance of Engineering programmes might be effective.

2. Secondly, Mathematics teachers at all levels – JHS, SHS and Universities must be critically monitored and occasionally given In-service training and refresher courses for instance those organized by the GES and University authorities. This would ensure the application of the appropriate strategies in imparting knowledge and skills.

3. Thirdly, in schools, since male teachers are especially noted to dominate the fields in mathematics, engineering, and sciences (Hoffman & Oreopoulos, 2007), females who want to pursue the science-related subjects have no choice but to fall fall into their hands for tutorials. It is therefore ethically very crucial that the young staff especially the NS personnel, other tutors or lecturers who behave indecently are sanctioned by the educational disciplinary boards. If sanctions such

as suspension of salaries for a number of months or dismissals depending on the severity of the offence are applied to the defaulting personnel, this immoral behaviour could be minimised or curtailed entirely. This would deter others from following suit, thereby ensuring a more responsible staff who would carry out their duties morally and decorously. Leaders of institutions ought to encourage the female-students to be reporting such incidence. There is however a need to conduct thorough investigations since, the female-students may have other motives for reporting. It is important that the students who are bold to report the indecent incidence at the second-cycle stage are relocated to other schools or the report kept strictly confidential for fear of victimisation.

4. The fourth recommendation expresses the need for Educational Boards of second-cycle Institutions and University Councils to employ career counsellors to educate the students on the wide range of courses such as Software Engineering whereby students can produce programmes for sale. ffort should again be made by the educational authorities to reach out to the social media to sensitise parents and the entire populace on equitable distribution of domestic chores at home to ensure division of labour underpinned by egalitarian principles.

5. On the fifth recommendation, feedback on staff-appraisal by students at the tertiary level must be discussed with concerned staff individually and confidentially by the Quality Control Units. Monitoring and evaluation team from the Quality Control Unit must be established by the Management Board to monitor staff-performance to ensure credible teaching or lecturing.

6. On how to reach out to females to enrol in technology-related programmes, the sixth recommendation emphasises that advertisements on televisions focusing on females and technological programmes must be placed by Faculties of Universities offering technology-related programmes. Flyers highlighting the programmes offered, showing gender-friendly and flexible machines that would transform the mindset of the populace must also be showcased. These would reveal the importance of Engineering and the prestige associated with it. The Registry of the Universities, Deans and Heads of Departments should also endorse and encourage the students to imitate the practice whereby some of the university students move round schools to sensitise the young students dubbed '*Fishing them young*' as emerged from the study. This ought to be replicated by other science and engineering students of other universities. When the students move round the schools and are permitted to talk to their peers, it is likely to reduce the stereotypical formation of attitudes and encourage more females.

7. On the seventh recommendation, policies should be formulated on the number of machinery, tools and equipment to be acquired prior to the mounting or establishment of a science or technological-based programme. Such machinery should be commensurate with the enrolment of the students. Although the ideal situation cannot be attained, at least students should not regret having enrolled in a department with scanty equipment. Well-developed geometrical and engineering drawing studios must be produced by the Faculties concerned for students to curb the tiredness and embarrassment associated with carrying drawing tools and equipment to-and-fro the homes and the lecture halls.

Workshops with adequate equipment and safety gadgets must be constructed for all engineering-related disciplines by a combined effort of the institutions and the Ministry of Science and Environment of the government.

8. The eighth recommendation is the need for the establishment of one technical school with boarding or residential facility and scholarship package for females at the second-cycle level by the joint effort of Science and Technical Education Ministries to encourage appreciable number of females into technical or technological programmes. This has been initiated by the Minister of Education and it is in the piloting stage. As found with the all-girls general senior high schools, performance is seen to be very good in single-sex second cycle schools.

9. The ninth recommendation highlights socio/cultural issues and views that; to diversify the technology-related fields for female students, a critical look into cultural stereotypes and biases that still pervade cultural issues must be taken. It therefore emphasises the need for the faculties of Universities instituting CS and Industrial Attachment (IA) programmes to ensure that students are issued with questionnaires that would spell out all criteria governing the exercise before embarking on them. Students should be assisted by the coordinators of such programmes to reach credible industries that would not discriminate in terms of gender and skill acquisition. Universalism that is; the "value that ensures that all people are treated similarly and that there is no favouritism based on family/friendship connection, or payment" (Haralambos & Holborn, 2004 p.307) must be ensured.

10. On interventions to enhance the enrolment of females, the tenth recommendation stresses the need for affirmative action (AA) by the leaders of the institutions (second-cycle, Universities) similar to practices in other African universities such as Makerere and UDSM. In line with such AAs, scholarships should be offered to females who opt for technology-related programmes in the Universities. To sustain the interest of students who enroll, lecturers and demonstrators should be regular and punctual to prevent statements made by a participant that "*he comes only once in a semester when we're about to write the end-of-semester examination*".

6.5 Suggestions for Further Research

This research covered a minimal area of gender and participation in technology-related programmes. In support of Andrews (2012), with continuous empirical research, as knowledge increases about a particular condition, attitude to it and how it is constructed also changes. The following suggestions are therefore made towards further research:

The issue revealed on the numerous slides or topics in the course outlines causing frustration to students at VarsD needs to be investigated into. If the claims of overburdening made by some of the female-participants are found to be a reality, then there is a need for a review of the courses and topics to ease the burden of especially female-students pursuing technology-related programmes in the universities.

Issues regarding the females and males who embark on CS ought to be investigated to find out the veracity of this claim. If females are restricted from attaining the necessary psychomotor skills from the lecture halls or experts outside the walls of the universities, they would definitely show limited performance in the acquisition of skills.

A research needs to be conducted on the religious barrier that emerged whereby females are disallowed to preach. In that regard, the research should endeavour to find out the degree of impact on scientific insights and technological innovations by females experiencing these role segregations in religion. This is the case since it is quite difficult to conclude that there are no female-engineers in the named religious sectors where restrictions are placed on females. Again, it would be biased without research to conclude that all female-engineers attend churches where females are allowed to mount the pulpit and deliver sermons.

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APPENDIX 1

Public and private universities and University Colleges in Ghana

Institution	**Nickname**	**Founded**		**Location(s)**
		Public Universities[1]		
University of Ghana	Legon	1948	7	Legon, Accra, Greater Accra, Ghana. Including over 10 Workers Colleges all over the ten regions of Ghana.
Kwame Nkrumah University of Science and Technology	KNUST	1952	2	Kumasi, Ashanti, Ghana
University of Cape Coast	Cape Vars	1961	5	Cape Coast, Central, Ghana
University of Education, Winneba	UEW	1992	3	Winneba, Central, Ghana
University for Development Studies	UDS	1992	4	Tamale, Northern, Ghana
University of Professional Studies	UPS	1965	10	Accra, Greater Accra, Ghana
University of Mines and Technology	UMAT	2001	9	Tarkwa, Western, Ghana

University of Health and Allied Sciences	UHAS	2011	8	Ho, Volta, Ghana
University Of Energy And Natural Resources	UENR	2012	6	Sunyani, Brong Ahafo, Ghana
[Ghana Institute Of Management and Public Administration (GIMPA)]				Legon - Accra

[1] There are ten national public universities in Ghana.[1]

Updated by researcher . courtesy by National Accreditation Board Ghana on 15th August, 2018

Private Universities

Chartered private tertiary institutions[3]

Valley View University	VVU	1979	Oyibi, Greater Accra, Ghana
Akrofi-Christaller Institute of Theology, Mission and Culture	ACI	1987	Akropong–Akuapem, Eastern, Ghana

Other University Colleges and Private Universities
(University of Ghana Affiliatied Institutions)

