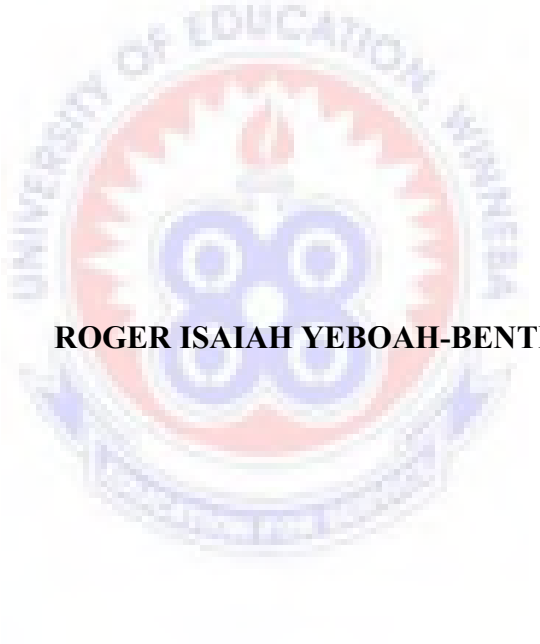
UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

FACTORS INFLUENCING LOW FEMALE STUDENTS' PARTICIPATION IN SCIENCE, TECHNOLOGY AND ENGINEERING COURSES IN SECOND CYCLE INSTITUTIONS IN THE BAWKU MUNICIPALITY



ROGER ISAIAH YEBOAH-BENTIL

AUGUST, 2017

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A Dissertation in the Department of MECHANICAL TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, submitted to the School of Graduate Studies, University of Education, Winneba in partial fulfillment of the requirements for the award of Masters of Technology (Mechanical Engineering) degree.

AUGUST, 2017

DECLARATION

STUDENT'S DECLARATION

I, **Yeboah-Bentil Isaiah Roger**, declare that this Dissertation, with the exception of quotations and references contained in the Published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ..…….

DATE: ……..…….

SUPERVISOR'S DECLARATION

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

NAME: **ENGR. STEPHEN K. AMOAKOHENE**

SIGNATURE: ..…….

DATE: ……..……..….

DEDICATION

This dissertation is dedicated to my wife Mrs. Yeboah-Bentil Aidam Yayra and my children Yeboah-Bentil Aboagyewaah Julian, Yeboah-Bentil Ambaabeng Princelord (Jnr) and Yeboah-Bentil Nimpaah Juanah.

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TABLE OF CONTENTS

CONTENT		PAGE
DECLARATION		ii
DEDICATION		iii
ACKNOWLEDGEMENT		iv
TABLE OF CONTENTS		v
LIST OF TABLES		xi
LIST OF FIGURES		xii
LIST OF ABBREVIATIONS		xv
ABSTRACT		xvi
CHAPTER ONE		
INTRODUCTION		
1.1	Background to the Study	1
1.2	Geographical Location	6
1.3	Statement of the Problem	8
1.4	Purpose of the Study	9
1.5	Significant of the Study	10
1.6	Research Objectives	12
1.7	Research Questions	12
1.8	Limitation	13
1.9	Delimitation	13
1.10	Organization of the Study	14

CHAPTER TWO

LITERATURE REVIEW

2.0	Introduction	15
2.1	Background on Gender Bias in Science and Technology Education	15
2.2	Low Representation of Females in Science, Engineering and Technology Education	17
2.3	Biological Factors of Females in Science, Engineering and Technology Education	18
2.4	Factors that Influence Girl-Child Education	20
2.5	Strategies to Improve Girl-Child Education	22
2.6	Alternative Education for the Girl Child	23
2.6.1	Equity and Access	24
2.6.2	Curricular Focus, Pedagogy and Climate in Science and Engineering	24
2.6.3	Attitudes of Girls Towards Science and Engineering Education	25
2.7	Gender-Friendly Strategies to Retain Girls in Applied Science and Natural Science	26
2.8	Teachers and Science Education	28
2.8.1	Teachers' Attitudes Towards Students	29
2.8.2	Lack of Female Peers and Role Models of Science and Engineering Education	31
2.9	Attitudes of Girls Towards Applied Science and Natural Science	32
2.9.1	Social and Cultural Factors of Girl Child Education in Applied and Natural	35

2.9.2 Factors Affecting Female Access and Participation in Education 38

2.9.3 Socio-Cultural Practices 38

2.9.4 Socio-Economic Practices and Conditions 40

2.9.5 School-Environment or School-Related Conditions 43

2.10 Political and Institutional Policy Practices 45

2.11 Educational Pathway for Women in "STEM" Careers 47

2.11.1 Job and Organizational Factors of Girl Child 49

2.11.2 Work – Life Balance 50

2.11.3 Work Related Discrimination 51

2.12 Summary 53

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction 54

3.1 Research Design 54

3.2 Population Identification 55

3.3 Sample and Sampling Techniques 56

3.3.1 Purposive Sampling 56

3.3.2 Random Sampling 57

3.4 Sampling Procedure 57

3.5 Research Instruments 58

3.5.1 Questionnaires 58

3.5.2 Documents Analysis 59

3.5.3 Focus Group Discussions 59

3.5.4 Scoring the Instrument(s) 59

3.6 Pilot Study 60

3.6.1 Ethical Considerations 60

3.7 Validity and Reliability 61

3.8 Data Collection 61

3.9 Data Analysis and Presentation 62

CHAPTER FOUR

ANALYSIS, DISCUSSION AND REPRESENTATION OF RESULTS

4.0 Introduction 63

4.1.1 Science and Applied Science Education is Only Preserve for Boys 63

4.1.2 Parents discourage their female children from undertaking Engineering (Technical) Education 64

4.1.3 Manufacturers prefer employing male students to their female counterparts as a results discourages them taking Engineering (Technical) Education 64

4.1.4 Women see themselves as inferior who cannot study engineering related courses 65

4.1.5 Female students under estimate their potentials in technical education 65

4.1.6 Girls who are gifted alone can Applied Science (Engineering) and Natural Science 66

4.1.7 Lack of Female Instructors Discourages female students to offer Applied Science (Engineering) Courses 66

4.1.8 Young Women are Motivated into Engineering Related Programs by their High Science and Engineering Ability 67

4.1.9 Women are Motivated to read Engineering Related Programs by their Natural Curiosity of Applied Science and Natural Science Discipline 68

4.1.10 There is a Strong Career Progression of Women in Applied Science (Engineering) Studies 69

4.1.11 Women in Engineering do not Progress in Engineering Professions 69

4.1.12 Society Mock at Women Who Offer Engineering and Technical Education 70

4.1.13 Female Students are not Skillful to Manipulate Heavy Engineering Tools and Equipments 70

4.1.14 Young Women do not have Interest in Science Related Courses 71

4.1.15 Women in Engineering and Technical Field cannot have Children 71

4.1.16 Women do not have the Strength to Offer Engineering and Technical Education 72

4.1.17 Girls are not Good in Science and Engineering Related Courses 72

CHAPTER FIVE

PRESENTATION AND DISCUSSION OF FINDINGS

5.0 Introduction 73

5.1 Results of Data 74

5.2 Background Analysis of Data 74

5.2.1 Research Question One 74

5.2.2 Research Question Two 77

5.2.3 Research Question Three 77

5.3 Suggestions of Improve the Participation of Women in Applied Science and Natural Science 80

5.3.1 Research Question Four (4) 81

5.3.2 Research Question Five (5) 82

5.4 Perception of Male Students 84

5.4.1 Perceptions of Teachers on strategies to attract females to the Engineering Profession 84

5.5. Attitude of Industry and Employers 85

5.5.1 Wage Gap 87

5.5.2 Coping and Survival of Female Engineers 87

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction 88

6.1 Summary 88

6.2 Conclusion 89

6.3 Recommendations 91

REFERENCES **93**

APPENDICES **99**

LIST OF TABLES

TABLE		PAGE
Table 5.1	The responses to whether female students drop out from applied science (engineering) education	74
Table 5.2	Manufacturers prefer employing male students to their female counterparts as a result discourages them from taking technical education	75
Table 5.3	Responses on the question whether female students underestimate their potentials and also gifted girls alone can study applied science and natural science	76
Table 5.4	Responses of question of whether any positive step(s) is being taking by professionals in engineering institutions towards increased participation of women in the field	78
Table 5.5	Women are motivated to read engineering by their natural curiosity	79
Table 5.6	Respondents which correspond to 6% were not sure of the assertion	79
Table 5.7	Respondents of advancement of women in engineering	81
Table 5.8	Students response to the question of how does the society see the female engineer	82
Table 5.9	Young women's response as how this perception influences their choice of engineering as a profession or career	82
Table 5.10	Female students' responses on the strength of young women	83

LIST OF FIGURES

FIGURE		PAGE
Figure 1.1:	Municipal and District Map of Upper East Region showing Bawku Municipal	8
Figure 2.1:	Factors that Influence Girls' Child Education	21
Figure 4.1	Science and Engineering Education is the Preserve for Boys	63
Figure 4.2	Parents Discourage their Girl Child from Undertaking Engineering (Technical) Education	64
Figure 4.3	Manufactures Prefer Employing Male Students to Their Female Counterpart as a Results Discourages Them Taking Engineering (Technical) Education	64
Figure 4.4	Women See Themselves as Inferior Students Who Cannot Study Engineering Related Courses	65
Figure 4.5	Female Students under Estimate Their Potentials in Technical Education	65
Figure 4.6	Girls who are Gifted alone can Study Applied Science and Natural Science	66
Figure 4.7	Lack of Female Technical Instructors discourages Female students to offer Applied Science (Engineering and Technical) Courses	66
Figure 4.8	Young Women are Motivated into Engineering Related Programs by their Science and Engineering Ability	67
Figure 4.9	Women are Motivated to read Engineering Related Programs by their Natural Curiosity of Applied and Natural Science Discipline	68

Figure 4.10	Strong Career Progression of Women in Applied Science (Engineering) Studies	69
Figure 4.11	Women in Engineering do not Progress in Engineering Professions	69
Figure 4.12	This Pie Chart above indicates that, 'Yes' respondents believe that the assertion above is true	70
Figure 4.13	Female Students are not skillful to manipulate heavy Engineering Tools and Equipments	70
Figure 4.14	Do young women not having interest in science related programs? Respondents believe the statement is not true	71
Figure 4.15	Do women in engineering and technical field can't have children? Respondents believe the statement is not true	71
Figure 4.16	Women do not have the strength to offer Engineering and Technical Education	72
Figure 4.17	Girls are not good Science in Engineering Related Courses	72

LIST OF ABBREVIATIONS

BECE	Basic Education Certificate Examination
WASSCE	West African Secondary School Certificate Examination
GPRS	Ghana Poverty Reduction Strategy
UNESCO	United Nation's Educational Scientific and Cultural Organization
UN	United Nations
FCUBE	Free Compulsory Universal Basic Education
STE	Science Technology and Engineering
STME	Science Technology Mathematics and Education
WUSC	World University Service of Canada
GCE	General Certificate of Education
UNICEF	United Nations Information Children's Fund
WAEC	West Africa Examination Council
TEC	Technical Examination Council
U.S.	United State America
BSHS	Bawku Senior High Technical School
BTI	Bawku Technical Institute
UK	United Kingdom
STEM	Science Technology Engineering and Mathematics
GIST	Girls into science and technology
FGD	Focus Group Discussion
SPSS	Statistical Package for Social Sciences
NSASE	Natural Science and Applied Science Education

SD	Strongly Disagree
D	Disagree
A	Agree
SA	Strongly Agree

ABSTRACT

This study explored students' perceptions of the factors influencing low female students' participation in science, technology and engineering courses in second cycle schools in the Bawku Municipality. The study also examined the kind and level of support, guidance and information students receive before making stream choices. Using both qualitative and quantitative approaches, data was gathered through questionnaires, document review, focus group discussions and semi – structured interviews from 110 students, 13 science teachers, three heads of schools and one Municipal Educational Officer in municipality. The literature review and research questions guided the analysis of data by organizing the analysis section into several themes. The findings of this study indicate that factors such as students' examination scores, self-efficacy in science, knowledge of available careers, gender and school resource contexts affect students' choice of science streams. The results also revealed that a majority of students had relatively little knowledge of available careers and how they are related to subject choices. This study recommends that efforts be made to improve secondary students' performance in Science, Technology and Engineering since a majority of students perceive performance as a main factor influencing their choice of science subjects. This will help the girl-child to build up a strong ego and confidence to go through school. Finally, special attention should be paid to female performance and participation in Science, Technology and Engineering because findings from this study have indicated this to be a serious problem.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Women are highly underrepresented in STEM (Science, Technology, Engineering, and Mathematics) field professions (Beede, et al, 2011). This has been a persistent issue since the study of Mathematics and Science has begun. The problem is well documented by research and there have been several efforts to remedy this issue, yet men are still dominant forces in the STEM world (Eccles, 1994; Xie & Shauman, 2003; Roberts & Ayre, 2002). As of 2009, men made up 52% of the workforce in the United States, and women made up 48% (Kimmel et al, 2012). This difference seems small, but when looking at STEM jobs in Africa, a larger gap is seen. Men hold 76% of STEM jobs and women only hold 24% of STEM jobs. Women's professional participation is cut in half when looking at STEM fields and is not representative of the overall employment of women. Thus, women are largely entering fields that are not STEM related.

In Ghana, there are often concerns that other countries are surpassing us academically and making better technological achievements. It is argued that this problem could be remedied if there were more women entering into the STEM workforce. Having more women in STEM fields would be beneficial to Ghana by providing a new source of STEM workers. A recruitment of passionate and capable women along with other minority populations would increase the STEM workforce and help Ghana to compete with the rest of the world in Science and Technology. It is clear that we need more women in STEM professions, but in order to make this happen, we need to determine what factors impact their participation.

This thesis analyzes the way the media, stereotype threat, education, and the work environment impact women in STEM, and it concludes with some ideas for the future. Many people believe that the gender gap in STEM fields can be explained by biological differences between men and women. There is no biological explanation for intelligence variations between the sexes. Where sex differences in the brain come into play is through how the brain functions. During pregnancy, there is a testosterone rush that kills some of the male fetus's brain cells in the communication centers (Brizendine, 2006). This gives women an edge when it comes to communication, particularly in areas of language and hearing. Furthermore, brain studies have shown that men only use the left side of the brain for language, whereas women access both sides of the brain in a more balanced manner (Boaler, 2008).