Accra Institute of Technology	AIT	2005	Cantonments, Greater Accra, Ghana
African University College of Communications	AUCC		Adabraka, Greater Accra, Ghana
Anglican University College of Technology	ANG.U.TECH	2008	Nkoranza Campus, Nkoranza, Brong Ahafo, Ghana
Catholic University College of Ghana	CUG	2003	Fiapre, Sunyani, Brong Ahafo, Ghana
Christian Service University College	CSUC	1974	Kumasi, Ashanti, Ghana
Good News Theological Seminary	GNTCS		Oyibi, Greater Accra, Ghana
Islamic University College, Ghana[5]	ICUG	1988	East Legon, Greater Accra, Ghana
Knutsford University College	Knutsford		East Legon, Greater Accra, Ghana
Lancaster University, Ghana	LUG	2013	Accra, Greater Accra, Ghana
Methodist University College Ghana[5]	MUCG	2000	Dansoman, Accra, Greater Accra, Ghana
Pentecost University College[5]	Pent Vars	2003	Sowutuom, Greater Accra, Ghana
Presbyterian University College[6]	PUC	2003	Abetifi-Kwahu, Akropong-Akuapem, Agogo Asante-Akyem and Tema, Ghana
Wisconsin International University College[5]	WIUC	2000	Agbogba Junction, Greater Accra, Ghana (Affiliated to the University of Cape Coast)
Central University College	Central	1998	Accra, Greater Accra, Ghana (Affiliated to the University of Cape Coast)
Catholic Institute of Business and Technology	CIBT		Accra, Greater Accra, Ghana
National Film and Television Institute	NAFTI	1978	Accra, Greater Accra, Ghana
Institute Of Accountancy Training	IAT		Accra, Greater Accra, Ghana
Narh-Bita School Of Nursing	Narh-Bita		Accra, Greater Accra, Ghana
Ghana Institute of Languages	GIL	1961	Accra, Greater Accra, Ghana (Affiliated to the University of Ghana)

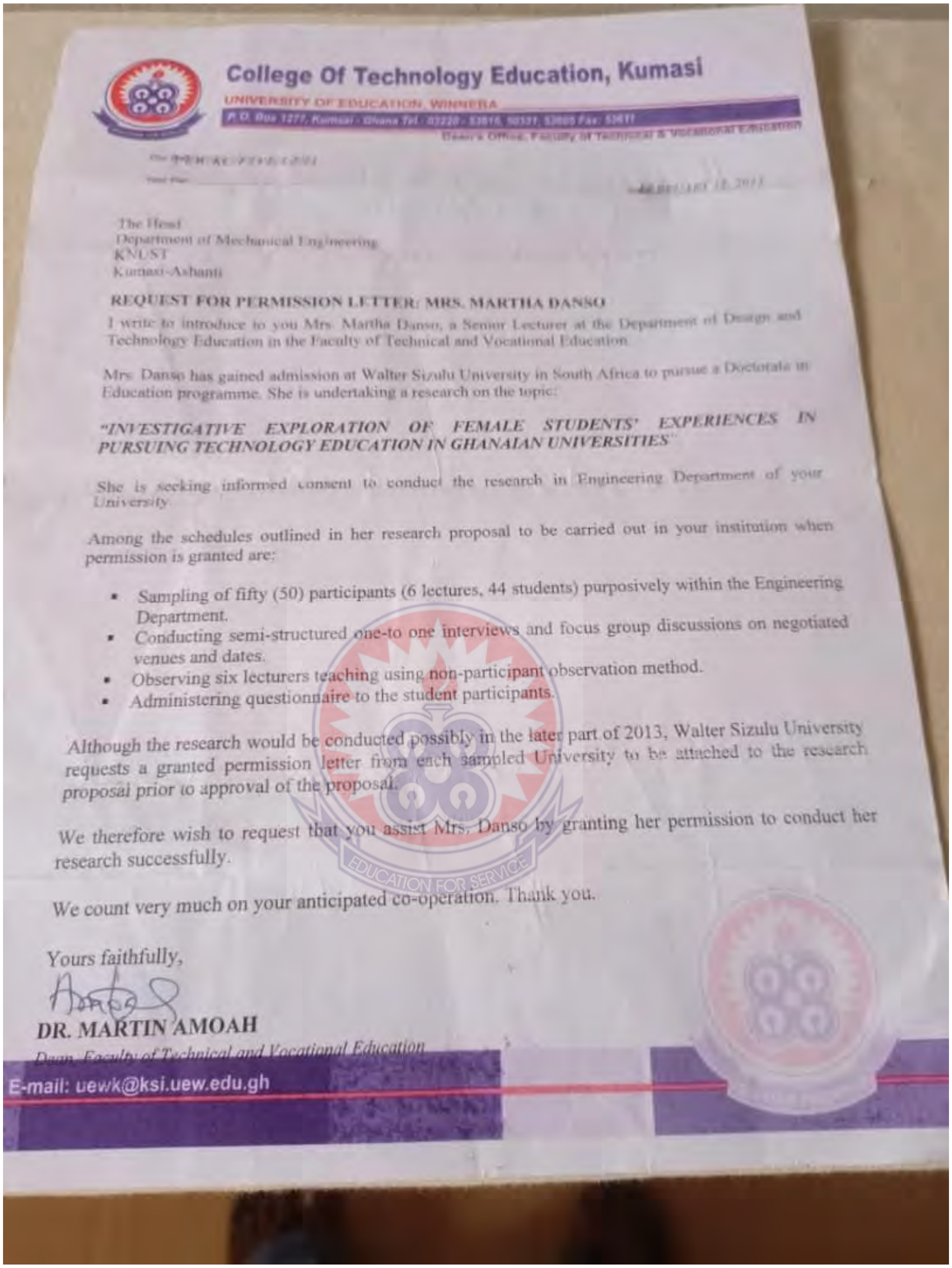
St. Victor's Seminary	SVMS		Accra, Greater Accra, Ghana
St. Peters Seminary	SPMS		Accra, Greater Accra, Ghana
St. Paul Seminary	SPCS		Accra, Greater Accra, Ghana
Ghana Armed Forces Command and Staff College - Masters Degree	GAFCSC		Accra, Greater Accra, Ghana
Regional Maritime University[4]	RMU	2007	Accra, Greater Accra, Ghana
Blue Crest College (formerly NIIT Ghana College)	BCCG	1999	Accra, Greater Accra, Ghana (Affiliated to the University of Education, Winneba)
Kwame Nkrumah University of Science & Technology			**Affiliatied Institutions[6]**
Accra Institute of Technology	AIT	2005	Cantonments, Greater Accra, Ghana
Osei Tutu II Institute for Advanced ICT Studies			Kumasi, Ashanti, Ghana
KAAF University College	KUC		Gomoa Buduburam, Central Region, Ghana
All Nations University[6]	ANU	2002	Koforidua, Eastern, Ghana (Affiliated to the Kwame Nkrumah University of Science & Technology)
Radford University College	Radford		Kumasi, Ashanti, Ghana
Garden City University College[6]	GCUC	2001	Kumasi, Ashanti, Ghana
Regent University College of Science and Technology[6]	Regent	2003	Accra, Greater Accra, Ghana (Affiliated to the Maastricht School of Management, Netherlands)
Technical University College	TUC		Tamale, Northern Region, Ghana (Affiliated to the University of Ghana)
Spiritan University College	Spiritan		Ejisu, Ashanti, Ghana
Data Link University College	DLUC	2006	Tema, Greater Accra, Ghana
Mountcrest University College	MCUC		Kanda, Accra, Greater Accra, Ghana
University College of Agriculture and Environmental Studies	UCAES	1963	Bunso, Eastern Region, Ghana
University of Cape Coast			**Affiliatied Institutions**
Central University College	Central	1998	Accra, Greater Accra, Ghana (Affiliated to the University of Cape Coast)
Ashesi University[6]	Ashesi	2002	Accra, Greater Accra, Ghana
Entrepreneurship Training Institute	ETI		Accra, Greater Accra, Ghana
Deltas University College	DUC		Accra, Greater Accra, Ghana
Evangelical Presbyterian University College	EPUC	2008	Ho, Volta, Ghana
Ghana Baptist University College[6]	GBUC	2006	Abuakwa, Kumasi, Ashanti, Ghana
Kings University College	KUC		Aplaku Hills, Accra, Greater Accra, Ghana
Maranatha University College	MUC		Sowutuom, Accra, Greater Accra, Ghana
Meridian (Insaaniyya) University College[6]	MEDUCOL		Weija, Accra, Greater Accra, Ghana
Pan African Christian University College	PACUC		Accra, Greater Accra, Ghana (Affiliation under negotiation)
Wisconsin International University College[5]	WIUC	2000	Agbogba Junction, Greater Accra, Ghana (Also affiliated to the University of Ghana)
University of Education, Winneba			**Affiliatied Institutions**

Advanced Business University College	ABUC					Accra, Greater Accra, Ghana
BlueCrest University College[7]	BCUC	2000				Accra, Greater Accra, Ghana Kumasi, Ashanti, Ghana
Jayee University College	JUC					Accra, Greater Accra, Ghana
University College of Management Studies	UCOMS	1974				Accra, Greater Accra, Ghana Kumasi, Ashanti, Ghana
Sikkim Manipal University, India						**Affiliated Institutions**
Sikkim Manipal University Ghana LC	SMUG	2008				Academic City, Ring Road, Accra, Greater Accra, Ghana
Sikkim Manipal University, Kumasi Ghana	SMUG	2011				CityStyle Building, Stadium Road, Kumasi, Ashanti Accra, Ghana
Karunya University, India						**Affiliated Institutions**
Ghana Christian University College	GCUC					Accra, Greater Accra, Ghana Kumasi, Ashanti, Ghana (Affiliation under negotiation)
Australian Institute of Business Administration						**Affiliated Institutions**
Zenith University College[6]	ZUC	2001				La, Accra, Greater Accra, Ghana Kumasi, Ashanti, Ghana (Affiliated to the University of Cape Coast)
China Europe International Business School						**Affiliated Institutions**
China Europe International Business School	CEIBS	1994				Accra, Greater Accra, Ghana
University of Wales Affiliated Institutions						
Ghana Christian University College	GCUC					Dodowa, Accra, Greater Accra, Ghana
Others -						**Unclear Affiliated Institutions**
The Bible University College of Ghana	BUCG					Akuapem, Eastern Region, Ghana
Catholic Institute of Business and Technology	CIBT					Accra, Greater Accra, Ghana
Ghana Telecom University College	GTUC	2005	1,500	20	1,520	Tesano, Accra, Greater Accra, Ghana
North American Center for Professional Studies	NACPS	2011				Kasoa, Central Region, Ghana
Premier Institute of Law Enforcement Management and Administration[8]	PILEMA					Accra, Greater Accra, Ghana

[3] There are three institutions in the **Chartered private tertiary institutions** category.[9]

Source: National Accreditation Board, Ghana (15th August, 2018)

APPENDIX 2



College Of Technology Education, Kumasi

UNIVERSITY OF EDUCATION, WINNEBA

Dean's Office, Faculty of Technical & Vocational Education

The Head
Department of Mechanical Engineering
KNUST
Kumasi-Ashanti

REQUEST FOR PERMISSION LETTER: MRS. MARTHA DANSO

I write to introduce to you Mrs. Martha Danso, a Senior Lecturer at the Department of Design and Technology Education in the Faculty of Technical and Vocational Education.

Mrs. Danso has gained admission at Walter Sizulu University in South Africa to pursue a Doctorate in Education programme. She is undertaking a research on the topic:

"INVESTIGATIVE EXPLORATION OF FEMALE STUDENTS' EXPERIENCES IN PURSUING TECHNOLOGY EDUCATION IN GHANAIAN UNIVERSITIES"

She is seeking informed consent to conduct the research in Engineering Department of your University.

Among the schedules outlined in her research proposal to be carried out in your institution when permission is granted are:

- Sampling of fifty (50) participants (6 lectures, 44 students) purposively within the Engineering Department.
- Conducting semi-structured one-to one interviews and focus group discussions on negotiated venues and dates.
- Observing six lecturers teaching using non-participant observation method.
- Administering questionnaire to the student participants.

Although the research would be conducted possibly in the later part of 2013, Walter Sizulu University requests a granted permission letter from each sampled University to be attached to the research proposal prior to approval of the proposal.

We therefore wish to request that you assist Mrs. Danso by granting her permission to conduct her research successfully.

We count very much on your anticipated co-operation. Thank you.

Yours faithfully,

DR. MARTIN AMOAH

Dean, Faculty of Technical and Vocational Education

E-mail: uewk@ksi.uew.edu.gh

APPENDIX 3

PERMISSION GRANTING LETTERS BY SAMPLED UNIVERSITIES

a.

College Of Technology Education, Kumasi

UNIVERSITY OF EDUCATION, WINNEBA

P. O. Box 1277, Kumasi - Ghana Tel.: 03220 - 53616, 50331, 53605 Fax: 53611

Dean's Office, Faculty of Technical & Vocational Education

Our Ref. UEW/KC/FTVE/R.03/13

Your Ref.:

Date: 4 MARCH, 2013

Mrs. Martha Danso
College of Technology Education
University of Education, Winneba
Kumasi

Dear Madam,

RE: PERMISSION TO CONDUCT RESEARCH

I write with reference to your letter UEW/KC/FTVE/1.2/21 dated 12 February, 2013, requesting for permission letter to conduct a research in the Faculty of Technical and Vocational Education University of Education, Winneba. On behalf of the Faculty, I write to inform you that we have granted you the permission to conduct the said research in the Faculty.

I wish to state that the University has a policy on research and you should therefore conduct this research within this policy framework.

I wish you the best of luck in your endeavour.

DR. MARTIN AMOAH
Dean, Faculty of Technical and Vocational Education

E-mail: uewk@ksi.uew.edu.gh

b.

UNIVERSITY OF GHANA
SCHOOL OF ENGINEERING SCIENCES

Ref. No.: ....SES/OB/9.......................

April 20, 2017

Engr. Mrs. Martha Danso
Department of Mechanical Technology Education
College of Technology Education,
University of Education
Kumasi

Dear Sir,

RE: PERMISSION TO CONDUCT A RESEARCH:
ENGR MRS. MARTHA DANSO

Your letter dated March 21, 2017 on the above subject refers.

Following a decision of the School Management Committee (SMC) meeting held on April 06, 2017, permission has been granted to undertake a qualitative research in Gender and Technology leading to the award of a PhD on the topic: '**Exploration of Critical Experiences Influencing Females Pursuing Technology-Related Programmes in Ghanaian Universities: A Phenomenological Study**'

The Board has requested that you share the finding of your research with the School.

Yours Sincerely,

Jennifer Amponsah (Ms.)
Assistant Registrar

1. Dean, School of Engineering Sciences
2. Prof. Stephen Jobson Mitchual, Dean, Faculty of Technical Education

COLLEGE OF BASIC AND APPLIED SCIENCES

c.

UNIVERSITY OF GHANA
OFFICE OF DEAN
FACULTY OF ENGINEERING SCIENCES
PMB, Legon, Accra. Ghana
Telephone: 233-0302-517742, 500263-4, Ext. 2022. Fax 233-21-517741
Email Engsci@ug.edu.gh

Our Ref:..................................

Your Ref:..................................

12[th] March 2013

Dear Sir/Madam

PERMISSION TO CONDUCT A RESEARCH – MRS. MARTHA DANSO

I have granted Mrs. Martha Danso permission to conduct a research on the topic "INVESTIGATIVE EXPLORATIOON OF FEMALE STUDENTS' EXPERIENCES IN PURSUING TECHNOLOGY EDUCATION IN GHANAIAN UNIVERSITIES" in the Faculty of Engineering Sciences in the University of Ghana.

I hereby request all staff and students to give her the necessary support.

Yours faithfully,

Prof. R.J. Bani

DEAN

DISTRIBUTION:

Heads of Departments

Non – Academic Staff

Students of the Faculty

Dean, Faculty of Technical and Vocational Education, Winneba

d

VALLEY VIEW UNIVERSITY

A Seventh-day Adventist Institution of Higher Learning • Chartered by the National Accreditation Board, Ghana

March 1, 2013

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF CONSENT TO CARRY OUT RESEARCH PROPOSAL

This is to inform you that the Dean of the Institute of Computer Science, Valley View University, Accra Ghana has given approval to Mrs. Martha Danso to carry out her research proposal in the said institute.

Thank you.

Sincerely,

Dominic Damoah

Dean, Institute of Computer Science, VVU

e

CENTRAL UNIVERSITY COLLEGE

Accredited by the National Accreditation Board

Main Campus Miotso: P. O. Box 2305, Tema. Tel: 023 9546164-5
P. O. Box DS 2310, Dansoman, Accra, Ghana. Tel: (233-302) 311040 - 1, 313185 Fax: (233-302) 311042
Website: www.central.edu.gh E-mail: administration@central.edu.gh

CUC/P/7/01/v.13/53

12th March 2013

Mrs. Martha Danso
Senior Lecturer
Dept of Design & Technology Education
Faculty of Technical & Vocational Education
College of Technology Education
Kumasi

Dear Madam,

PERMISSION GRANTED FOR RESEARCH AT CUC

I write granting you permission to conduct research on the Central University College campus on the topic "Investigative exploration of female students' Experiences in pursuing technology education in Ghanaian universities".