Similarly, when looking at emotionally charged images, women's brains were accessing and using nine different sections, but men only used two. All of these different studies lead to the idea that men and women are biologically suited to excel in different areas. For women, this means being more inclined to shine in disciplines about communication and making connections. For many, this would prove that men are naturally better at Math and Science. However, if this were true, then we would expect to see a trend in gender achievement gaps across countries, which we do not (Guiso et al, 2009).

In their study, Guiso et al. (2009) tested 15-year-old students from 40 countries in order to explore culture and gender. The Science, Engineering and Mathematics tests used were identical and were designed to be free of cultural biases. They found that the size of the gender gap in science performance varies between countries, and these

differences can be explained by the country's measure of gender equality. This measure was calculated using a variety of methods: The World Economic Forum's Gender Gap Index, the World Values Surveys, female economic activity, and the political empowerment index as computed by the World Economic Forum.

The study found a correlation between gender equality and the gender gap in science, where an increase in gender equality showed a diminishing gender gap. For example, Turkey was given one of the lowest scores for gender equality, and also found to have one of the largest gender gaps at the expense of women. However, Iceland received one of the highest scores for gender equality, and testing showed that girls outperformed boys in science related causes. Sweden was found to have the highest equality scores, and though women underperform compared to men, the gap is almost absent and not significant. This study supports the idea that cultural factors impact math achievement more than biology. It also shows that when gender equality is accepted as a cultural norm, the gender gap diminishes. Therefore, it is important to examine sociocultural factors and not just biological factors in order to fully understand the underrepresentation of women in STEM fields (Ceci et al., 2009).

Education is a basic human right and a significant factor in the development of children, communities and countries. It is usually considered as the backbone of every economy. The reason is that it is concerned with the provision of the required work force to take up position at the labour front. The new global economy increasingly demands more high-skilled and better educated workers than ever before. Due to this, governments often commit huge investments to education projects and programmes in order to realize its intended benefits. Notwithstanding improved access to education, female participation

in education in most developing countries is still characterized by disparities. Girls continue to constitute the majority of children out-of-school.

According to Ayonmike (2014), girls represent 55 per cent of all children who are out of school worldwide. Available data have indicated that worldwide, for every 100 boys out of school 122 girls are also out of school. In Ghana, however, there is a marked difference between the enrollment rates between males and females. Although the Ghanaian government and other development partners have worked hard to overcome the gender gap in the formal educational system, there is still much work to be done.

The economic benefits of educating females are enormous. Studies have shown that when females earn money, that money is more likely to be put into savings, into the community, into education, or into a family's well-being and health than when that same amount of money is earned by a male. Educating females has been shown to reduce fertility rates of females and to delay when they begin childbearing. In addition, more educated females seek earlier prenatal care when they are pregnant, which lowers maternal mortality (Tayie and Lartey, 2008).

Science and Technology have been a determining factor in human history since time immemorial, contributing to economic competitiveness on a global scale and providing essential services, infrastructure and effective healthcare. Aminu (cited in Imarhiagbe, 1996) observes that if anything is important to any nation in solving its problems, it is Science and Technology education. But it is common knowledge today that enrolment in Science and Engineering courses appears to favour the males more than the females. It is observed from various studies that gender differentials in enrolment and achievement in higher education is invariably rooted in inequality at the primary and

secondary levels where the real sorting out of University bound students take place (Aguele & Uhumuavbi, 2003). This is because female participation and interest in science and engineering diminishes as they move up in the educational ladder towards the university level due to a variety of factors that are primarily rooted in their religious and cultural belief surrounding the role of women in the society.

The widest gap by gender is seen in South Asia, the Middle East and Africa. While an overview of educational statistics in Africa indicates that tremendous gains have been made in increasing female access and participation in education since 1960, this has not reversed the trend of girls' participation levels remaining lower than boys especially in the areas of mathematics, the physical sciences and engineering (Odaga & Heneveld, 1993).

Science and Engineering (SE) are today known to be very central to the development of any nation. Ukeje (1997) observes that the development of a nation is properly accessed by the level of the education of its citizens in science, Technology and mathematics. What this means is that to attain national development, it is not enough to educate the citizens in the broadest sense, but to give them sufficient education in SE. This is so because SE is considered as the vehicle for rapid development and economic transformation of a nation. According to Commonwealth (1999) women constitute more than half of the world's population, hence, for any meaningful development to occur they cannot be ignored.

In Ghana, second cycle education is of two types; these are, a three-year Secondary Education and a three year Technical/Vocational Education. The Secondary education is examined by the West African Council (WAEC) and the certificate awarded

is West African Senior School Certificate Examination (WASSCE) and the Technical/Vocational Education is also examined by the National Board for Professional and Technician Examination (NABPTEX) and Technical Examination Units (TEU). NABPTEX examines the students on the core subjects leading to the award of Certificate II and TEU examines them on the elective subjects, also leading to the award of certificate II.

The school curriculum is mainly subject-based. Students start Secondary Education at an average age of 14 depending mainly on how early they started Primary Education. Junior High School curriculum requires that students take seven compulsory subjects and at the Secondary Education, students are required to choose either joining the science streams, art streams or technical streams. For the few schools with business streams, students can choose to join business streams. There are minimum numbers of subjects required for each stream that students will have to choose. It is at this selection stage where the problem of students 'involvement and persistence in science and Engineering fields is explicitly seen. Normally only a few female students choose to join the science and technical streams due to the motive behind this study.

1.2 Geographical Location

The Bawku Municipality is one of the 13 districts in the Upper East Region in northern Ghana. The Kusasis are the indigenous inhabitant population of the Bawku area. There are however large immigrant populations from other locations in northern and southern Ghana as well as from Burkina Faso, La Cote De Voire, Togo, Niger and Nigeria. The inhabitants are peasant farmers, cultivating crops like tomatoes, pepper, onions, cereals, legumes and rear animals like cattle, goats, sheep and poultry. Bawku is

the capital town of Bawku Municipality and it is located about 84 Kilometers East from Bolgatanga, the Regional Capital with an estimated urban population of 86,248 people according to the Ghana 2010 population census.

According to Mr. Yakubu Issah, a Bawku Municipal Education Officer, in September, 2016 when this study was conducted, Bawku had a total of Six Senior Secondary Schools, of which three are public schools and rest private. The three public schools include Bawku Senior High School (3,156 students), Bawku Senior High/Technical School (1,876 students) and Bawku Technical School (2,735 students). The public sector senior high schools were with a total number of 7,767 (5,261 boys, 2,506 girls) students.

In this study the researcher limited the study population to public schools only because most private schools have different procedures and structures in relation to the study topic. Moreover, public schools had a more easily accessible population than the private schools.

According to the District Education Officer, in 2016 when this study was conducted; public secondary schools in Bawku Municipality had a total number of 291 teachers, of whom 58 or 20% are science, mathematics and engineering teachers. Overall the teacher-students' ratio for Bawku Municipality is 24:1. This relatively good teacher-student ratio is not surprising because Bawku Municipality is not that remote compared to other districts in this region. Figure 1.1 is map showing how Bawku Municipality is situated on the map of Ghana in the Upper East Region.

Figure 1.1: Municipal and District Map of Upper East Region showing Bawku Municipal; **Source**: Paavola (2008)

1.3 Statement of the Problem

The involvement of female students in Science and Engineering related subjects in Ghanaian institutions stands very poor when compared to enrollment in general education programmes. Despite successive governments' efforts directed at improving science and engineering education at all levels to make Science and Technical education attractive, recent statistics available from the three public second cycle schools show that a relatively low number of girls, take science and engineering courses as their electives.

In Figure 1.1, shows that less girls opt for the Science and Engineering courses compared to the number of girls who go in for the other courses.

This low participation in these subjects may impact on the level of scientific literacy of these girls and the future workforce of the country as girls will lack important knowledge, conceptual understanding and skills needed for facing the challenges of the fast changing world. It is based on this background that this study is set out to identify the factors influencing the involvement of female students in science and engineering courses in second cycle institutions in the Bawku Municipality.

It would be seen however that with various efforts made by appropriate authorities and professional bodies, couple with advancing economic development, remarkable, albeit show, an increase began to be record in female participation in science – related courses.

1.4 Purpose of the Study

The purpose of this study is to identify the factors that influence the involvement of female students in Science and Engineering courses in the Bawku Municipality. The study is to highlight the relevance of young women participation in Science related education. It is to satisfy some expected conditions when in effect renders it extremely significant to the researcher. It is concern with Factors Influencing Female Students Involvement in Science and Engineering courses in Second Cycle Institutions in the Bawku Municipality.

1.5 Significance of the Study

This study will be important for policy makers, teachers and other stakeholders as they can manipulate the factors that influence students' choices of Science and Engineering streams to encourage more students' participation and persistence in Science and Engineering fields. This study will also help in identifying different motivational components that are missing in school streaming processes and hence inform policy makers on how to improve subject streaming in schools. This information will then inform creation of systems that will encourage more female students to choose science and engineering related subjects. In addition, this study will inform pre-service and in-service education programs that train science and engineering teachers on the factors that influence stream choices. This may lead to the integration of student support and advisory services into teacher education programs. Ghana needs a scientifically literate society in order to develop the strong science and technological manpower necessary for Ghana to compete in the global economy. This dream will only be possible if we have more students participating in science and engineering related courses.

This study is important and worth the time and resources spent on it for a number of reasons. The study will help;

- Lecturers/Teachers
- Parents
- Educational Authorities to identify proper ways of encouraging the female student to opt for science and engineering related courses. It is also to survey girls entering the natural science (Biology, Chemistry, Physics etc.) and applied science (Engineering and Technology) courses to determine whether their perception, perceive social and cultural support, self – esteem and self - efficacy

play a significant role in their participation in the study of Natural Science (Physics, Chemistry, Biology etc.) and Applied Science (Engineering).

There is generally a low female participation in science and technology courses in Senior High and Technical Schools in the Bawku Municipality. This study may come out with some useful recommendations which will lead to an increase in the number of female students who enroll in science and technology courses in the Municipality and beyond.

Males, historically have dominated the workforce in fields such as engineering, architecture, skilled trades, and mechanics. According to the U.S. Department of Labor (2009) women held only 6% of the jobs as engineering and construction managers, while almost 70% of the medical/health service managers and Social/community service managers were female. If the trend for females in nontraditional careers is going to change females need to be exposed to these opportunities early in life especially at the second cycle institutions.

Students enroll in elective courses for different reasons. One reason students may enroll in an elective course is they find the content interesting. According to Welty (1996) female students view technology differently than male students and take a different interest in it than males. This study may provide recommendations to make science and technology education in Bawku Municipality more interesting to female students. The findings of study this would also be of great importance to researchers as it will help develop additional literature in the area of factors that influence enrolment of female students in science and technology oriented courses in senior high and technical training institutions in Ghana.

In conclusion, findings from this study will benefit the government of Ghana in developing and implementing policies that promote proper and informed subject enrolment among students.

1.6 Research Objectives

Basically, the research is to investigate into Factors Influencing Female Students Involvement in Science and Engineering related programs. The study will be guided by the following objectives:

a. To find out the perception of female students about the studying of science and engineering courses in Senior High and Technical Schools in the Bawku Municipality.
b. To examine the extent to which female students' attitudes influence their enrolment in science and engineering oriented courses in Senior High and Technical Schools in the Bawku Municipality.
c. To identify the outcome expectation influence on enrolment of female students in science and engineering oriented courses in Senior High Schools in the Bawku Municipality.

1.7 Research Questions

a. What perception do female students have with regards to studying of science and engineering courses in Senior High and Technical Schools in the Bawku Municipality?

b. How does female students' attitude influence their enrolment in science and engineering oriented courses in Senior High and Technical Schools in the Bawku Municipality?

c. What outcome expectations influence the enrolment of female students in science and engineering oriented courses in Senior High Schools in the Bawku Municipality.

1.8 Limitation

The study would be confined to the Bawku Municipality in the Upper East Region of Ghana. The Bawku Municipality has one public Senior High School, one public Senior High Technical School and one public Technical Institution. The school and institutions train both sexes in different programmes at different levels in science and technology. The study was limited to first and second year female students, since those in the third year had completed.

1.9 Delimitation

The study would be confined to the Bawku Municipality in the Upper East Region of Ghana. The Bawku Municipality has one public Senior High School, one public Senior High Technical School and one public Technical Institution. The school and institutions train both sexes in different programmes at different levels in science and technology. The study was limited to first and second year female students, since those in the third year had completed.

1.10 Organization of the Study

This study was divided into five chapters as follows: Chapter One gave the background of the study and introduces the problem statement describing the specific problem addressed in the study, as well as the purpose, objectives and research questions that the study sought to answer. Chapter Two presented a review of literature and relevant research associated with the problem addressed in the study, giving theoretical foundations of the study and conceptual framework. Chapter Three presented the methodology and procedures used for data collection and analysis. Chapter Four analysis, discussions and representation of results. Chapter Five is the presentation and interpretation of the findings. Chapter Six presents a summary of the findings, conclusions, recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The purpose of this study was to assess the factors influencing female students' participation in Science and Technology courses in the Bawku Municipality in an effort to increase female enrollment in science and technology courses. The data collected from this study may lead to recommendations to make technology education more appealing to all students especially females. This review of literature will provide a review of gender bias within technology education. The perception females have about science and technology courses and its effect on them. Reasons why female students are reluctant to enroll in science and technology education will also be presented. In addition, the socio-economic and instructional material factors impeding their participation will also be looked at.

2.1 Background on Gender Bias in Science and Technology Education

Technology education has its roots in manual training, which has been around since the turn of the nineteenth century. According to Woodward (1890) the basis of manual training was to prepare males for the world of work for industry. This shows since the time of manual training, technology education has evolved and gone through many changes with regards to curriculum, facilities, and teaching methods. According to Puck and Welty (2001), the history of technology education has been an endeavor that was taught by males to benefit male students and only in the past few decades has the curricular area welcomed female students.