I understand that you are a Senior Lecturer at the Department of Design and Technology Education of the University of Education, Winneba currently pursuing a doctorate programme in South Africa.

By a copy of this letter, I am notifying the Dean of the School of Applied Sciences and the Head of the Department of Civil Engineering of your project, and I do expect them to assist you in anyway possible to ensure the success of your project.

Yours faithfully,

Kwesi Yankah

Prof. Kwesi Yankah, FGA
PRESIDENT

Cc: VP (Academic) CUC
VP (F & A) CUC
Dean, Faculty of Technical & Voc. Educn, UEW
Dean SAS, CUC
HOD Civil Engineering, CUC

f

ALL NATIONS
UNIVERSITY
COLLEGE

The Dean,

Faculty of Engineering

All Nations University College.

P. O. Box KF 1908,

Koforidua.

Dear Sir,

GRANT PERMISSION TO CONDUCT RESEARCH

Following the discussions we had with Mrs Martha Danso on her intention to carry out research for the benefit of women in Science and Technology Education, we write to grant her approval. She is therefore permitted to carry out her research work when the time is up.

We wish her the best in her research.

Yours faithfully

Dr. Paul Blay

Dean of Engineering.

9

RECEIVED

UNIVERSITY FOR DEVELOPMENT STUDIES
FACULTY OF APPLIED SCIENCES
NAVRONGO CAMPUS

P.O. Box 24
Navrongo, Ghana
April 5, 2016

OFFICE OF THE DEAN

The Dean
Faculty of Technical Education
University of Education, Winneba

Dear Sir,

RE: REQUEST FOR PERMISSION LETTER- MRS. MARTHA DANSO

Your letter dated November 27, 2015 on the above subject refers.

I write on behalf of the Faculty of Applied Sciences of the University for Development Studies (UDS), Navrongo Campus and grant permission to Mrs. **Martha Danso** to carry out her research work in the Faculty on the topic ***"EXPLORATION OF FEMALE STUDENTS' EXPERIENCES IN PURSUING TECHNOLOGY EDUCATION IN GHANAIAN UNIVERSITIES."***

The Faculty has also agreed to the scheduled outline of her research proposal as follows:

- Sampling of fifty (50) participants (6 Lecturers, 44 students) purposively within the Science or Engineering Department.
- Conducting six (6) lecturers teaching using non-participant observation method.
- Administering questionnaires to the student participants.

Kindly communicate to the Faculty Officer (0208508818) the date Mrs. Martha Danso would like to conduct her research in the Faculty.

Thank you.

(2) Mrs Danso

Please, f.y.i

Am 05/05/16

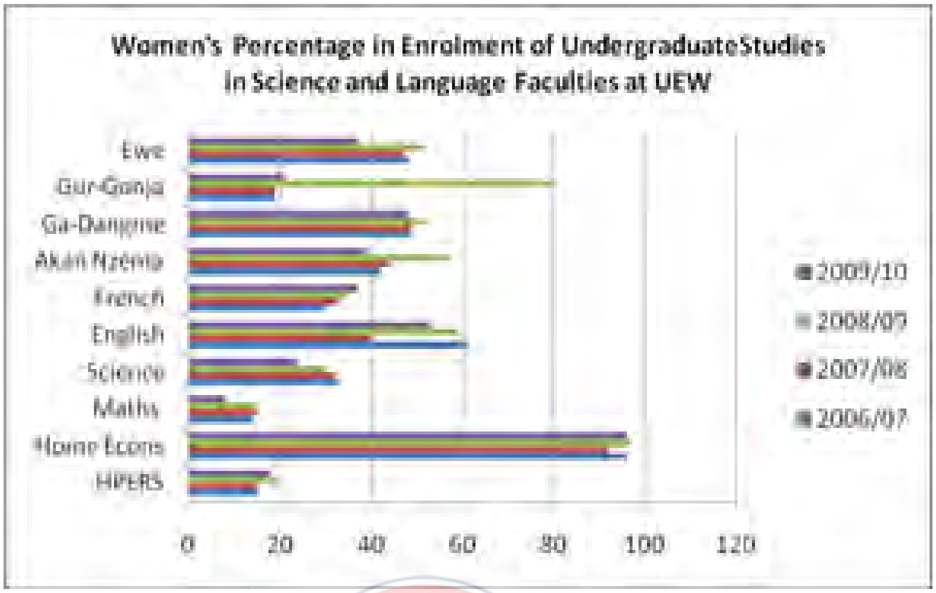
Yours faithfully,

Mathias A. Ateng
(Assistant Registrar/Faculty Officer)
For: Dean

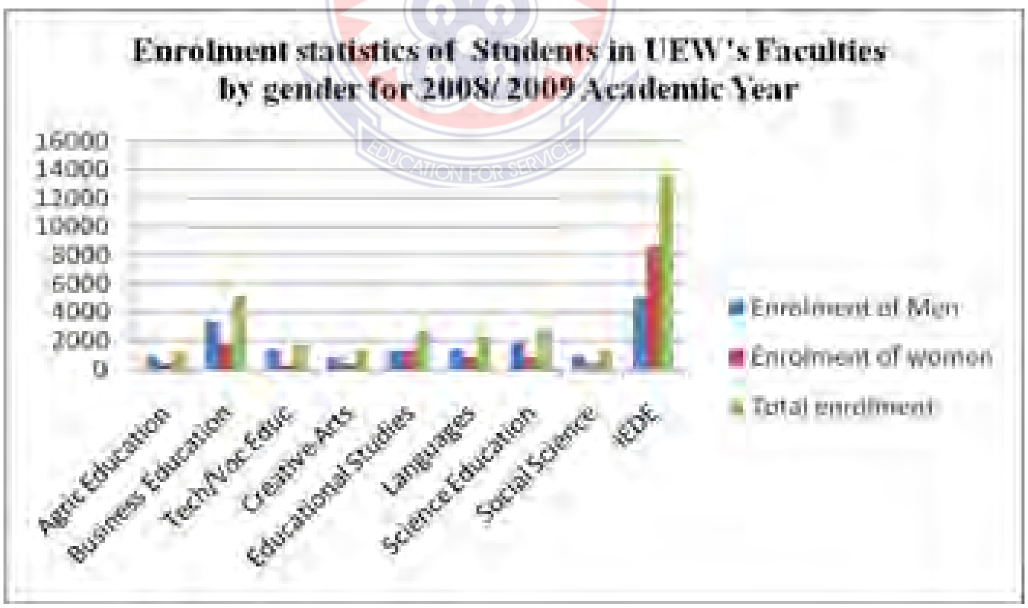
Cc: Mrs. Martha Danso, Vice Dean (FAS), All Heads of Departments (FAS)

APPENDIX 4

a



b

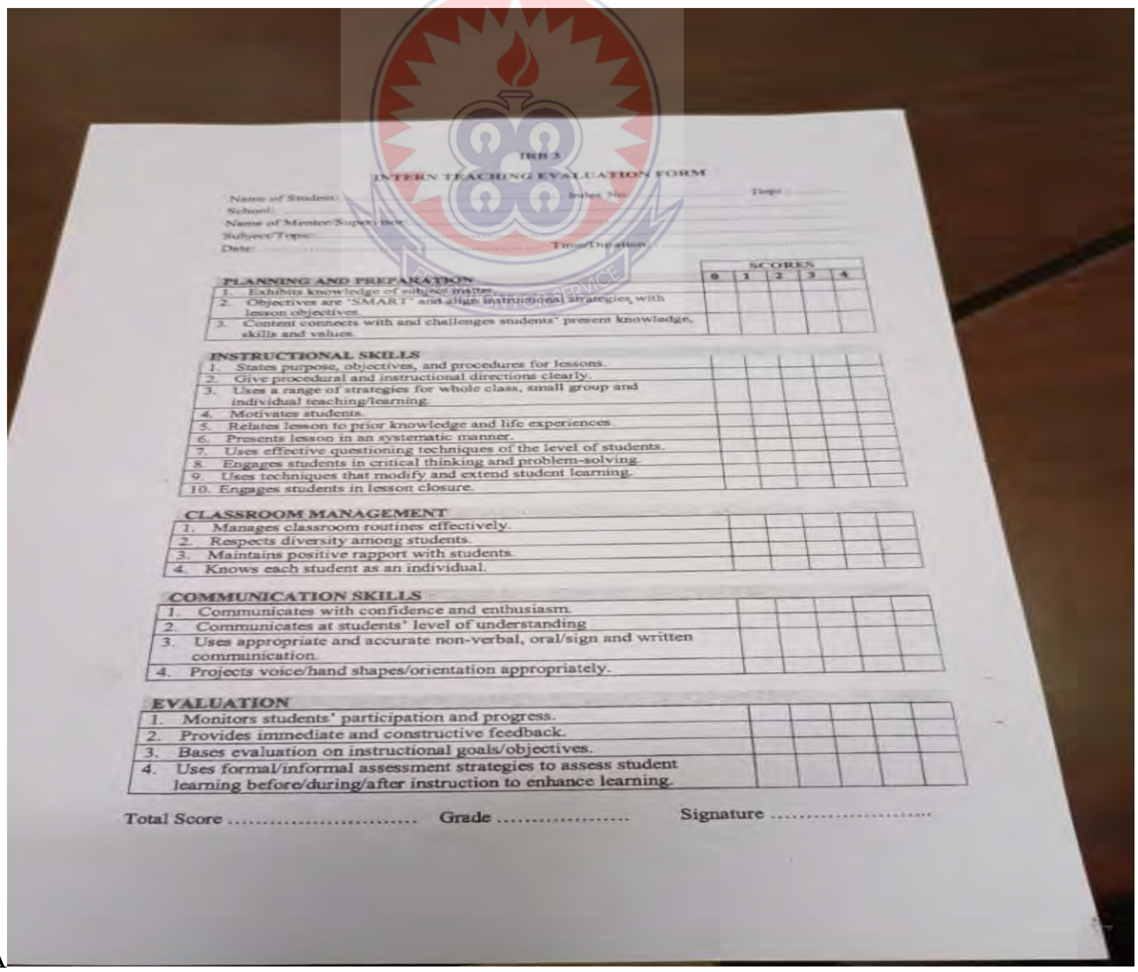


APPENDIX 5

SAMPLED INSTITUTIONS

s/n	Institution	Accreditation	Ownership	Regional Location
1	University of Ghana – School of Engineering (VarsA)	1948	Public	Greater Accra
2	University for Development Studies (VarsB)	1993	Public	Northern
3	Central University College (VarsC)	1998	Private	Greater Accra
4	Valley View University (VarsD)	1995	Private	Greater Accra
5	All Nations University College (VarsE)	2005	Private	Eastern

APPENDIX 6



INTERN TEACHING EVALUATION FORM

Name of Student: .... Index No: ....

School: ....

Name of Mentor/Supervisor: ....

Subject/Topic: ....

Date: .... Time/Duration: ....

PLANNING AND PREPARATION	SCORES 0	1	2	3	4
1. Exhibits knowledge of subject matter.					
2. Objectives are 'SMART' and align instructional strategies with lesson objectives.					
3. Content connects with and challenges students' present knowledge, skills and values.					

INSTRUCTIONAL SKILLS					
1. States purpose, objectives, and procedures for lessons.					
2. Give procedural and instructional directions clearly.					
3. Uses a range of strategies for whole class, small group and individual teaching/learning.					
4. Motivates students.					
5. Relates lesson to prior knowledge and life experiences.					
6. Presents lesson in an systematic manner.					
7. Uses effective questioning techniques of the level of students.					
8. Engages students in critical thinking and problem-solving.					
9. Uses techniques that modify and extend student learning.					
10. Engages students in lesson closure.					

CLASSROOM MANAGEMENT					
1. Manages classroom routines effectively.					
2. Respects diversity among students.					
3. Maintains positive rapport with students.					
4. Knows each student as an individual.					

COMMUNICATION SKILLS					
1. Communicates with confidence and enthusiasm.					
2. Communicates at students' level of understanding					
3. Uses appropriate and accurate non-verbal, oral/sign and written communication.					
4. Projects voice/hand shapes/orientation appropriately.					

EVALUATION					
1. Monitors students' participation and progress.					
2. Provides immediate and constructive feedback.					
3. Bases evaluation on instructional goals/objectives.					
4. Uses formal/informal assessment strategies to assess student learning before/during/after instruction to enhance learning.					

Total Score .... Grade .... Signature ....

A

APPENDIX 7

a. QUESTIONNAIRE FOR PILOTING BY STUDENTS (at COLTEK)

INTRODUCTION

Thank you for agreeing to take part in this research. The purpose is to find the issues that encouraged you into pursuing a programme in Science/Engineering as well as those that nearly put you off its study. The questions set are not to examine your mental ability but for you to share some of your views on your past and present experiences. Please, feel completely at ease and provide honest responses of your opinion or view of the questions framed. You are assured of optimum confidentiality and anonymity so do not write your name. Follow the instructions by ticking or completing the blank space.

BIO-DATA (please tick √ in the box)

MALE ☐ FEMALE ☐

AGE (years): Under 17 ☐ 18-20 ☐ 21-23 ☐ 24-26 ☐ 27 and above ☐

REGION OF YOUR TRIBE: Ashanti ☐ Brong-Ahafo ☐ Central ☐

Eastern ☐ Greater Accra ☐ ☐

Northern

Upper East ☐ Upper West ☐

Volta ☐ Western ☐

If a foreigner, please specify your country of origin ------------------------------------

EDUCATIONAL BACKGROUND:

PROGRAMME / COURSE being pursued at the university

LEVEL / CLASS / YEAR: 100 ☐ 200 ☐ 300 ☐ 400 ☐

2nd Cycle attended

Senior High School ☐ Senior Secondary Technical ☐ Technical Institute ☐

Vocational Institute ☐ Other ☐ Please if other, specify ------------------------

Tertiary

Polytechnic Education ☐ Teacher Training Post-Sec ☐ Post-Sec Nursing ☐

None of these ☐ Other ☐

If other, please specify --

ACADEMIC FIELD

Please, tick (√) the space that reflects your opinion in the options or give a response to the question.
A programme in this questionnaire could mean

i. Science based-courses or
ii. General Arts courses or
iii. Visual Arts courses or
iv. Technical courses or
v. Vocational courses
vi. Languages like English, French or
vii. Commercial courses like Business Management, Accounting, etc.

1. Why did you decide to study science-based programme?

----

2. What do you like most about the study of science-programme being studied?

----

3. What do you dislike about the programme you are studying?

----

4. If you were given another chance to attend a second cycle school, what programme would you have selected?

----

5. Why would you have opted for that programme?

----

6. Why are there few women in Science-based programmes?

----

7. State one preferred teaching method employed by your lecturers in your programme

----

----

8. Give one reason why you prefer the method.

----

9. State one teaching method employed by your lecturers you dislike very much.

----

10. Give one reason why you dislike this method

----

11. State one cultural practice in your region which you think affect the study of science and mathematics by girls.

----

12. Why does this affect girls' studies?

----

13. Most people in our societies consider technical education to be suitable for boys! What is your opinion about this?

----

14. Traditionally, girls are not supposed to use certain science and engineering tools like the saw. What is your opinion about this?

----

15. Who encouraged you greatly into the study of the Sciences? --------------------------------

----

----

16. What form of encouragement was offered to you?

----

17. Most gender activists advocate for actions to increase the number of females in Science / Engineering. Kindly specify one action you think can improve enrolment in this field for females

----

----

18. Please, the space below is for you to air your view/s on any relevant issue that was not captured in the questionnaire.

Thank you very much for your support.

b. Completed questionnaire by one female and a male-participants

QUESTIONNAIRE FOR STUDENTS

Thank you for agreeing to take part in this research. The main purpose is to find the issues that encouraged you to pursue a programme in Science/Engineering as well as those that nearly put you off its study. The questions set are not to examine your mental ability but for you to share some of your views on your past and present experiences. Please, feel completely at ease and provide honest responses of your opinion or view of the questions as stated. You are assured of optimum confidentiality and anonymity so do not write your name. Follow the instructions by ticking or stating responses in the blank spaces.