Despite the change technology education has undergone, the stereotype still exists today that technology education is designed for male students. Technology education has historically been a male dominated subject area that has created a gender bias against female students. For example, Mader (2002) stated:

Young women and girls face widespread sex discrimination in high school vocational and Technical education programs across the country, according to a rep Oli issued by the National Women's Law Center. Females face pervasive sex segregation, sexual harassment in the classroom, discrimination in counseling and recruiting, and other gender-based bias, according to the report, which was heavily based on records of state depaliments of education in 12 states, representing all regions of the country. (p. 1) Due to the gender bias that has been created within technology education, female students are reluctant to enroll in some programs.

In 1995, focus groups were formed and students were asked to express views about high school gender differences (Gloeckner & Knowlton, 1995). The study uncovered the following about females in technology education:

- Technology courses were found outside the core of the building and females felt intimidated by remote locations.
- Students believed technology classes were clearly "guy" classes.
- Females perceived classrooms as being dairy and not feminine.
- Technology courses were “rough” and “tuff”' which drove many students away.

Gloeckner and Knowlton (1995), obviously these perceptions that females have about technology education courses may have an impact on enrollment in courses

offered. Gender bias and equal rights can also play a factor in the perception that females have on technology education courses.

Bowden (2001) stated the following: Whatever real progress has been made during the past 30 years to improve the quality of life for girls and women and the number of career and lifestyle choices available to them, women still make only about 63 cents for every dollar a comparable employed man makes. These same biases and pressures discourage girls from entering vocational and technology fields which we continually tout as well-paying alternatives to college there may be underlying reasons why females have still not been taking technology education courses, and these may contribute to a stereotype that technology education is a study for male students.

2.2 Low Representation of Females in Science, Engineering and Technology Education

Despite the various philosophical and pedagogical changes, the field has undergone in the past century, females continue to be reluctant to enroll in technology education courses. The fact still remains that most technology education programs across the country continue to suffer from low female participation. In recent history there have been studies conducted to Support the fact females are under-represented in technology education. Studies have shown that females are under-represented in most areas of technology education except in some graphic and communication programs.

Gloeckner (1980) (as cited in Gloeckner, 1997) found that in the State of Montana the number of females in technology education was 10%; however, graphic a1ts areas had a 51 % population of female students. Likewise, Flowers (1994) found similar results in Virginia. Over a four-year period from 1990 to 1993, the number of females in high

school technology education programs was about 12%. The communication technology area, however, had between 42% and 48% female students. The findings of these studies were also consistent with other programs across the country. In his graduate thesis, Zum (2005) stated that in 2004, the woodworking technology course at Lampeter-Strasburg High School in Pennsylvania had 4% female students, while the graphic communication course was 50% female students. Similarly, Silvelman and Pritchard (1993) indicated that almost 24% of students in communication technologies were female, while less than 4% in construction were female.

Female students have been underrepresented in technology education courses at Poynette High School as well. Over the past decade, class rosters show that females have comprised only 11 % of the students enrolled in Science, Engineering and Technology education courses. The breakdown of students in particular courses is also consistent the research findings. From 2007 to 2010, about six percent of all students in construction, woods manufacturing, and transposition have been female, while approximately 30% of students in communications have been female.

2.3 Biological Factors of Females in Science, Engineering and Technology Education

Many people believe that the gender gap in STEM fields can be explained by biological differences between men and women. As technology develops, there is growing research on this topic, which has led to varying conclusions. In her book what's science got to do with it, Jo Boaler explores some of the findings from different studies of the brain. First, it should be noted that on average men's brains are larger than women's

(Boaler, 2008). This could lead many to believe that men are thus innately smarter than women. However, men and women on average have the same amount of brain cells, meaning that they are equally intelligent (Boaler, 2008). There is no biological explanation for intelligence variations between the sexes.

Where sex differences in the brain come into play is through how the brain functions. During pregnancy, there is a testosterone rush that kills some of the male fetus's brain cells in the communication centers (Brizendine, 2006). This gives women an edge when it comes to communication, particularly in areas of language and hearing. Furthermore, brain studies have shown that men only use the left side of the brain for language, whereas women access both sides of the brain in a more balanced manner (Boaler, 2008).

In a study with newborns, it was found that girls are more likely than boys to pay attention to a face as opposed to a mobile (Boaler, 2008). Similarly, when looking at emotionally charged images, women's brains were accessing and using nine different sections, but men only used two. All of these different studies lead to the idea that men and women are biologically suited to excel in different areas. For women, this means being more inclined to shine in disciplines about communication and making connections. For many, this would prove that men are naturally better at engineering and science.

However, if this were true, then we would expect to see a trend in gender achievement gaps across countries, which we do not (Guiso, Monte, Sapienza, & Zingales, 2008; Ceci, Williams, & Barnett, 2009). In their study, Guiso et al. (2009) tested 15-year-old students from 40 countries in order to explore culture and gender. The

mathematics tests used were identical and were designed to be free of cultural biases. They found that the size of the gender gap in engineering and science performance varies between countries, and these differences can be explained by the country's measure of gender equality. This measure was calculated using a variety of methods: The World Economic Forum's Gender Gap Index, the World Values Surveys, female economic activity, and the political empowerment index as computed by the World Economic Forum. The study found a correlation between gender equality and the gender gap in natural science and applied science, where an increase in gender equality showed a diminishing gender gap. For example, Turkey was given one of the lowest scores for gender equality, and also found to have one of the largest gender gaps at the expense of women.

Therefore, it is important to examine sociocultural factors and not just biological factors in order to fully understand the underrepresentation of women in STEM fields (Ceci et al., 2009).

2.4 Factors that Influence Girl-Child Education

Randell and Gergel (2009) and Rena (2007) give some of the factors that influence Girl-Child Education as follows:

- Curricula that reinforce traditional gender stereotypes.
- Cost of Primary and Secondary Education.
- Inadequate sanitation facilities and lack of provision of sanitary.
- Cost of basic and secondary education.
- Sexual harassment by male teachers and classmates
- Lack of female teachers as role models

Ocho (2005) adds that in developing countries, despite the decrease in the gender gap, girls still receive less education than boys for reasons such as institutional structure which exhibits biases against girls' school choice and cultural impediments. These factors have been categorized by Odaga & Heneveld (1995) in Figure 2.1. As seen from Figure 2.1, the outcome for girls is absenteeism, high levels of dropout and levels of illiteracy particle.

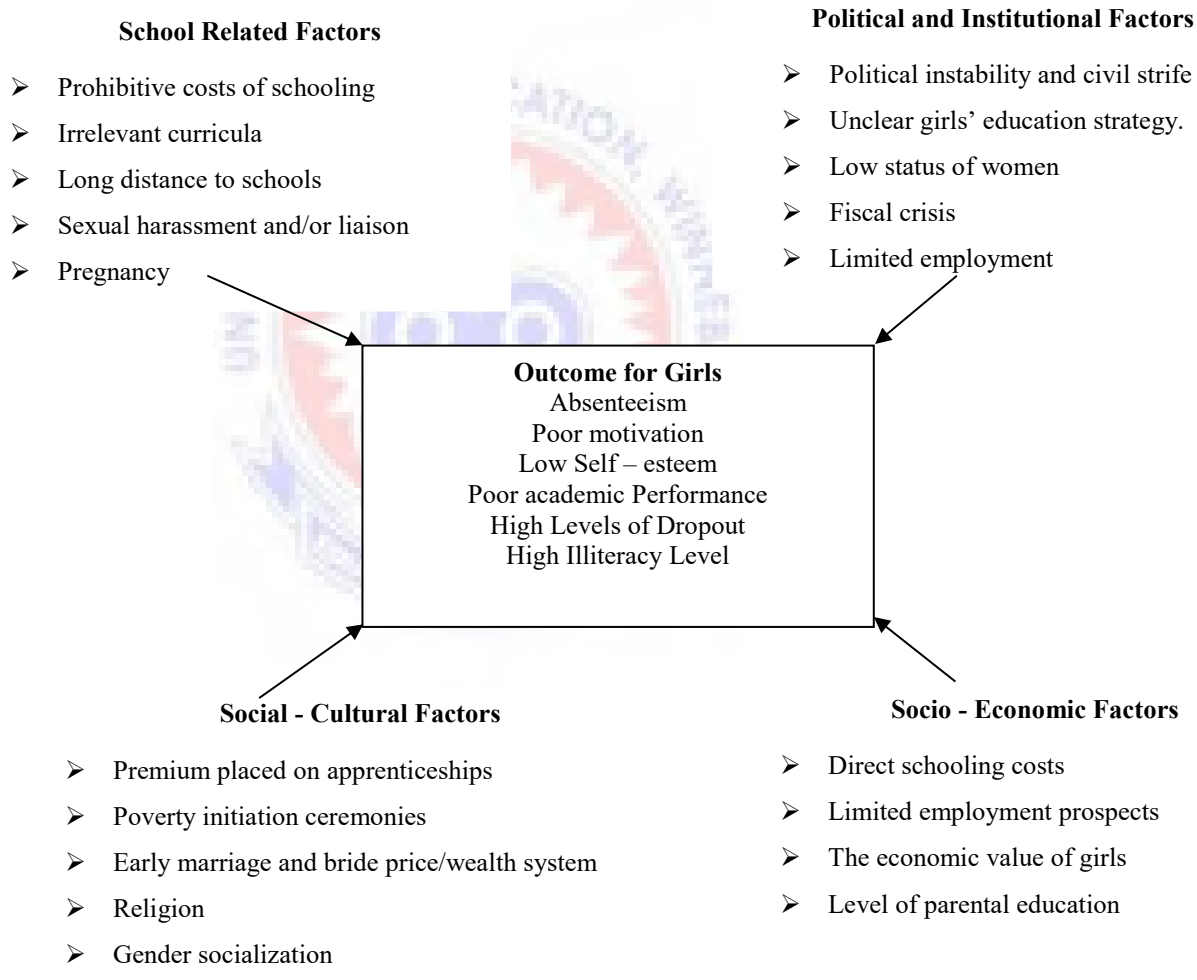

Figure 2.1: Factors that Influence Girls' Child Education

Source: Odaga and Heneveld (1995)

Adetunde and Akensina (2008) cite some of the factors that influence the girl-child education in the Kassena - Nankana District of Upper East Region, Ghana, as poverty, long-held negative attitudes about women's intellectual capabilities, teenage pregnancy, early marriage, examination failure in mathematics and science, and the traditional division of household labour that continues to keep vast numbers of girls out of the classroom.

2.5 Strategies to Improve Girl-Child Education

Bruce's (1997) view, girls' education in Ghana has some strategies which are quantitative (targeting access to and participation in education), and qualitative (focusing on transforming the learning environment and increasing achievement).

They also include improving management efficiency, which could increase retention and completion. Other strategies that can help increase access to education of girls are:

- Use of role models.
- Mobilising parents, communities and the private sector in support of girls' education.
- Supporting guardians or parents to cater for their children or wards schooling.
- Addressing local problems.

The qualitative strategies in girls' education are:

- Making education relevant to the lives of girls.
- Providing incentives to female teachers to teach in remote areas.
- Providing teachers with sensitisation and training.
- Increasing the supply of school infrastructure or teaching and learning materials.

In a speech on the strategies to increase girls' education, Kofi Annan, UN Secretary General mentioned at the World Education Forum in 2000 that No development strategy is better than one that involves women as central players.

2.6 Alternative Education for the Girl Child

According to Dennis and Fentiman (2007), alternative education is the over-arching term that refers to all types of education programmes that are often not considered formal education programmes by agencies, governments and donors. To them, alternative education normally goes on outside the classroom. The authors explain that alternative education programmes are generally designed for children and youth who have missed the opportunity to go to school or who have dropped out of school.

Baxter and Bethke say there are two broad types of alternative education programmes which are those that provide an alternative means of access to education (for example, accelerated learning programmes and home-based or community-based schools) and those that are alternative in curriculum provision. The authors explain the alternative access programmes as those that provide alternative methods of delivery to "fill the gap" of education provision for children who are not enrolled in the formal system due to age, gender, ethnicity or geographical location.

Alternative access programmes generally include the use of a formal curriculum and pedagogy. According to the Baxter and Bethke (2009), case studies in Nepal, Sierra Leone as well as Liberia reveal that the introduction of such programmes often improve quality at the learner level but may not always address quality concerns related to the overall education system.

2.6.1 Equity and Access

Equity and access focus on eliminating sexism and gender differences in science classrooms and call for equal access for males and females to the study and practice of science and engineering. The findings on classroom biases and inequities are quite mixed. For example, studies by Catsambis (1995) on Grade 8 students indicated that girls of all ethnic groups had more negative science experiences than boys but they achieved as well as boys.

Bailey, Scantlebury and Johnson (1999) examined whether boys and girls participated equally well or better in hands-on experiences and they found that equitable interactions (i.e. classroom dynamics where gender issues are considered) were observed. Miller, Blessing and Schwartz (2006) investigated high school students‟ views and perceptions about science classes, science and scientists in USA. Access is not a problematic issue in science education in Mauritius as choice of science subjects at age 14 depends on girls‟ preference for what they would like to study but equity is an area that requires further research. Gender equity in science education is still not well understood by many educators in Mauritius though it is being debated in other areas for example, in politics recently.

2.6.2 Curricular Focus, Pedagogy and Climate in Science and Engineering

Pedagogy and curriculum that incorporate the experiences, interests, learning styles and preconceptions of boys and girls have been termed ‘gender inclusive’ (Harding & Parker, 1995; Rennie, 2002). They pay attention to issues such as sexism and gender bias in the teaching strategies and the curriculum and it has been found to have a positive effect on girls (Rennie, 2003). Harding and Parker (1995) reviewed policy and practice

around gender inclusive science in five countries (Australia, Denmark, England, Sweden, and Wales) and they concluded that progress towards gender inclusivity in science in those countries fluctuated due to changing political and economic circumstances.

Roychoudhury, Tippins and Nichols (1995) explored the application of feminist ideas about women's learning to science teaching and they found that collaborative learning triggered empowerment and confidence among girls. Haussler and Hoffmann (2002) studied the impact of a year-long curricular implementation on girls' interest, self-concept and achievement in physics. They found that curricular changes, teacher training and small single-sex classes, increased interest, achievement and feelings of self-confidence in both boys and girls. Zohar and Bronshtein (2005) examined teachers‟ knowledge and views about gender gaps in physics participation in Israel and their findings showed that teachers did not know about gender inclusive pedagogy.