BIO-DATA (please tick √ in the box)

MALE ☐ **FEMALE** ☑

AGE (years): Under 17 ☐ 18-20 ☑ 21-23 ☐ 24-26 ☐ 27 and above ☐

REGION OF YOUR TRIBE: Ashanti ☐ Brong-Ahafo ☐ Central ☐ Eastern ☐ Greater Accra ☑ Northern ☐ Upper East ☐ Upper West ☐ Volta ☐ Western ☐

If a foreigner, please specify your country of origin ……………………………………

ACADEMIC FIELD

Please, tick (√) the space that reflects your opinion in the options to the question.

a. **Kindly tick (√) the programme you are pursuing in the following.**

A programme in this questionnaire could mean

i. Mechanical Engineering ☐
ii. Mechanical Technology ☑
iii. Civil Engineering ☐
iv. Building Construction ☐
v. Chemical Engineering ☐
vi. Mathematics ☐
vii. Physics ☐
viii. Biology ☐
ix. None ☐
x. If none, please, specify your programme of study ……………………………………

b. **LEVEL / CLASS / YEAR:** 100 ☐ 200 ☑ 300 ☐ 400 ☐

1

c. 2ND CYCLE SCHOOL ATTENDED

Senior High School ☐ Senior Secondary Technical ☑ Technical Institute ☐

Vocational Institute ☐ Other ☐ Please if other, specify ----------------------------

Current Programme of Study

1. Why did you decide to study your selected programme chosen at at question 'a' above?
I develop interest in it when I was introduce into it

2. What do you **like** most about the programme you are studying?
It helps you to have a general or indebt Knowledge of what entails in engineering

3. What do you **dislike** most about the programme you are studying?
We don't base are Theoritical aspect or Convert the Theoritical aspect into practical

4. If you were given another chance to attend a second cycle school, what programme would you have selected?
Metal work

5. If you would have opted for a new programme, give one reason for that, please.

Teaching method

6. Please, state one teaching method employed by your lecturers you like very much in your programme
Demonstration

7. Give one reason why you **like** that method.
For I to have a hand grip of it first before doing it on my own.

8. State one teaching method employed by your lecturers you **dislike** very much.
----

9. Give one reason why you **dislike** this teaching method.

2

Leadership style

10. State the most important quality or attribute that a leader of an institution should possess in order to attract females into the study of technological courses such as Mechanical Engineering.

11. Why do you consider this quality or attribute to be the most important in attracting females into the study of technological courses?

12. Give the name of one leader you admire most for his/her encouragement given to females in studying technological courses such as Mechanical Engineering.

13. Why do you admire him/her?

Mr. S.K. Amoakohene

14. What should leaders of institutions do in order to attract females into the study of technological courses such as Mechanical Engineering?

Organise Seminar once a month to introduce The technological Courses in Various Second Cycle

Policy

15 What law could be enacted by leaders of institutions to encourage females into technological courses such as Mechanical Engineering?

They Should Sign a memorandum with The Germany dual System Organisation to Construct Their Centres here for female only.

16 What law could be enacted by the government of Ghana to encourage females into technological courses such as Mechanical Engineering / Technology?

Government Should institute a TVET programme that will Combine both vocational and technical abilities and academic Knowledge into The developing Knowledge of the youth and Implement prudent measures.

17 Most gender activists advocate for actions to increase the number of females in Science, Technology, engineering and Mathematics (STEM). Kindly specify one action you think can improve enrolment in this field for females.

Introduce the TVET System in Ghana rather than the traditional school

3

18. Please, name and specify the field of one female Scientist or Technologist or Engineer you know apart from your Lecturers.

Cultural and Traditional Practices

19. State one cultural practice in your region which you think affect the study of technological courses such as Mechanical Engineering by females.

---

20. In your opinion, why does this cultural practice affect the study of technological courses by females?

---

21. What could be done in our homes to encourage females into the study of science and mathematics in earlier stages of our development?

---

22. Traditionally, in some societies, girls are not supposed to use technological and engineering tools like the hacksaw and tenon-saw. Do you know of any such practice in the region you hail from?

Yes ☐ No ☑

23. If your response to question 22 is Yes, what is your opinion about this?

---

24. If your response to question 22 is No, what should be done about those who practice that?

They Should be educate On the technological Courses and the benefit of it to the females

Motivation

25. Who encouraged you greatly into your programme of study?

My Father and my role model

4

26 What form of encouragement was offered to you by the one?

A Positive encouragement

If your response to question 25 is either your parents or teachers or both, then do not respond (skip) to question 27 below.

27 What form of encouragement was offered to you by your parents and teachers towards the study of your programme?

i. Parents: Your potential determine your future Career

ii Teachers: Most female fear to pursue a technological course but what entails in it is very great and amazing.

28 Please, the space below is for you to air your view/s on any relevant issue/s that was/were not captured in the questionnaire.

Thank you very much for your support.

If you wish to contact me for further information, my telephone number is: 0244220744

5

QUESTIONNAIRE FOR STUDENTS

Thank you for agreeing to take part in this research. The main purpose is to find the issues that encouraged you to pursue a programme in Science/Engineering as well as those that nearly put you off its study. The questions set are not to examine your mental ability but for you to share some of your views on your past and present experiences. Please, feel completely at ease and provide honest responses of your opinion or view of the questions as stated. You are assured of optimum confidentiality and anonymity so do not write your name. Follow the instructions by ticking or stating responses in the blank spaces.

BIO-DATA (please tick √ in the box)

MALE [√] **FEMALE** [ ]

AGE (years): Under 17 [ ] 18-20 [ ] 21-23 [ ] 24-26 [ ] 27 and above [√]

REGION OF YOUR TRIBE: Ashanti [ ] Brong-Ahafo [ ] Central [ ]
Eastern [ ] Greater Accra [ ] Northern [ ]
Upper East [√] Upper West [ ]
Volta [ ] Western [ ]

If a foreigner, please specify your country of origin ------------------------------------

ACADEMIC FIELD

Please, tick (√) the space that reflects your opinion in the options to the question.

a. **Kindly tick (√) the programme you are pursuing in the following.**

A programme in this questionnaire could mean

i. Mechanical Engineering [ ]
ii. Mechanical Technology [√]
iii. Civil Engineering [ ]
iv. Building Construction [ ]
v. Chemical Engineering [ ]
vi. Mathematics [ ]
vii. Physics [ ]
viii. Biology [ ]
ix. None [ ]
x. If none, please, specify your programme of study ....

b. **LEVEL / CLASS / YEAR:** 100 [ ] 200 [√] 300 [ ] 400 [ ]

1

e. 2ND CYCLE SCHOOL ATTENDED

Senior High School ☐ Senior Secondary Technical ☑ Technical Institute ☐

Vocational Institute ☐ Other ☐ Please if other, specify ----------------------------

Current Programme of Study

1. Why did you decide to study your selected programme chosen at at question 'a' above?

Because I have basis on it and also like designing

2. What do you **like** most about the programme you are studying?

----

3. What do you **dislike** most about the programme you are studying?

It does not offer opportunity outside the teaching profession.

4. If you were given another chance to attend a second cycle school, what programme would you have selected?

Metalwork

5. If you would have opted for a new programme, give one reason for that, please.

Teaching method

6. Please, state one teaching method employed by your lecturers you like very much in your programme

Discussion

7. Give one reason why you **like** that method.

I am at liberty to share my opinions

8. State one teaching method employed by your lecturers you **dislike** very much.

~~Dis~~ Lecture

9. Give one reason why you **dislike** this teaching method.

I am ~~spoon~~ fed which makes me reluctant to think.

2

Leadership style

10. State the most important quality or attribute that a leader of an institution should possess in order to attract females into the study of technological courses such as Mechanical Engineering.

Innovative

11. Why do you consider this quality or attribute to be the most important in attracting females into the study of technological courses?

They will be able to solve daily family problems

12. Give the name of one leader you admire most for his/her encouragement given to females in studying technological courses such as Mechanical Engineering.

Mr. B. K. Amoakohene

13. Why do you admire him/her?

He has wide experience

14. What should leaders of institutions do in order to attract females into the study of technological courses such as Mechanical Engineering?

By giving them awards and counselling

Policy

15 What law could be enacted by leaders of institutions to encourage females into technological courses such as Mechanical Engineering?

A law ~~on~~ enforcing the award of scholarships.

and

16 What law could be enacted by the government of Ghana to encourage females into technological courses such as Mechanical Engineering / Technology?

A law to ensure increase enrolment of females into Technological courses.

17 Most gender activists advocate for actions to increase the number of females in Science, Technology, engineering and Mathematics (STEM). Kindly specify one action you think can improve enrolment in this field for females.

By creating a separate department to take charge of such programmes relating to females.

3

18. Please, name and specify the field of one female Scientist or Technologist or Engineer you know apart From your Lecturers.

Cultural and Traditional Practices

19 State one cultural practice in your region which you think affect the study of technological courses such as Mechanical Engineering by females.

Females are given out for early marriage

20. In your opinion, why does this cultural practice affect the study of technological courses by females?

Because most of them are not privilage to even reach Junior High School level.

21 What could be done in our homes to encourage females into the study of science and mathematics in earlier stages of our development?

Parents and family members of females should support and encourage them to persue such programmes.

22 Traditionally, in some societies, girls are not supposed to use technological and engineering tools like the hacksaw and tenon-saw. Do you know of any such practice in the region you hail from?

Yes ☐ No ☑

23 If your response to question 22 is Yes, what is your opinion about this?

---

24 If your response to question 22 is No, what should be done about those who practice that?

Laws should be enacted to prevent it.

Motivation

25 Who encouraged you greatly into your programme of study?

My Uncle

4

26 What form of encouragement was offered to you by the one?

He always ~~tells~~ tells me you are very good at drawing and can become an engineer.

If your response to question 25 is either your parents or teachers or both, then do not respond (skip) to question 27 below.

27 What form of encouragement was offered to you by your parents and teachers towards the study of your programme?

i. Parents: Usually bring all problems concerning artifacts to me for solving

ii Teachers: I Used to engage in practicals in school and ask me to support others.

28 Please, the space below is for you to air your view/s on any relevant issue/s that was/were not captured in the questionnaire.

The challenges that are faced by females in pursuing such programmes.

Thank you very much for your support.

If you wish to contact me for further information, my telephone number is: 0244220744

5

APPENDIX 8

INTERVIEW WITH STUDENTS (INFORMED CONSENT)

Introduction

I have agreed to participate in the research conducted by Mrs Martha Danso. She has explained the reasons for the conduct of the research to me. I have been assured of optimum confidentiality and anonymity.

Please complete the following before the interaction begins.

BIO-DATA (please tick √ in the box)

MALE ☐ FEMALE ☐

AGE (years): Under 17 ☐ 18-20☐ 21-23☐ 24-26☐ 27 and above ☐

REGION OF YOUR TRIBE: Ashanti ☐ Brong Ahafo ☐ ☐
Central ☐ Eastern G☐ter Accra ☐
Northern
Upper East ☐ Upper West ☐
Volta ☐ Western ☐

If a foreigner, please specify your country of origin -----------------------------------

EDUCATIONAL BACKGROUND:

Title of PROGRAMME / COURSE being pursued at the University

LEVEL / CLASS / YEAR: 100 ☐ 200 ☐00 ☐400 ☐

Any Tertiary institution attended

Polytechnic Education ☐ Teacher Training Post-Sec ☐ Post-Sec Nursing ☐

None of these ☐ Other ☐

Name of your University ---

ACADEMIC FIELD

Please, tick (√) the space that reflects your opinion in the options to the question.

a. Kindly tick (√) the programme you are pursuing in the following.

A programme in this questionnaire could mean

viii. Mechanical Engineering ☐
ix. Mechanical Technology ☐
x. Civil Engineering ☐
xi. Building Construction ☐
xii. Biomedical Sciences ☐
xiii. Oil and Gas ☐
xiv. Chemical Engineering ☐
xv. Information Technology ☐
xvi. Mathematics ☐
xvii. Physics ☐
xviii. Biology ☐
xix. None ☐
xx. If none, please, specify your programme of study ……………………………………………..

b. **LEVEL / CLASS / YEAR**: 100 ☐ 200 ☐ 300 ☐ 400 ☐

c. 2ND CYCLE SCHOOL ATTENDED

Senior High School ☐ Senior Secondary Technical ☐ Technical Institute ☐

Vocational Institute ☐ Other ☐ Please if other, specify -------------------------
----

Name: --

Signature ---

THANKS FOR YOUR SUPPORT

APPENDIX 9

STUDENTS' SEMI-STRUCTURED INTERVIEW GUIDE

ITEM	Questions	Prompts / Probes
1	**SOCIAL CONSTRUCTIONISM - GENDER, BRAIN LATERILIZATION** a. To what extent do we inherit mathematical concepts or acquire them? b. If acquired, how? If inherited how? c. Boys are known to perform better in science and Mathematics. What do you think account for this, please? d. Girls are also known to perform well in languages. What do you think account for this, please? e. How can we improve girls' performance in science and maths?	
2	**SOCIO/CULTURAL ISSUES** What /who encouraged you into the technology-related studies? What form of encouragement, please?	Some are encouraged by their performance in science and maths, parents and siblings, etc.
	What nearly discouraged you into participating in the technology-related disciplines	Performance, siblings, reaction of peers, parents etc
3	**CURRICULA ISSUES** What was your best subject at second cycle level (SS, STECH, ETC.) Why was it your best subject? How did you develop interest in it? What did you like most about it? What was the subject you disliked most? Why did you dislike that subject? Who influenced your subject choice in the second cycle? **PEDAGOGICAL STRATEGIES** What did you like most about the teaching with your lecturer this morning during the observation? What did you like least about the teaching with your lecturer this morning during the observation? Teaching style ---- what do you consider to be very good teaching that can encourage females into the	Through parents, siblings, teachers, role model yourself etc Use inquiry approach of teaching which emphasises that teaching and learning must be made practicable in Ghana Authority/lecture /

	sciences? How often do your lecturers use multimedia presentations? How often do your lecturers use the lecture presentations	demonstration etc.
4.	**How could leadership influence females' participation in technology-related studies** What are some of the practices that could be changed in schools? In what ways could they be changed? What practice cannot be changed? Why can't we change these? What roles could leaders play to effect the change? What laws could be enacted? What policies could be put in place to ensure that a number of girls enter the sciences and also perform well?	Eg Govt of Ghana, Heads of institutions?
5	What policy in Ghana has been formulated towards access, entry and retention towards participation of females into / in science and tech studies? If there is no idea, in your opinion, what policy can the government formulate to ensure active participation by females in the study of technology-related courses?	Any known law or rule in your University that are set to encourage females? What rules or laws discourage females in entering or enhancing their interest after entering?
6	What are some interventions that have been put in place to boost enrolment of females in technology-related disciplines in your University?	What level does it apply? Who qualifies? How many students? etc
7	Why is your programme considered important?	To the nation, society, etc
8	Societies consider clerical and stenographical work to be suitable for females. What's your opinion on that?	

APPENDIX 10

INFORMED CONSENT QUESTIONNAIRE FOR LECTURERS OBSERVED

OBSERVATION OF TEACHING BY STAFF (LECTURERS)
IN RESPECT OF MARTHA DANSO'S RESEARCH

TITLED:

EXPLORATION OF CRITICAL EXPERIENCES INFLUENCING FEMALES PURSUING TECHNOLOGY-RELATED PROGRAMMES IN GHANAIAN UNIVERSITIES: A PHENOMENOLOGICAL STUDY

Course Title ---

Lesson Topic ---

Sex of staff MALE ☐ FEMALE ☐

AGE (years): Under 35 ☐ 36-40 ☐ -45 ☐ 50 51 ☐ above ☐

REGION OF LECTURER'S TRIBE: Ashanti ☐ Brong Ahafo ☐ ☐

Central Eastern ☐ Greater Accra ☐ ☐

Northern

Upper East ☐ Upper West ☐

Volta ☐ Western ☐

If a foreigner, country of origin, please -------------------------------------

Date the observation was carried out ---

i. Size of class ----

ii. No of Females -----

I have agreed to participate in the research conducted by Martha Danso (Mrs). She has explained the purpose for the conduct of the research to me. I am optimistic that the findings of this research may enhance the enrolment of females pursuing science and technology-related programmes in the near future.

Name: ---

Signature of lecturer ---

APPENDIX 11

OBSERVATIONAL CHECKLIST

Areas	Tally	Specific comments
1. Classroom/ lab/workshop environment/ atmosphere i. Resource materials (types) a. Audio-visual support materials b. Charts c. Real objects ii. Seating arrangement iii. Ventilation		
2. Lesson presentation Methods used i. Lecture ii. Demonstration iii. Role play iv. Discussion v. Simulation vi. Any other ?		
3. Student participation i. Group work ii. Student/student interaction iii. Lecturer/student interaction iv. Questioning i. Gender-sensitiveness ii. Spread of questions v. Responses i. Male ii. Female vi. Voluntary response i. Males ii. Females vii. Lecturer's appointing i. Males ii. Females viii. Lecturer's humour		
4. Language-use by lecturer i. Verbal communication ii. Non-verbal iii. Compliments to males iv. Compliments to females v. Negative gestures i. To males ii. To females		
5. Closure i. Summarises with recap of main points? ii. Summarises through questioning? iii. No conclusion? iv. Set assignments?		
6. Time management a. Meets set objectives b. Pace up c. Slows down delivery		

APPENDIX 12

POST-OBSERVATIONAL INTERVIEW WITH LECTURERS

Introduction

Thank you very much for offering me the opportunity to observe your teaching / lecturing. I hope you would not mind sparing me an additional ten to fifteen minutes' interaction for me to gain insight into some of the reasons why you employed certain techniques during your lecturing.