2.6.3 Attitudes of Girls towards Science and Engineering Education

Young people's interest in choosing science is to a high degree influenced by the topics which influenced them in their preceding years. Gender stereotyping perceptions of selected science courses have also been identified by Farenga and Joyce (1999) who, in their study of course preferences of young students between the ages of 9 to 13 in the USA, reported a strong gender effect where both boys and girls perceived physical science and technology-related courses as appropriate subjects for boys to study and life sciences as appropriate subjects for girls to study. Other additional measures involved improving the ability of teachers to provide girls with an opportunity to improve their self-concept about physics. The situation in Mauritius is unclear on the issue of girls‟ attitudes towards science subjects and needs to be addressed.

2.7 Gender-Friendly Strategies to Retain Girls in Applied Science and Natural Science

Girl-friendly strategies are interventions or actions taken to promote interest and motivate girls to engage in science and engineering by making use of examples as scene-setting devices or as illustrations of phenomena (Whitelegg, 2006). Life examples which are often meaningful to both males and females are used emphasizing social issues, human activity, making use of personal experience, context, practical activities and curriculum and resource materials which have relevance to their everyday lives and which are sex-equitable in students‟ use of language and illustrations and examples (Kahle & Meece, 1994). One example is a US study by Freeman (2002) which showed that active participation involving laboratory and project work increased girls‟ engagement and achievement in learning science and engineering.

In the last twenty years, the development of a growing body of literature has reflected the need for the reconstruction of women to science and the attributes that women bring to science (Manthorpe, 1982; Kelly, 1985; Bentley & Watts, 1986; Harding, 1991; Kenway and Gough, 1998). Gender- friendly strategies consist of the following, though a number of the approaches seem also to engage boys in their science learning:

- Collaborative/cooperative learning/active participation where through classroom discussion and group dynamics, imaginative and creative abilities can be encouraged (Gardner et al., 1989; Harding & Parker, 1995).
- Hands-on experiences and investigations and any challenging visual and tactile or other experiences which develop practical skills.

- ❖ Use of science fairs, exhibitions, lunchtime clubs, visits to museums and interactive science centres.
- ❖ Experiences and examples from the personal lives of females to serve as role models and stimulate girls‟ interest in science and technology.
- ❖ Opportunities for boys and girls to explore opinions on science-related issues and to perceive science as a holistic and socially responsible subject that emphasises dependence and connection among humans, other living things and environment.
- ❖ Use of curriculum materials and resources which have no gender bias orsex stereotyping and are relevant to everyday life.
- ❖ Emphasis on the practical applications of science and technology.
- ❖ Use of appropriate language and teacher talk.
- ❖ Employment of learning styles and assessment tasks which suit both boys and girls.
- ❖ Taking account of variations among boys and among girls.
- ❖ Integration of information from the history of science.
- ❖ Paying attention to student girls with self - awareness of the extent to which their education-related decisions and experiences are socially constructed.

The results when these strategies have been used are far from clear cut because most of the projects, for example Girls into Science and Technology (GIST) that have been implemented then have never been formally evaluated but these strategies have generally been more successful in changing girls' views about science and engineering than in changing their actual behaviour. Data gathered by GIST on the effects of such strategies showed that there was an increase in the number of girls who opted for the

physical sciences in the eight „action schools" involved in the project. Significant improvements were observed where teachers showed a strong commitment and showed willingness to change and bring about innovations and where women were in a position of authority and teachers were more encouraging towards the girls.

2.8 Teachers and Science Education

Most applied science and natural science teachers in Ghana are well qualified, being graduates and having a teaching qualification, and they have an important role to play in preparing young girls and boys to emerge with sufficient knowledge and skills to face the future with confidence and become responsible citizens. As agents of change, they are expected to bring about a progression in students learning through effective science teaching. Pedagogy which takes into account the differences between the sexes is seen to have been successful in many countries, but apart from superficial interventions in Mauritius (Commonwealth Secretariat, 2000-2003; 1993, 1996, 2000, 2003) science and engineering is still being taught to boys and girls in the same way as if one size fits all. In a small intervention study undertaken by Goel et al. (2000) in three government schools in upper east Ghana, low cost materials and examples reflecting the local culture and relevance to everyday life were used to produce gender-friendly resources for science at lower secondary level with the aim of popularising science, biology, chemistry, physics and technical.

Teachers were trained in their respective subject areas in writing materials at workshop sessions held at the Bawku Senior High School (BSHS), Bawku Senior High/Technical School (BSHTS) as well as (BTI) Bawku Technical Institute of

Education. They then tried the materials in the schools where they were teaching. Though the project was not evaluated, feedback received from teachers participating in the project at workshops held at these three schools showed that it generated interest of boys and girls in science. Teachers reported that the gender aspect was not very evident in all topics and they needed more time to get familiar with gender- friendly strategies to teach an already overloaded syllabus.

2.8.1 Teachers' Attitudes Towards Students

School-related parameters such as attitudes of teachers towards boys and girls can be seen to be favourable or unfavourable, that is either positive or negative (Schreiner, 2005; Zohar & Bronshtein, 2005). Researchers have claimed repeatedly that there is differential treatment of boys and girls in science and engineering lessons with teachers interacting more with boys than with girls, and that this has a crucial influence on students' attitudes, motivation and continuing participation and achievement in science and engineering subjects (Labudde, 2000).

In mixed-sex situations, male students have been noted to receive more teacher attention than females (Spender, 1982; Spear (1987), in a classic study, showed that teachers tended to favour boys and awarded higher marks if the piece of work was thought to have been written by a boy. Reiss (2000), in his study about gender effects on the interaction of boys and girls with their teachers in mixed-sex classes, found that the girls‟ participation in scientifically meaningful pupil-teacher utterances gradually declined over the period of the study with the boys increasing their oral exchanges with the teacher and making a greater impression on the teacher by their assertiveness.

In biology, chemistry, physics and engineering, particularly, the nature of the teacher-student relationship is more important for girls than boys (Sharp, 2004; Krogh & Thomsen, 2005). It has been pointed out that although such relationships are important for all students, they are particularly useful in developing the positive self-concept of girls in applied science and natural science (Murphy & Whitelegg, 2006).

Many studies have examined the teacher-student relationship. Kelly (1988), in her meta-analysis of international research on gender differences in teacher-student interactions of the quantifiable data obtained from 81 studies from the UK, Canada, USA, Australia and Sweden, concluded that girls showed willingness to participate in science and engineering lessons but did not receive their fair share of teachers‟ attention in class. Boys had a tendency to call out the answers to questions before being selected by the teacher to answer. Though girls raised their hands, they received less attention and were not able to participate as much as the boys. Other studies focusing on science and engineering lessons have obtained similar findings (Spender, 1982; Tobin, 1988; Delamont, 1990). It is very often reported that boys tend to dominate the class in physics, chemistry and engineering lessons in coeducational settings (Sorensen, 2006). Female students tended to be quieter and less active in class (Fennema et al., 1980; Morse & Handley, 1985). Thus, traditional sex-typing of the classroom environments gives science, engineering and mathematics a male image.

More recently, a small scale study about school-related factors carried out by Robinson and Gillibrand (2004) with thirteen-year-old girls confirmed the arguments put forward by Dawes (1996) that higher set girls' performance was better in single-sex grouping than mixed-grouping and their interest in science greater and engineering. Boys

in the higher set benefited too but their interest and performance in biology were lower than the girls. Previously, Harding (1981) provided evidence that girls do better in science in an all-girls‟ school and an earlier classic large scale study by Dale (1974) had shown that pupils benefited socially from mixed schools and boys performed better in mixed schools than in an all-boys‟ school, a finding which also has been confirmed by McEwen et al. (1987).

2.8.2 Lack of Female Peers and Role Models of Science and Engineering Education

Role models have been suggested to make a difference to girls' interest in science and engineering as women role models may help to engage them in science and engineering by de-stereotyping the objective and value-free image of science (Kelly, 1987; Pettitt et al., 1995). It has been argued that male teachers tend to predominate in the physical sciences and girls could possibly be less attracted to physical sciences due to lack of female teachers acting as role models.

However, Eggleston et al. (1976) have argued that the teaching style in science and engineering is more important than the sex of the teacher. How more women acting as role models could encourage more girls to study the sciences has been explored by Byrne (1993) who argues that a critical mass of women scientists and engineers is a significant factor for girls in science, engineering and technology and one way of achieving this is through affirmative actions' such as recruiting more role models at higher levels of applied natural and natural science. Interestingly, an initiative in the USA by Buck et al. (2002) cautions against this; they contended that pupils retained a

persistent stereotypical image of science and engineering despite efforts made to change this by making use of role models.

Furthermore, it has been argued that maternal interaction and socialisation have a particular influence on girls, indicating that there is a gender similarity of girls with the mothers whereas boys develop autonomy and separation from their mothers (Keller, 1986). Recent studies have pointed out that the gender of the teachers is not important; typically, young people simply prefer teachers who can forge a good relationship with them (Skelton, 2002; Newman, 2000).

2.9 Attitudes of Girls Towards Applied Science and Natural Science

Young people's interest in choosing natural science or applied science is to a high degree influenced by the topics which influenced them in their preceding years. Interest does not only affect career and course choices but also the ability to learn (Dierking et al., 2009). Research has shown that boys are, on average, more interested in science and engineering than girls (Gardner, 1975, 1998; Miller et al., 2006) especially in physics, engineering and technology, whereas girls are more interested in biology than boys while chemistry is typically equally interesting to both sexes. These are findings from various countries (Friedler & Tamir, 1990; Kahle et al., 1993; Woodward & Woodward, 1998; Farenga & Joyce, 1999; Jones, Howe & Rua, 2000; Osborne & Collins, 2001; Hoffmann, 2002; ROSE, 2005; Murphy & Whitelegg, 2006). The international studies (Sjoberg & Schreiner, 2005) conducted in Denmark, England, Finland and Norway and indicated that girls' interests were focused on the body, the mind, health and medicine whereas boys were more interested to learn about dramatic aspects of chemistry, physics, engineering

and technology. It is noteworthy that in the past girls had to adapt themselves to a curriculum where for many years the school was a boy institution, where subjects and school books did not cater for girls.

Furthermore, it has been observed that towards the end of the second year of secondary schooling, there is a significant decline in girls‟ attitudes towards science and engineering relative to boys‟ attitudes (Reiss, 2000, 2004; Reid & Skryabina, 2003; Osborne et al., 2004). Reid and Skryabina noted that factors such as students' enjoyment and liking for the subject influence course choice by students, particularly for the physical sciences.

In Reiss study (2000), many negative comments were expressed about Chemistry as many chemical topics were remote from students‟ concerns and virtually unintelligible. However, Salta & Tzougraki (2004) contended that sex differences in chemistry were less pronounced than often presumed although boys tended to give the subject a higher ranking than the girls. More girls than boys tended to express negative attitudes regarding the difficulty of the chemistry courses as girls had stereotyped beliefs about the courses.

Negative attitudes about science held by girls deter young people from acquiring an interest in the subject (AAUW, 1992; Osborne et al., 2003; Miller et al., 2006). Science and engineering is perceived as being too difficult, remote from the experiences of everyday life and more of a male activity. Studies undertaken by Johnson (1987), Woodward and Woodward (1998), Sjoberg (2000) and Reiss (2003) have demonstrated that boys generally prefer physical science topics while girls are attracted to biological/medical topics because of the humanistic elements present. Girls have

generally outperformed boys in biology and overall there is a trend for boys to outperform girls in physical sciences (GCSE results in UK; School Certificate results, MES Statistics, 2008). The context in which science is taught is important according to the studies mentioned above.

Gender stereotyping perceptions of selected science courses have also been identified by Farenga and Joyce (1999) who, in their study of course preferences of young students between the ages of 9 to 13 in the USA, reported a strong gender effect where both boys and girls perceived physical science and technology-related courses as appropriate subjects for boys to study and life sciences as appropriate subjects for girls to study. Several studies, particularly Hoffman (1985), have showed that interest in physics progressively decreases among boys and girls with an increase in age; however, this is greater in the case of girls. The diminishing interest of girls in physics has been linked to the growing acceptance of their gender role. For example, there are topics which girls find attractive which Hoffmann and Haussler (2002) identify. They state that girls‟ interest in physics could be promoted if topics such as weather, rainbows, and eclipses of the moon, astronomy, optics and presentation of physics in a biological or medical context were integrated into the physics curriculum. Girls would respond better to the physical sciences if scientific knowledge was more closely linked to their direct personal experiences and societal issues rather than to technical apparatus, engines and war materials.

In their intervention study Hoffman and Haussler made use of measures in physics which adapted the curriculum to the interests of girls but which proved advantageous to boys too during a period of a whole year. Other additional measures

involved improving the ability of teachers to provide girls with an opportunity to improve their self-concept about physics. The situation in Bawku is unclear on the issue of girls‟ attitudes towards science and engineering subjects and the needs to be addressed.

2.9.1 Social and Cultural Factors of Girl Child Education in Applied and Natural Science

Gender differences seem principally, or even entirely, to be the result of social factors due to the socialization experiences of males and females and the socially determined assumptions and viewpoints of researchers studying the area. Adolescence marks the point of significant transition for both sexes and it is a particularly difficult time for girls as they move from “young girl” to the “young woman” stage.

The gender specificity of identity development has been further emphasised by Duveen (2000); boys and girls tend to develop different ways of responding to the world and making sense of it. Girls from a very young age take part in activities which are creative such as drawing, reading or talking whereas boys are generally observed to be more constructional and involved in technical tasks (Murphy, 1997, 2002). By taking part in activities which are characteristic of their sex, students develop gendered ways of being in the world (Murphy, 2000).

Societal factors, childhood socialisation, the learning environment in the science classroom and altruistic reasons for choosing science and engineering have also been reported to develop gendered identities in girls (Baker & Leary, 2003). One way of understanding the importance of these socialising effects is through the concept of “cultural capital”. The notion of cultural capital was first articulated by Pierre Bourdieu

and Jean Claude Passeron in 1973, with two other important forms of capital being economic and social capital. Cultural capital concerns form of knowledge, skills, education and advantages that a person has acquired and is passed down the generations and gives him/her a status in society.

Parents provide their children with cultural capital by transmitting to them the knowledge and attitudes needed to succeed in the education system (Bourdieu & Passeron, 1990). Parents play a crucial role in the creation of sex-differentiated values and self-perceptions. Though these effects may not be intentional, parents, perhaps unconsciously, promote gender-specific beliefs and behaviours which discourage their daughters from studying natural science and applied science subjects. Andre et al. (1999), in their study on competency beliefs, positive effect and gender stereotypes of elementary students about science versus other school subjects, showed that parents perceived science as more important for boys than girls and expected boys to do better in science. They suggest that attitudes and beliefs about gender differences in science and engineering tend to start by the earliest elementary school years. The role of parents in the choice of subjects is an area that has not been explored in Bawku and Ghana as large requires further investigation.

Normally girls are treated differently from boys from an early age by their parents; boys are encouraged by parents to be more adventurous and forceful and are more likely to have hobbies and interests dealing with electrical and mechanical devices; they may be asked to help their father doing technical tasks in the house and garden and use tools such as electric drills, saws and hammers. Girls, by contrast, are more likely to be asked to play with soft toys or to help their mother with housework and not to involve

themselves in dangerous activities which could hurt them. Such interests, hobbies and behaviour could be linked to boys' preference for the physical sciences (Murphy, 1986; Whyte, 1986; Dawson, 2000).

Many experiments in Science and Engineering involve equipment and tools which are unfamiliar to girls. Boys, therefore, get a better chance to process scientific knowledge in schools. Family background, such as having a relative who is in the engineering or scientific field, has been found to be another predictor of whether girls choose science or engineering career (Breakwell, 1992; Gogolina & Swartz, 1992; Dalgety & Coll, 2004). These researchers noted that having a mother or a father who strongly supported science and engineering was a predictor for greater involving in scientific activities and development of positive attitudes to natural science and applied science by students.

Nevertheless, it has been found that parental influence for the study of science tends to decline as boys and girls grow up and relationships with teachers and other role models become more important (Johnston & Spelepeng, 2001; Jarvis & Pell, 2002a). However, in the Ghana context, it may be that stereotyped beliefs and perceptions about girls and boys are gradually reducing as girls' experience change as a result of modernisation of the society. Adolescent girls are continually changing and adopting new roles associated with their sex. Home environment and parental influence may be important factor influencing girls‟ choice of subjects in Mauritius given the fact that parents provide strong support to their children's education and their future career.

2.9.2 Factors Affecting Female Access and Participation in Education

The theoretical framework for this research draws on available international and national literature. A synthesis of studies conducted in Ghana, Africa and the world at large has identified a cascade of factors that affect female participation in education. These factors are multi-faceted and interrelated. They are synthesized into socio-economic-cultural practices and conditions, school-environment or school-related conditions, political and institutional policy practices of governments.

2.9.3 Socio-Cultural Practices

In many societies and communities, home-environment practices have been identified as significant influences which affect the education of children. Coombs postulated that cultural values, norms and practices, and attitudes significantly influence the enrolment and participation of children. He observed that these things contribute to sexual disparities in education of a given society (Coombs, 1985). Home-environment factors have a direct relationship with a child's education. Poor parental perceptions about the benefits of education and negative attitudes towards children's education contribute to low familial investment in children's education in developing countries. According to Fraser, parental attitudes exercise greater influence than intelligence in a child's education (Fraser, 1959). According to Clerk studies by a group of ethnographers into the forces behind the success of children in the midst of poverty in Africa indicated that poor children of all family types succeed in their education because their parents inculcate discipline and good study habits into them (Clerk, 1983 cited in Astone and Mclanaham, 1991).

In Buganda parents viewed western formal education with skepticism because educated girls became discontented, immoral and felt reluctant to undertake heavy field labour (that is farming). Despite this, parents invested in their children's education because it offered opportunities for the expression of one's higher social status in the community and helped their sons to obtain lucrative jobs and daughters a higher bride-wealth in marriage (Burns 1964). Khan found similar practices in Nepal. He found that economic conditions have influenced cultural practices in a way that families actively promoted the education of their daughters to increase their chances of marrying a "white collar" husband and poor families concentrated their resources to educate one son through secondary education to obtain a lucrative job (Khan, 1993).

Cultural sanctions on women have also been identified as a major factor which restricts girls' participation in education in societies and communities of Indian, African and Pacific cultures (Commonwealth Secretariat, 1988). Psacharapoulos (1985) indicated that in the Middle East and North Africa, religious and socio-cultural traditions such as early marriage, child bearing and an unwillingness to allow girls to travel long distances have contributed to low participation of women in education in those regions. This pattern of educational provision and attendance is echoed in other regions of the developing world. In Nepal, for example, early marriage and motherhood account for 40 percent of girls who get married before age 15 (UNESCO, 2003a).

Gender differences are seen as a significant influence which negatively affects female participation in education in many communities and societies. The long traditional and conservative belief that a woman's role lies in the kitchen or home has tipped the balance in favour of male children in education in many countries. Lichter's study into

high school drop-outs in some developing countries indicated that while 47 percent of boys indicated that their fathers earnestly desired college education for them only 17 percent of girls reported same. Similarly, 40 percent of boys and 32.5 percent of girls respectively indicated that their mothers wanted college education for them Lichter (1962).

2.9.4 Socio-Economic Practices and Conditions

Certain socio-economic conditions and practices have been implicated for causing the early termination of children's education in some societies in the developing countries. Socio-economic status of families is the foremost factor. This relates to a family's level of educational attainment, occupation and income. Tadoro in his studies on school performance of children in some developing countries identified four determinants of a child's capacity to learn which eventually determine the child's participation in education.

These are family environment (including income and educational level), peer group interaction and the type of children whom an individual associate with, the child's interest, intelligence and ability, and early nutrition and health. He argued that these factors affect the performance of both sexes (Tadoro, 1985, cited in Zewide, 1994, p. 7).

Some studies have indicated that there is a positive relationship between a family's socio-economic status and the education of children. A child's educational attainment would be high if the child's family socio-economic status is high and vice versa "ceterus paribus". According to Kelly there is a strong correlation between parental income and social status and school enrolment of girls than for boys (Kelly, 1984). As the

Robbins' Report (1963) observed despite the astounding academic abilities of children of manual working class and those of the upper middle-class, only 11 percent of children of lower manual working-class compared to 44 percent of upper middle class children went to grammar school. Mac-Gayin's (1996) study into factors which influence educational attainment of children in Cape Coast found that about 94 percent of the subjects with lower than secondary school educational attainment had mothers whose educational attainment was lower than secondary education.

Bishop indicated similar patterns of discrimination in education provision among university students in Pakistan. He indicated that the degree of literacy within a home and the attitude of parents towards education constituted the most significant influences for admissions of students into the university for literate or illiterate parents in Pakistan. He found that at the University of Karachi, children of parents with university education were in greater percentage of about twenty times more compared to children of illiterate parents (Bishop, 1989).

Economic considerations have motivated familial preference for investing in male education rather than female education over the years (Burns, 1964; Khan, 1993). The act of families placing high premium on the economic contributions of girls has been identified as a factor which restricts girls' participation in education. Handa (1996) found that for the academically elite high school, income was the single most influential characteristic affecting enrolment. Poverty has been implicated as a major underlying factor in the decisions of parents and families to invest less in female education. In many families in poor societies and communities, girls are tasked to make contributions in the form of child care, home production, agriculture and trade which are essential for the

survival of family members and the education of siblings. Girls' contributions to their families begin at an early age and this underpins low priority given to female education in those communities. Investment in the education of boys in many poor families is seen, however, as a security for old age (Psacharapoulos, 1985).

In Ghana, the implementation of neo-liberal market measures increased the burden on most women who managed households and this brought in its trail inequalities in the education of school-going children especially girls. The introduction of higher user charges or fees increased educational costs to families in terms of higher school fees payment and these compelled households constrained by limited resources to prefer educating boys to girls (Nikoi, 1998, p. 59; Aryeetey, 2000, p. 235). This phenomenon became increasingly characterized by increased child labour for girls especially those of poor households as their overburdened mothers tasked them to provide help to earn income for the survival of their families (Nikoi, 1998, p.60; Commonwealth Secretariat, 1989, p. 75).

In Sri Lanka, however, female participation in secondary education is reported to be higher than that of males. Girls' enrolment often surpassed that of males. Jayaweera (1991) indicated that gender is not an important influence but rather the type of school girls attended and the socio-economic status of a student were factors responsible for this healthy development. Jayaweera, however, observed that throughout most of the region of Asia, the educational base for women's participation in technological studies and technological work was very limited.

2.9.5 School-Environment or School-Related Conditions

Academic performance of the sexes is a characteristic feature in the whole saga of gender inequality in education provision. Girls are perceived as being academically inferior to boys in many societies and communities in the developing countries.

A study in Mali on academic performance of boys and girls found that almost a third of households surveyed admitted that they differentiated between girls and boys because they thought boys were more intelligent than girls (UNESCO, 2003a). Scholars are divided over the issue of female academic performance. Some scholars argue that the assertion is real and attribute its causes to the socio-economic environment.

Other scholars argue that the assertion is a perceived relationship in developing countries. Duncan's (1989) review of several studies in Africa by Hussen (1977) and Kann (1981) indicated that there was a weak relationship between the socio-economic background of parents and the academic achievement of students in Ugandan and Botswana's schools. Simmon and Alexander (1980) concluded differently. They postulated that home background has important influences on the achievement of pupils and students in primary schools and lower secondary schools in those countries. The role played by girls at home has been implicated as contributing to poor female performance at school. Most girls were tasked to provide domestic services in the form of cooking, care of siblings as training for their future roles as wives and mothers. This tended to affect their attendance and performance at school.

A study which analyzed 'O' level (Grades 11 - 12) examination results in Botswana, Zambia and Kenya showed that girls performed poorer than boys in almost all subjects especially in the Physical Sciences, Biology and Mathematics. The analysis,

however, showed that girls did better in English Literature in all the three countries (Duncan, 1989 cited in Zewide, 1994).

Chinapa (1983), however, found no significant gender differences in achievement levels in the national examination results conducted at the end of primary level in Botswana. In Mauritius girls' performance was found to be better than boys. A similar pattern of female performance was found in the UK. Girls attained higher performance than boys in reading, mathematics, verbal and non-verbal reasoning in school examinations. Some of the reasons adduced as explanations for boys' poor performance included a tendency for boys' disregard for academic work, indulgence in "laddish behaviour and bravado acts and male peer-group pressure. Girls, however, emphasized collaboration and sharing (Arnot and Phipps, 2003). In Chile, in university selection tests girls performed less well than boys as in the US National Assessment of Education Progress testing (UNESCO, 2003a).

Female self-imposed low self-esteem has been identified as a factor which affects female participation in education and especially in science and technology studies in many countries. As a result of girls' poor perception of their academic prowess they tend to shy away from offering subjects such as mathematics and the physical sciences. This has affected female participation in scientific and technical education in most developing countries. Houphouet-Boigny (2000) indicated that in Côte d'Ivoire female students in higher education chose liberal professions so that they can combine a career with family life rather than risk to enter into the study of the sciences. He found that in 2001-2002 female students' preference for specialized education accounted for a lower female

enrolment rate (20 percent) at the Université de Cocody but 33 percent in private technical education. Similar trends are prevalent in other countries.

In Chile, though girls have higher performance than boys at secondary level yet their enrolment in science and technology-related courses is lower than boys. Referring to the participation of the sexes in technical education at secondary level, it was found that from 1995 to 1996 girls achieved 82.2 percent in commercial specialization. However, boys attained 58.5 percent and girls 13.1 percent respectively in industrial specialization (UNESCO, 2003).

2.10 Political and Institutional Policy Practices

Political and institutional policy practices of governments constitute significant factors that affect female participation in education in the developing world. The pervasiveness of the perception that girls are academically inferior to boys provides significant influences in decisions to sideline girls in education, employment and power sharing or governance systems. Women have become subjects of various forms of discrimination which impinge on their steady progression in the society. In some instances, women are subjected to discriminatory and segregative practices on the labour market and performance of schedules. Raj (1982), argues that often a woman's long years of education and training do not constitute significant factors in female employment.

According to him, most women suffer discriminatory acts such as lower grade placement, underpayment for equal work and shorter hiring/employment periods despite possessing equal or better qualifications than their male counterparts (Raj, 1982). The absence of adequate female role models and employment avenues for women underpins

the under representation or marginalization of women in labour issues in developing countries (Raj, 1982). According to Coombs, limited employment opportunities for women affects female occupational aspirations and expectations and this contributes to produce few female role models which eventually impinges on female participation in education (Coombs,1985). Duncan has drawn attention to the negative impact of labour practices against women in the teaching profession in Africa. He observes that 'While women form the majority of the teachers in primary schools in the Western countries, this is not true in many African countries. The proportions decline even further at the secondary and tertiary levels. Less information is available concerning women in administrative positions. Nevertheless, it is clear that in most African countries, few are appointed as principals. Segregating women into lowest states of jobs, school authority and staffing structures reinforce the view that women occupy a subordinate position in the work place' (Duncan, 1989 cited in Zewide, 1994, p. 9).

In Ghana, the provisions of Article 35 of the 1992 Constitution guarantee all persons' equal opportunity to participate in all spheres of national life. Additionally, the government has ratified a convention which calls for an end to all forms of discrimination against women and children (Awumbila, 2001, p.56). On the Labour market, the Industrial Relations Act of 1965 entitles women to equal pay and since 1971 women have been entitled to three months' pay of maternity leave in the country (Aryeetey, 2000, p.338).

Female participation in public life is however restricted due to a number of deep-seated socio-cultural structures, systems and practices such as traditional notions which advocate a preference for the education of male children. According to Oware, female

access to the formal job market in urban areas is quite limited. This is because most women do not possess the required skills and qualifications for entry (Oware G, et al, 1998, cited in UNDP Ghana Human Development Report, 2007, p. 112.

2.11 Educational Pathway for Women in "STEM" Careers

Over the years, the face of education for women has drastically changed. Women have made great strides in this aspect. This change has accomplished an improvement in their status, however; the fight for equal educational opportunities is far from over. Unintentional biases, outdated institutional policies, lack of mentoring and lack of networking are still attributed to the serious underrepresentation to women in STEM fields. Studies have found that women are unfairly treated and face barriers regarding retention and promotion, even in fields in which they have reached relative parity. High education is considered the 'true gatekeeper to technical careers' (Davis, C et al, 1996, p. xii).