1. Please kindly share with me why you used mainly …. method in the course of presenting your lesson.
2. Please, you have been with the class for quite some time so do the females on the average prefer certain methods of teaching as compared to the males?
3. If yes, kindly explain further to me as to the preferred method and the reasons for the preference.

If no, to what extent do the females cope equally as the males?

Thanks very much for this great support!

APPENDIX 13

Pictures of two scenes of focus-group discussion session at one sampled university


APPENDIX 14

TRANSCRIPTION OF INTERVIEW OF ONE FOCUS-GROUP PARTICIPANTS AT CENTRAL UNIVERSITY

CENTRAL UNIVERSITY INTERVIEW focus-group 2017 (One group)

R: Do you think that boys are born with mathematical abilities and girls are born with language abilities? Give me your view.

I: Well, I don't think so. From my own experience I used to love Arts but I didn't like math at all and so my mum used to teach me math when I was very little. When I go to SHS, I had a very good Physics teacher and at same time double as my E-math teacher. Even though I was doing good in Chemistry and Biology but I had love for Physics so I didn't want to do something outside Physics.

R: OK. Lady let's hear your voice.

I: Personally I don't also think people are born with this and others are not. When I was in basic school we had two different teachers in math. One who takes care of the word problem and one who takes care of the fractions and the others so we were doing well even than the boys because of how he explains things. But then when I got to SHS, I had a chemistry person turning to a physics and all he did was to read Aki-Ola to us. He was suppose to explain something to me not to read to me and I can also do the reading.

R: Yes next person

I: I also think guys are not born with special abilities in math than girls but then it because most guys are tougher when it comes to learning. For girls we think we cant do it all because we are girls. I have brothers and they don't like math but my father just encouraged me that I can do it and by God's grace I have been able to do it.

R: We are all saying that we are not born with anything.

I: I Also don't think boys are born with special abilities with math. When I started my primary education I didn't like math at all just because of the teacher. The way he presents it make it boring. By then when I got to JHS, we got a different math teacher who handled the whole thing differently so it gave me that interest. he made us understand that math is not difficult and so is a constant practice.

R: Ok. Now let move on to another important aspect in our society. We have quite a lot of social cultural activities in our system. In fact people really discourage us or encourage us, that one is a fact. Let's know the one who influenced your subject of choice when you were choosing your subjects in the SHS level. Who really influenced you to pursue the science or who encouraged you into the sciences.

I: I am Kwadwo Addo. For me it was my father. My father was a Civil Engineer but I hadn't thought of being a civil engineer when I was little.

R: Magdalene, yes.

I: For me it was my teacher back in basic school. I have a very close relationship with my proprietress who used to call and advise me. She went to Wesley Girls and wanted me to go to Wesley Girls too. She sometimes call me to encourage me to learn very hard and at the end of the term ask all the teachers what I had. When we were about to write BECE, my mistress called me. She want to know the course I want to offer in SHS and I told her either Arts or Science. She said I should choose science. She asked me to challenge myself.

R: Oh, ok let hear from Hannah.

I: Ok me too it was my brother. So he encouraged me. Initially I wanted to do Arts in SHS but when I told him, he said I should choose science if I come out and I want to read law I can still do it with the sciences so I followed my friends to the same school and we chose the same course. And after school she did the science and the law I don't know where it vanished to.

R: Yes Seyram.

I: At the basic school I was very close with my science teacherso before BECE I didn't know what to do at the SHS and my dad asked me to consult my teacher because he knew my strength and weaknesses maybe he could help me select the best subject for me so he advised I do the science and I chose the science. So I can say that I had the encouragement from both my father and my teacher.

R: Ok, you see some time ago I heard that some cultural practices that discourage girls from entering science based subject. Somebody told me that when you are in his tribe girls are not allowed to hold technical tools and I don't know if you have also heard of it. Do you think they affect girls in the science? Like the Trokosi,, female genital mutilation and the rest. how do they affect girls in the study of science?

I: I don't think all those practices have effects on girls studying science. Science is just an aspect of learning so if she can learn English and other courses like home Econs that same way like the science. Leaders in the societies too have to be educated on the importance of women doing science. Sometimes they may say this is for boys that's for girls. They think that the tools are too heavy for the girls to carry.

R: Yes Magdalene.

I: Personally I don't also think it affects the study of science as Hannah said in the society everybody have their minds in the old days that girls are for the kitchen, girls are for house wives and those kind of things. If you are a girl and you are pushing in the sciences sometimes people will tell your parents that ei the way this your daughter is going she will become like this, they all bring you down. I don't think is the practices but the mindset of the person.

R: This is highly confidential, as I told you. I am sure you remember it. Tell me about the lecturer you like most regarding the teaching. So who do you like most.

I: Sometimes when we have a class we the ladies sit in front and the boys will pack themselves at the back so any question that comes the lecturer throws it to the guys at the back. He involves them more than the ladies. I: I also think sometimes the lecturers think the boys are not serious so he trying to get them involved. They come to class late when you are teaching and they will also be chatting so he is trying to get them involved.

R: Yes Kwadwo.

I: Yes I agree because in my class for instance when we were in level 100 we had quite a number of females and there was a very good structure engineer who is to teach us basic structures and he throws questions across board whether male or female but he realized that some of the boys were not pulling their way and so decided to focus more on them. What is happening there is not that he feels this class is best suited for males probably he's trying to get the boys to be involved.

R: I have already asked this; tell me the lecturer you like most. Is confidential. After this you don't discuss anything

I: First on my list he's is called Eugene Boadi Dankwa but he is no longer here. The first time I stood in his class I understood everything he taught in the class. It was as if I have I have learnt it so many years and he was just brushing over it because he started from the basics. He assumed we didn't know anything so there was nothing left.

R: Ok Magdalene.

I: I have two, the first one is the one he just talked about. Eugene Boadi Dankwa, he took us into basic structures and I mentioned earlier my physics was so bad in my basic school so when I came here I didn't know anything. I had no idea about what I was doing. He made me to understand everything and told me to see his T A if I need help.

R: What about you.

I: Ok, my best lecturer is Prof Googo. He met us this SEM but the way he started from the basics what we have even done. He went on and he brushed through everything and then took his time and made the thing very practical and lecturer Eugene Boadi Dankwa.

R: This confidential. Whatever we discuss here is not discussed outside. Tell me who you dislike not the personality but the teaching aspect. I: His name is Dr. Lumor. He teaches structures in fact I love structures a lot because of the foundation I had by Eugene Boadi Dankwa and so the problem I have with him I think he so knowledgeable, very intelligent but his teaching does not suit me because it loaded.

I: Mine is also the same man because I am also doing structures and then he usually doesn't start from the basics. He assumes that you know something. Sometimes he just comes and he will be reading the notes to you

R: What is the importance of girls studying engineering. What do you think? What are the importance.

I: Ok personally, I think everybody has a potential, everybody have set of knowledge in them, has set of creativity in them, some strength. Everybody has got the chance to do it so it's not men dominated course.

R: What else Kwadwo.

I: I agree gender does not limit our intellectual ability and apart from that women are generally more careful. Having girls it brings a whole new perspective into seeing things.

R: Yes Hannah.

I: Ok, so as Kwadwo said women in engineering they are also as important as the men. In this case there will be a balance in the engineering course so sometimes if the guys are doing the construction the women can be there also supervise or show them the design they should choose.

I: Think the men think we don't have the strength when it comes to the concrete mixing so there must be some kind of strength imbedded in us

R: Thank you very much but before you leave, I am very sure you are feeling exhausted. I realized that you were coughing, I decided to hold on until everything is done. Just pick one each of these.

I: Thank you very much! R: Please, put down your telephone numbers as well.