Since higher education sets the standards for entrance into the STEM fields as well as provides the breeding ground for future teachers, it only makes sense to focus on the restructuring of higher education's role in advancing women in STEM fields (Davis, et al, 1996). While the most important contributors to the socialization of gender roles are parents, teachers, counselors and peers; (Ambrose et al, 1997) these contributors have the chance to alter perceptions and institutional change.

The National Science Board released an action plan for 2008 to address concerns in the U.S STEM Education System. According to this plan, danger exists that Americans may not know enough about science, engineering, technology, or mathematics to

contribute significantly to, or fully benefit from, the knowledge based economy that is already taking shape around us' (National Science Foundation [NSF], 2007).

The plan further states that 30% of college freshman must take remedial science and engineering courses before being able to take on college – level courses (NSF, 2007). It would seem that not only are women through the cracks as far as retention goes, but that all students entering college are slipping as well. In order to start seeing real change in STEM education, there is an important call for leadership at all government levels (NSF, 2007); perhaps institutional change is really not so far off with dedication from leadership and dedication to making the U.S STEM Education System as diverse and inclusive as possible.

Surprisingly, females who choose to study science and engineering programmes in college and up having much higher dropout rates than excellent SAT scores would predict (Baum, 1990). These are perfect examples for why educators should 'maintain aspirations of women already committed to science, technology and engineering and keep the door open for others to rediscover science and engineering in colleges and universities' (Davis et al, 1996). Between 1966 and 2001, the number of women earning science and engineering degree has increased; 41% of science and engineering graduates and 37% of doctoral degree recipients are women (Byko, 2005). Yet, women hold only 1 out of 6 bachelor's degrees in engineering and only 25% in Computer and Information Science (Fountain 2000).

2.11.1 Job and Organizational Factors of Girl Child

Women continue to encounter numerous hurdles in their path of finding the right career path to suit priorities. A wide majority of articles have raised concerns regarding the availability of opportunities and prospects for women in their respective careers. Today's working women still report significant barriers to career advancement. Women still feel excluded from informal networks in their organizations. Organizations are still charged with bias regarding family responsibilities and work. Compared to men, women still feel like they have to prove themselves again and again in order to prove their worth. In spite of talent and ability to deliver, organizations make little or no effort to make the work environment more favorable to women.

According to the Equity Equation, 'in spite of somewhat reduced academic and research opportunities, scientific and technical occupations still present greater opportunities and rewards for women than more traditional fields' (Davis, et al, 1996). Still women in STEM fields contend in practice with Merton's theory on the sociology of science and engineering where 'the urgency of original discovery creates both great intellectual pressure and a work environment that encourages competition rather than cooperation' (Rayman and Brett, 19993).

Obviously there is a need to break down the institutional stereotypes that still exist about women's desires and needs in the workplace and beyond. In order to attract and retain highly skilled professionals, there has to be an understanding between how men and women perceive their own professional and domestic roles (Beasley, Lomo and Seubert, 2001).

Recently, career development is documented as more rewarding for women in biology than in physical science, engineering and mathematics (Sonnert and Holten, 1996). Women are less likely to enter natural science and applied science occupations because they have less confidence and place less subjective value on these field (Eccles, 1994). Only 4.9% of Ph.D.'s in Physics and Astronomy are given to women (Cole, 1994), while astronomy has much higher representation of women than physics (Ivie and Ray, 2005). Only 5% full time physics professors are women and only 10% of physics faculties are women (Ivie and Ray, 2005).

In addition, women in the field of physics are paid less than man (Ivie and Ray, 2005). Solutions to combat pay inequity include more women with union representation and comparable worth policies (Bodger, 1985). Obviously there is under – representation of women in many sciences. Additionally, there is also a shortage of minority women. Between 1976 and 2003, nearly thirty years, just 35 African – American and 57 Hispanic women earned Ph.D.'s in physics (Ivie and Ray, 2005).

2.11.2 Work – Life Balance

Balancing work with family can be regarded as the biggest challenge women continue to encounter. Women wrestle with thoughts on how to prioritize these two equally important aspects of their lives. Women struggle with the stereotype that having a family translates into a lack of commitment to career and job; further inferring that women who hold their careers at a high priority, make bad mothers (Ambrose et al, 1997).

A significant 'structural issue is the notion that science is unlike other professions in that it involves a special calling and the expectation that scientists will be wedded to

their work, culminates in a career model that takes little account of having a life outside of work. At each stage of scientific training women are thus expected to conform to a traditionally male mode of behavior' (Rayman and Brett 1993).

Motherhood presents a set of expectations; there is a need to balance family and life, which Evetts says requires developing a particular resolution and identity (1994). In order to adapt to the balance of work and life, many women accept part – time work while others prefer flexible scheduling as a condition of full time employment (Beaseleyet et al, 2001). Often, balancing between work and family results in women taking breaks from their employment track which leads to less occupational advancement and opportunities (Rosenfeld, 1978).

Interestingly the perception that married women with children may not publish as much as their single female colleagues are not true (Zuckerman and Cole, 1987). Yet, the most significant differences in pre – doctoral productivity involved the effects of young children because having young children decreased the odds of having a mentor, which in turn decreases productivity (long, 1990).

Key questions to consider include; can there really be a 'balance' between work and family? In order to be a successful scientist, must one be 'wedded' to science and engineering and place in a family life of secondary status?

2.11.3 Work Related Discrimination

Apart from gender discrimination a lot of women have to combat sexual and racial discrimination constantly to survive in college and work places. In order to overcome discrimination, many women scientists report having to work harder and be

more successful than men in order to succeed; professors' report training their female students to think in these terms as well (Etzkowitz and Kemelgor, 1994).

Sexual harassment is a serious concern for women in the sciences. During a 1993 survey, respondents report: 46% were sexually harassed; 55% handled this harassment themselves; 40% told their harasser to stop; 7% were forced to quit working; 3% transferred within the company; 2% filed legal action; 18% experienced a combination of all the situations (Boiarsky et al, 1993).

Bar – Haim and Wikes conducted a quantitative analysis which documents 'that the perspectives of men and women, among potential science and engineering aspirants, differ enough to skew the types of men and women recruited to natural science and applied science in different directions and that these differences have implications for distribution of cognitive types one would expect to find entering each field by sex' (1988). This research indicates that discrimination not only takes place at the workplace, but often beings at the educational level, where women and girls might get 'weeded out' of the sciences and engineers. But regardless of what size the supply of scientists should be, the proportion of women at every level of scientific and technological education and work should be equitable' (Davis, et al, 1996).

Key questions to consider include: Voices of women who have been discriminated have certainly been heard and actions have been taken; however, is there still 'unconscious discrimination' against women in all fields? Did 'affirmative action' change anything? Do models exist within the academy and corporate sectors which prevent discrimination and create a culture of fairness and inclusion?

2.12 Summary

The reviewed literature has revealed that women all over the world and especially in developing countries remain under-represented in all sectors of education. The gender imbalance is particularly strong in the areas of science and engineering oriented disciplines. It has also revealed that the lack of female participation in these disciplines means that many countries currently do not exploit the full potential in their populations. This is because the potentials in the women in these countries are never fully unlocked because of the earlier mentioned barriers thus, only a portion of their potential in these areas is realized.

This, therefore, calls for developing countries to urgently explore ways to promote the participation of women in sciences and engineering. It is in view of this that the current study sought to investigate the factors influencing women's access to and participation in science - oriented VET programmes in Bawku with an aim of giving suggestions for alleviating the problem.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The chapter discusses and covers the procedures and strategies used in the study. Research design, locale, target population, the sample and sampling procedures, data collection, data analysis and presentation are also discussed.

This chapter discusses the process of data acquisition and how the research was planned. It covers the research methodology used, the size of the target population for the study and sampling techniques employed in selecting the participants from whom data for the study were obtained. This gives a vivid explanation of the population and sample sizes, and the data collection instruments and procedures used.

3.1 Research Design

Research work is a systematic way of finding facts and addressing concerns to advance the frontiers of knowledge, which includes studying and trying to discover facts about a situation or challenge. Various design methods are adopted to collect information about the topic including the use of structured and unstructured questionnaires.

The design of this study was a descriptive survey. Descriptive survey research studies are designed to obtain pertinent and precise information concerning the current status of phenomena and whenever possible to draw valid general conclusions from the facts discovered (Lokesh, 1984). Surveys also aim at obtaining information, which can be analysed, patterns extracted and comparison made (Bell, 1993), hence its choice for this study. The methods are non-experimental as they deal with the relationships among non-

manipulated variables. Since the events or conditions have already occurred or exist, the researcher merely selected the relevant variables for analysis of their relationships (Best and Khan, 1993).

3.2 Population Identification

The study was conducted in all the three Secondary and Technical Schools in the Bawku Municipality, which were Bawku Senior High School, Bawku Senior High/Technical School as well as Bawku Technical Institute was chosen because the Municipal had only three out of the six both private and government secondary school in the Bawku Municipality that offered a wide spectrum of Science and Technology-oriented courses. Because of the multicultural nature of the municipal, the three institutes in Bawku municipal offered a diversity of programmes tailored on the job, skill training, focusing on specific labour market conditions, and were well equipped in terms of facilities and manpower with high student enrolments.

Many categories of personnel come to mind when an attempt is made to assess the factors influencing their participation, the population was considered to have a holistic idea of the topic. The following therefore from the population;

- Parent
- Teachers
- Female students

3.3 Sample and Sampling Techniques

The study comprised students, Heads of Departments and Heads of the Institutes/Schools in the three Secondary and Technical Institutes in Bawku Municipality. A sample of 220 female students was selected through simple random sampling methods. The respondents were distributed as follows: 80 respondents from Bawku Technical Institute, 60 from Bawku Senior High/Technical School, and 100 from Bawku Senior High School. The choice of the number of respondents from each school was based on the enrolment of the students. For the purpose of this study, all the population stated above was considered. However, the researcher sampled the population, and these were the two methods used;

- Purposive sampling
- Random sampling

3.3.1 Purposive Sampling

This is a very simple method of sampling where sample is chosen to sit the purpose of the study. Certain elements of the population were purposively selected on the judgment of the researcher and nothing is left to chance. It is geared towards a specific goal. It used on the basis of the particular knowledge of the respondents about the issue understudy.

3.3.2 Random Sampling

This sampling procedure ensures that every possible element of the population has an equal chance of been selected for the study. It is the type, which does not select people based on their skills or background. This method was chosen such that much confidence can be placed on the representatives about issues under study.

3.4 Sampling Procedure

The sample of students was obtained from all the three secondary /technical training institutes by using simple random sampling. A list of the female student names in all the departments from each institute was obtained from the departmental heads with details of age and year of study. A sample of 30% of the total female student population in the three institutes was drawn. The researcher folded papers with numbers and asked those who had picked numbers within the range of the sample size and these are the ones that were asked to participate in the study. According to Kerlinger (1973), a sample drawn at random is unbiased in the sense that no member of the population has any more chance of being selected than the other members are. All the heads of the three institutes and 15 Heads of Departments were used in the study. This was to gain insight into their views as professionals on the factors that influence women's access and participation in science-oriented courses and possible remedies to this problem.

3.5 Research Instruments

Subsequently the study adopted the quantitative and qualitative approaches; a combination of two means of gathering data was involved. In-depth interviews were conducted with the selected samples. This was necessary to avoid restricting responses of samples. The second method of data generation was the use of questionnaires for teachers who have no time for, nor granted oral interviews with researcher. Questions asked revolved around the following factors; emotional, cultural, risk taking, desire for gender equality, remuneration, experience, self- concepts, coping strategies and government policies, as it affects natural science and applied science female performance of the different engineering fields, role of Science and Engineering teachers influence of role models. The following instruments were used to collect data;

3.5.1 Questionnaires

Two sets of questionnaires Appendix A and Appendix B were used. Students' questionnaire sought information on socio-economic background of the students, occupational aspirations, views on women access and participation in technical training and recommendations. Heads of Institutes and Departments questionnaire provided information on their views on what contributes to low enrolment of women in science-oriented courses and possible recommendations to alleviate this situation. The researcher administered the questionnaires personally to ensure high response rate.

3.5.2 Documents Analysis

The researcher analysed institutional records for the last years (between November 2017 and April, 2017) to establish the ratio of women to men, the courses they enroll in, and their academic performance. Among the documents analysed were the Bawku Education Office, the Education Strategic Plan and the Ministry of Education Gender Policy. These are documents that provide policy guidelines in the provision of education and more so, technical and vocational education in Bawku. This was used as a supplementary method of gathering information especially from institutional records for the last six months (between November 2017 and April, 2017), relevant policy documents example, Strategic Plan and the Ministry of Education gender policy.

3.5.3 Focus Group Discussions

A total of three FGDs were conducted, one in each institution and which comprised of 7-10 female students selected from across the offered courses in that institution. This sought information on courses the students enrolled in, their views regarding why the gender differences in the courses they enrolled in, their ways of explaining this gender differences in the course enrolment and how these differences can be addressed.

3.5.4 Scoring the Instrument(s)

The questionnaire for teachers, and teachers had possible responses from which the respondents had to indicate the one they find applicable by ticking (√) in the appropriate space provided. The questionnaires for students were in two forms, where she has to tick. The other part was a structured interview, demanding respondents to give

their own candid view. Some of the female students were also interviewed, based on the topic. They gave fruitful responses to the questions.

3.6 Pilot Study

Piloting was conducted to determine the reliability and validity of the instruments. The piloting also helped in modifying and to remove ambiguous items on the instruments. The drafted instruments were piloted at Bawku Technical Institute. A purposive sample of 30 female students was used in piloting. Bawku Technical Institute was purposively chosen due to its proximity to the technical institute in Bawku and Ghana at large.

3.6.1 Ethical Considerations

In conducting research, it is important that ethic consideration be given due attention in an ethically responsible manner. (Robson, 2002). Bassey (1999) also contends that in any piece of research in the applied and natural sciences ethical considerations are necessary in conducting and reporting the research in respect of democracy, respect for truth and respect for persons. Permission to carry out the research was obtained from the Office of the President as required by law. Permission and introductory letter to the heads of the technical institutes was obtained from the Municipal Technical Training Officer, Bawku. A preliminary visit was made to the one technical institute to inform the heads of the institutes of the intended research. A date to administer the instruments was arranged. The research was conducted in an ethical manner and all participants treated with dignity and outmost respect. All participants

were directly asked for permission to participate in the study. The researcher self-administered the instruments to respondents, a fact that helped achieve a good return ratio. It also gave the respondents a chance to seek clarification on items that proved difficult.

3.7 Validity and Reliability

The questionnaire items were strictly and carefully examined by the supervisor with particular reference to the topic. The questionnaires were scrutinized for the following factors;

- Proper construction of items
- Additional information needed for research topic
- Ambiguity in the items of the questionnaire
- Elimination of items not peculiar with topic
- Rewording of some items

3.8 Data Collection

In writing about such a topic, there was the need to contact other people for the required relevant information to enable the research question be addressed, as this could not be done in a vacuum. There were several methods that could be used for the data collection. For this study, however the methods used to collect the relevant information were questionnaires, interviews and observation. All these methods were used to help obtain the relevant data.

There researcher strongly believes that the combination of these methods were enough to enable him to gather the necessary and relevant information to address the issue at hand. This was because, the combination of these methods enable all the relevant aspects of the topic being tackled.

3.9 Data Analysis and Presentation

The researcher made use of tables and graphs in analyzing the data collected. Each question was analyzed and the number of respondents who gave particular responses was qualified into percentages. The opinion or responses with the highest percentages was considered as the general opinion of people with regard to that point. This study collected data from three main sources, namely FGDs, student questionnaire and secondary data. This were generated both qualitative and quantitative data, hence descriptive statistics were used to analyses the data obtained. Data from FGDs were analysed by way of making inferences from the qualitative expressions and the opinions of the respondents. After the analysis, this data was thematically presented in narrative form and where possible tabular form. Content analysis yielded data in form of trends such as enrolment trends over the years. These were presented in form of tables and percentages. The questionnaires gave rise to quantitative data that were analysed using the statistical package for social sciences (SPSS version 11.5). This analysis mainly involved descriptive statistics which made use of frequencies, totals, percentages, and tabulation. For example, students' enrolments per department per year, year of study, socio-economic background, among others.

CHAPTER FOUR

ANALYSIS, DISCUSSION AND REPRESENTATION OF RESULTS

4.1 Introduction

This chapter deals with the analysis of the information gathered from the questionnaire, items on perception as well as test scores obtained from the respondents as generated by Statistical Package for Social Sciences (SPSS 16.0 version). They are presented in Figures 4.1 to 4.20. The following abbreviations represents these words were used in the tables. (SD, D, A, SA, NS).

4.1.1 Science and Applied Science Education is Only Preserve for Boys

Figure 4.1: Responses from respondents indicating their views on whether Natural Science and Applied Science Education is only preserve for Boys

4.1.2 Parents discourage their female children from undertaking Engineering (Technical) Education

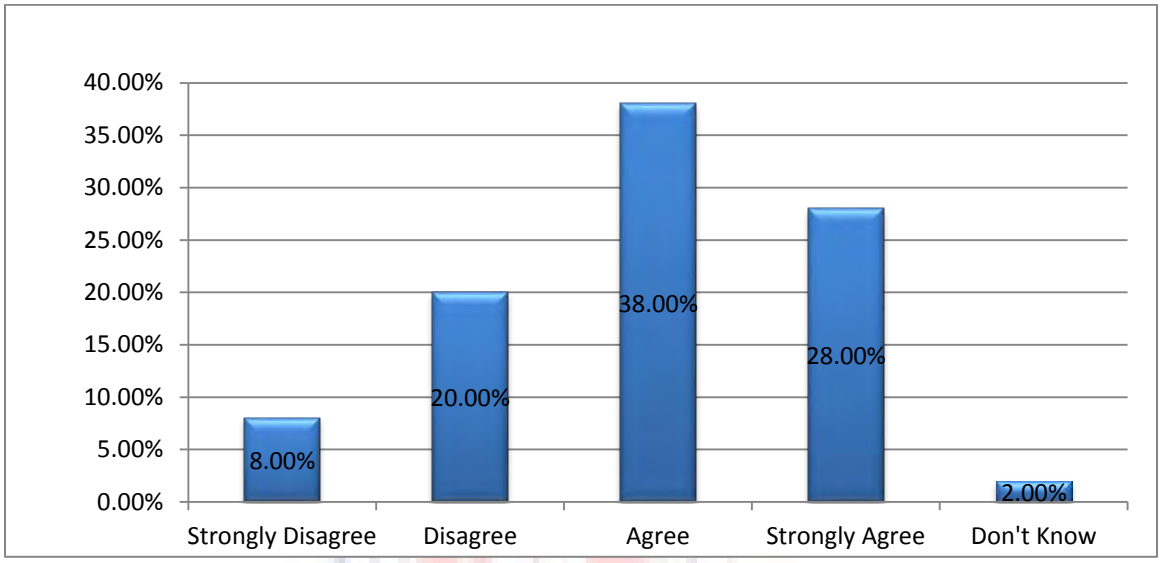

Figure 4.2: Responses from respondents as to whether parents discourage their female children from undertaking Engineering (Technical) Education

4.1.3 Manufacturers prefer employing male students to their female counterparts as a results discourages them taking Engineering (Technical) Education

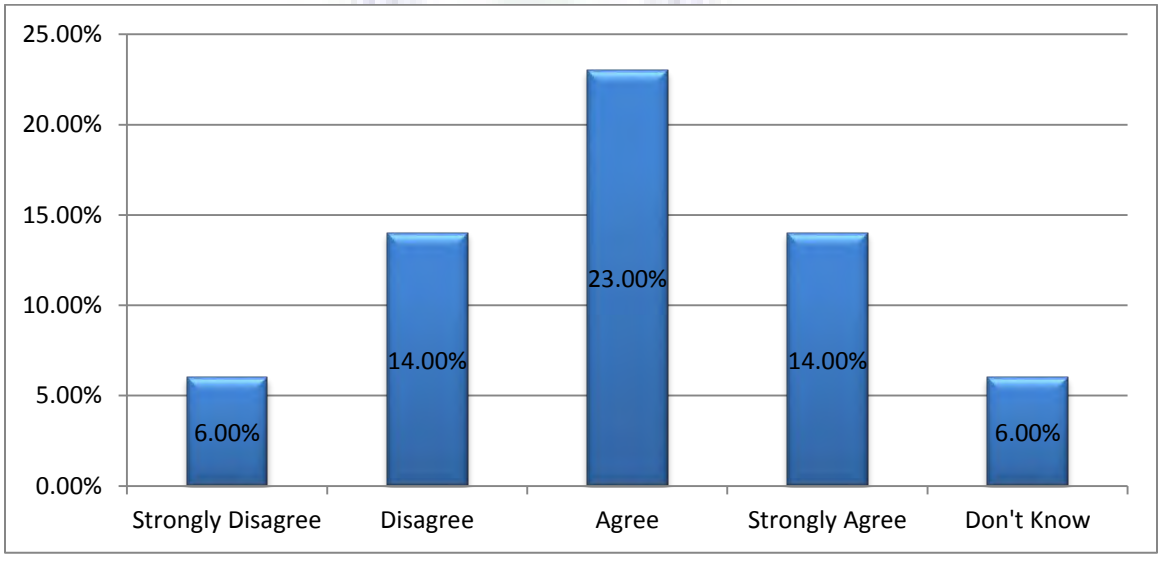

Figure 4.3: Do manufacturers prefer employing male students to their female counterparts? Respondents believe the assertion is true.

4.1.4 Women see themselves as inferior who cannot study engineering related courses

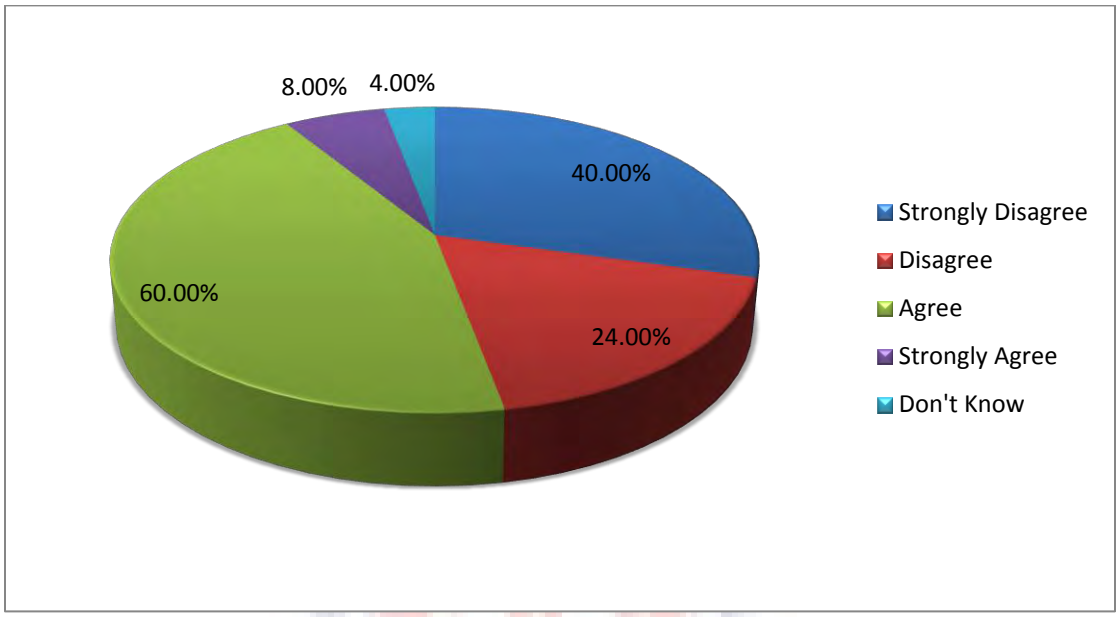

Figure 4.4: This Pie Chart indicates that women see themselves as inferior students who cannot study engineering related courses

4.1.5 Female students under estimate their potentials in technical education

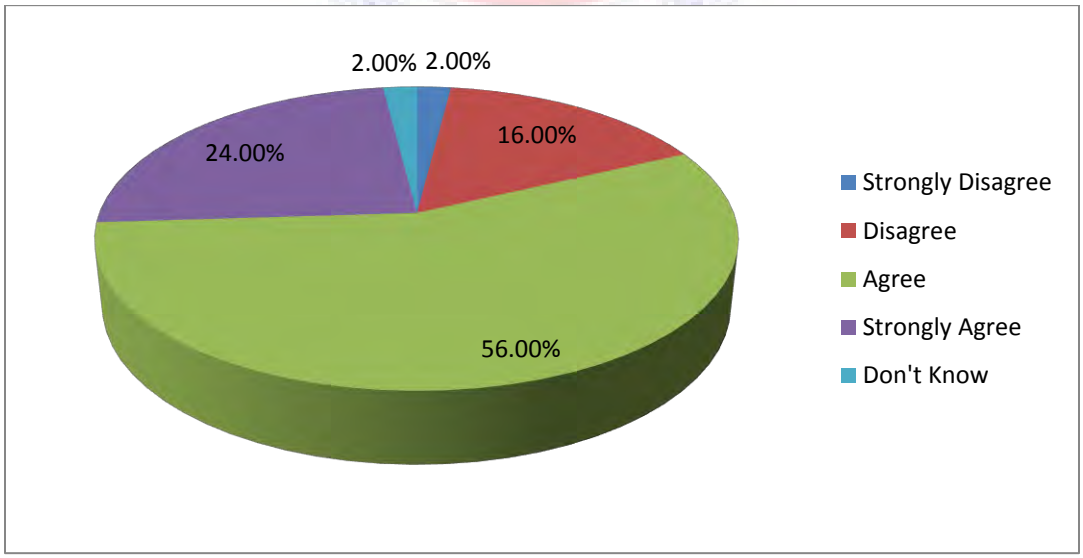

Figure 4.5: This Pie Chart indicates the respondents agree that female students under estimate their potentials in technical education

4.1.6 Girls who are gifted alone can Applied Science (Engineering) and Natural Science

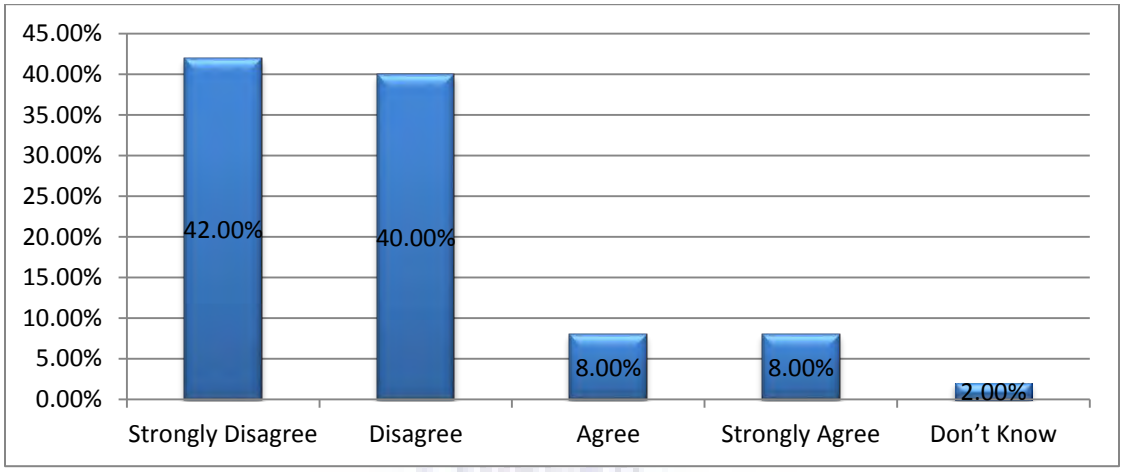

Figure 4.6: Girls who are Gifted alone can Study Applied Science and Natural Science

According to Figure 4.6, respondents disagree that not only gifted girls alone who can study Applied Science (Engineering) and Natural Science

4.1.7 Lack of Female Instructors Discourages female students to offer Applied Science (Engineering) Courses

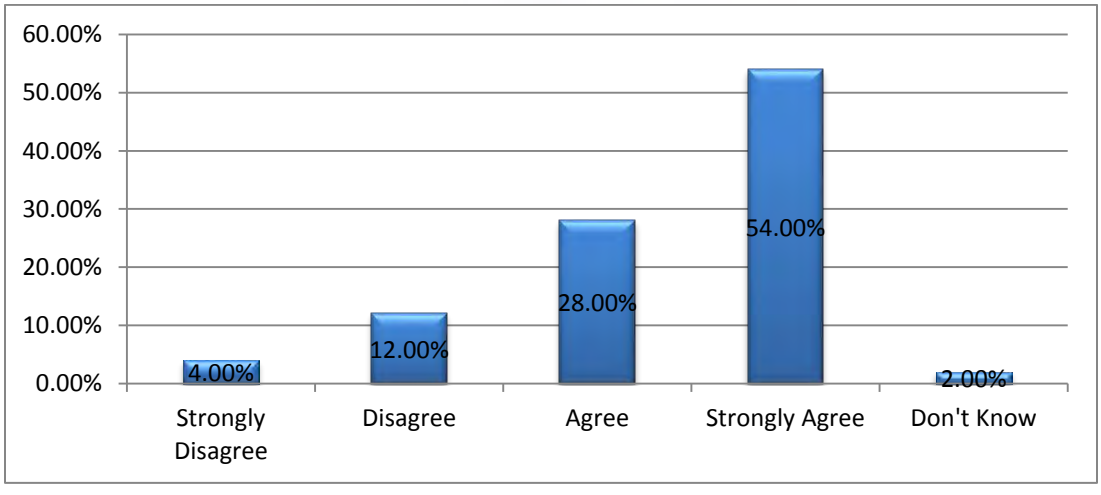

Figure 4.7: Lack of Female Instructors

According to Figure 4.7, it is true that lack of females Technical and Engineering Instructors discourage female students who offers Applied Science (Engineering and Technical) Courses.

4.1.8 Young women are motivated into engineering related programs by their high Science and Engineering ability

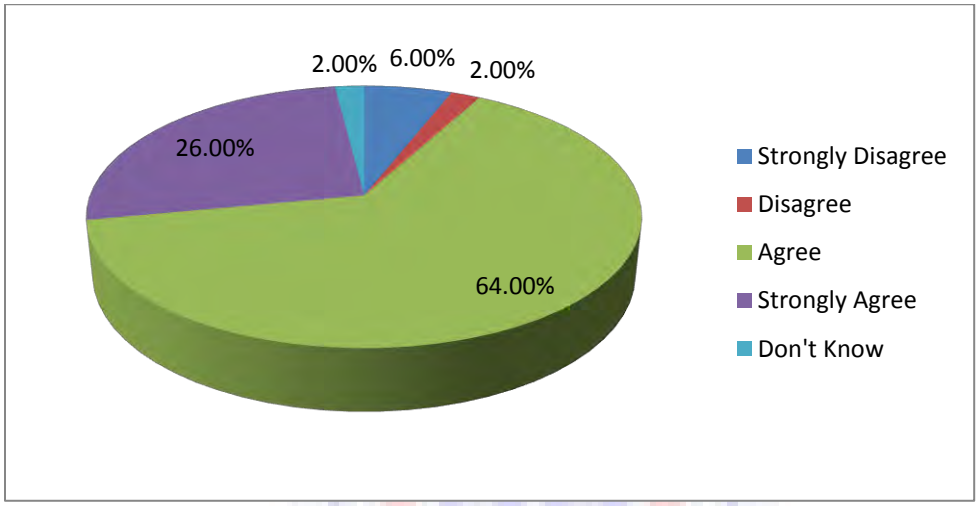

Figure 4.8: This Pie Chart indicates that, Young women are motivated into science and engineering related programs by their high science and engineering abilities

4.1.9 Women are motivated to read engineering related programs by their natural curiosity of applied science and natural science discipline

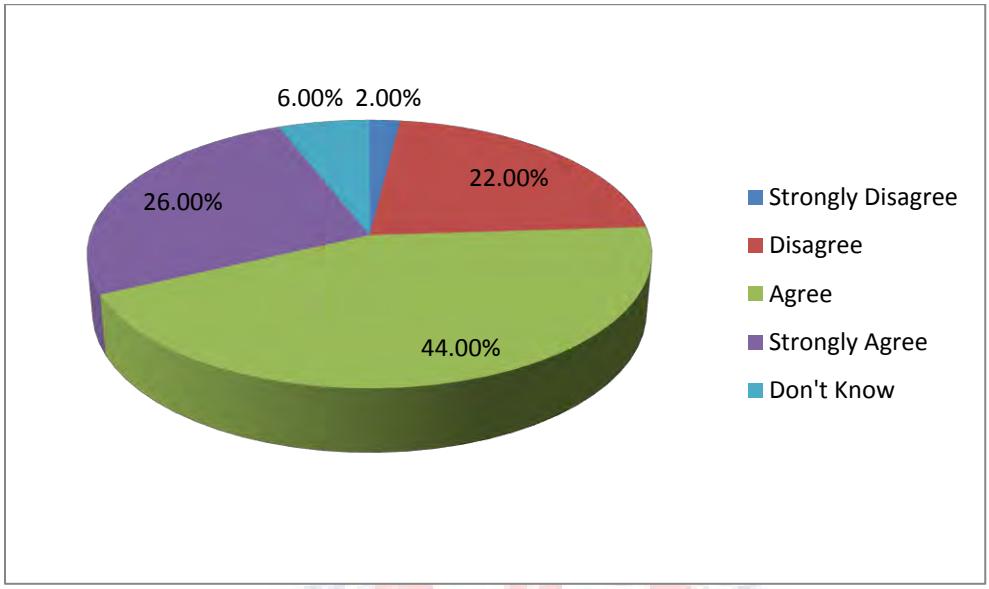

Figure 4.9: Women are Motivated to read Engineering Related Programs by their Natural Curiosity of Applied and Natural Science Discipline

According to Figure 4.9, it indicates that women are motivated to read engineering and science related programs by their natural curiosity of engineering and science discipline.

4.1.10 There is a strong career progression of Women in Applied Science (Engineering) Studies

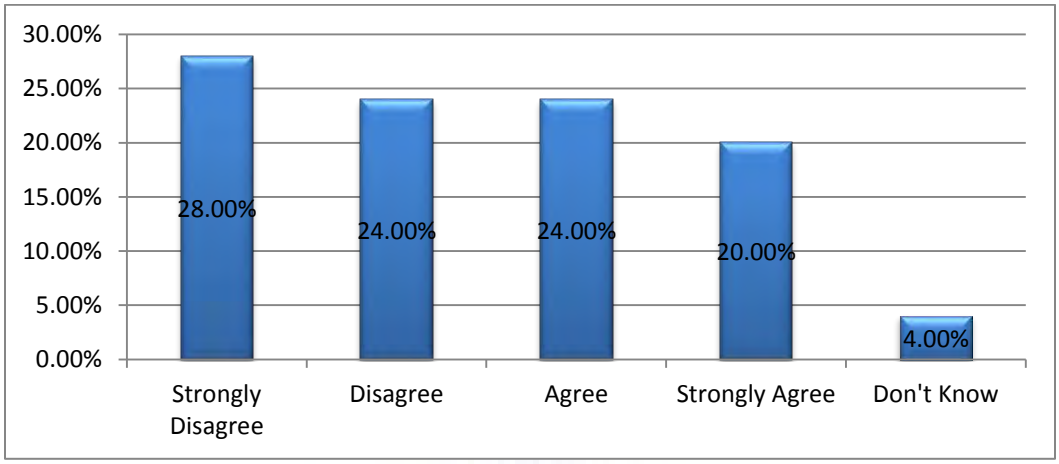

Figure 4.10: There is a strong career Progression of Women in Applied Science (Engineering) Studies

According to Figure 4.10, Respondents disagree that, there is a strong career progression for women in Applied Science (Engineering and Technical) Studies

4.1.11 Women in engineering do not progress in engineering professions

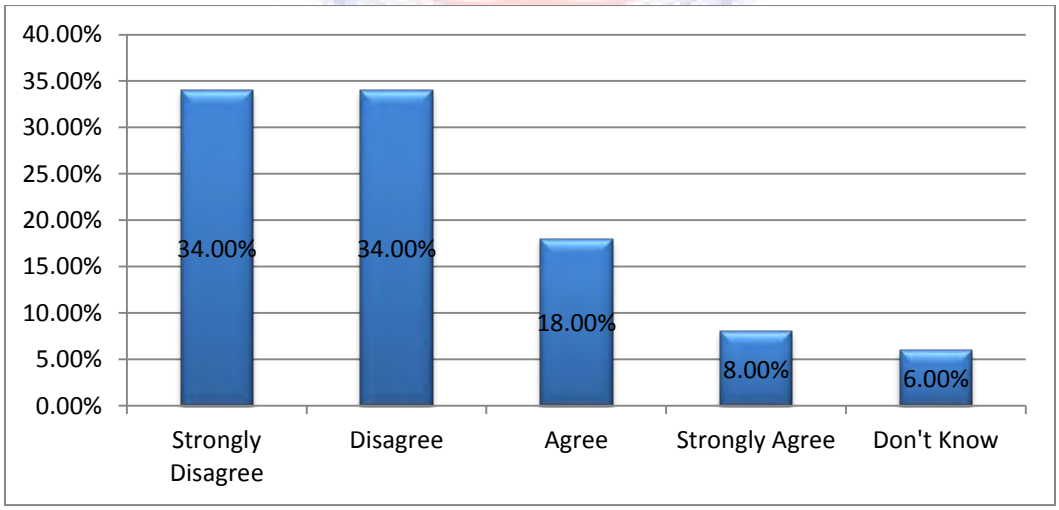

Figure 4.11: Women in Engineering do not Progress in Engineering Professions

With respect to Figure 4.11 and 4.12 Women in engineering do not progress in engineering professions.

4.1.12 Society Mock at Women Who Offer Engineering and Technical Education

Figure 4.12: This Pie Chart above indicates that, 'Yes' respondents believe that the assertion above is true

4.1.13 Female Students are not Skillful to Manipulate Heavy Engineering tools and Equipments

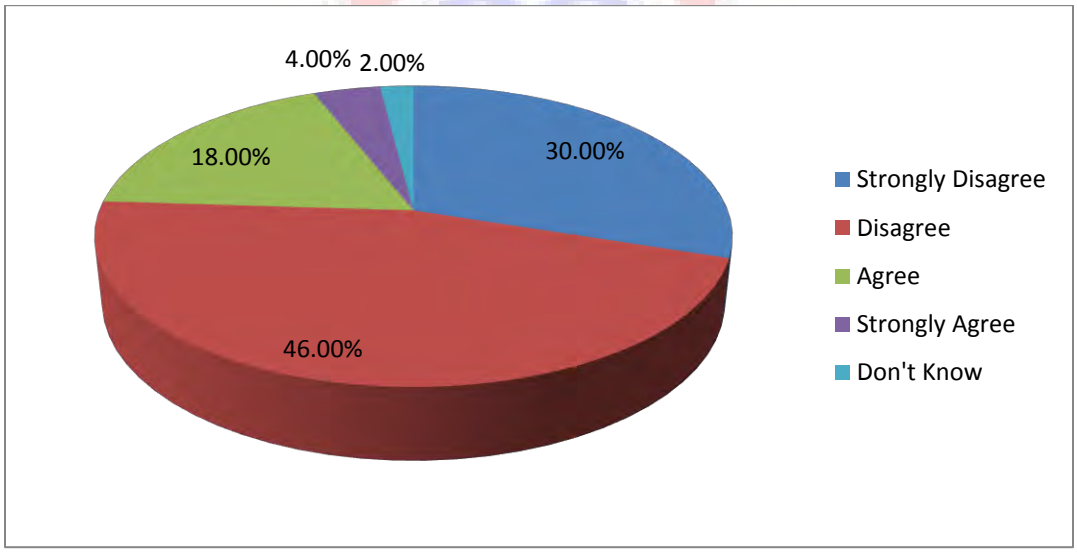

Figure 4.13: Female Students are not skillful to manipulate heavy Engineering Tools and Equipments

According to Figure 4.13, the respondents disagree to the assertion that, female students are not skillful to manipulate heavy engineering tools and equipment.

4.1.14 Young Women do not have Interest in Science Related Courses

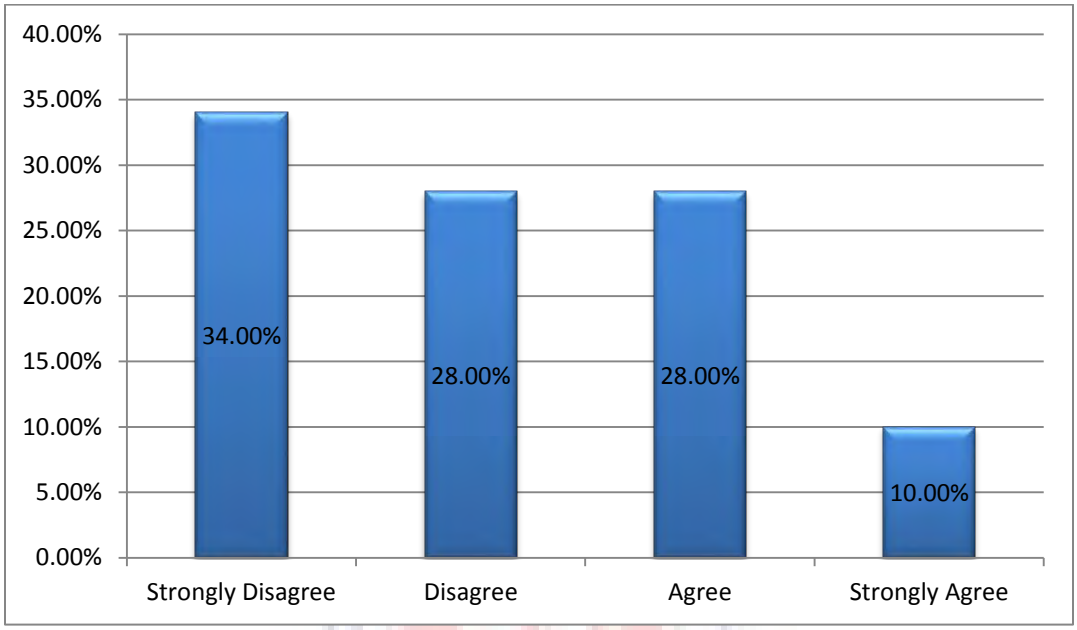

Figure 4.14: Do young women not having interest in science related programs? Respondents believe the statement is not true

4.1.15 Women in Engineering and Technical Field cannot have Children

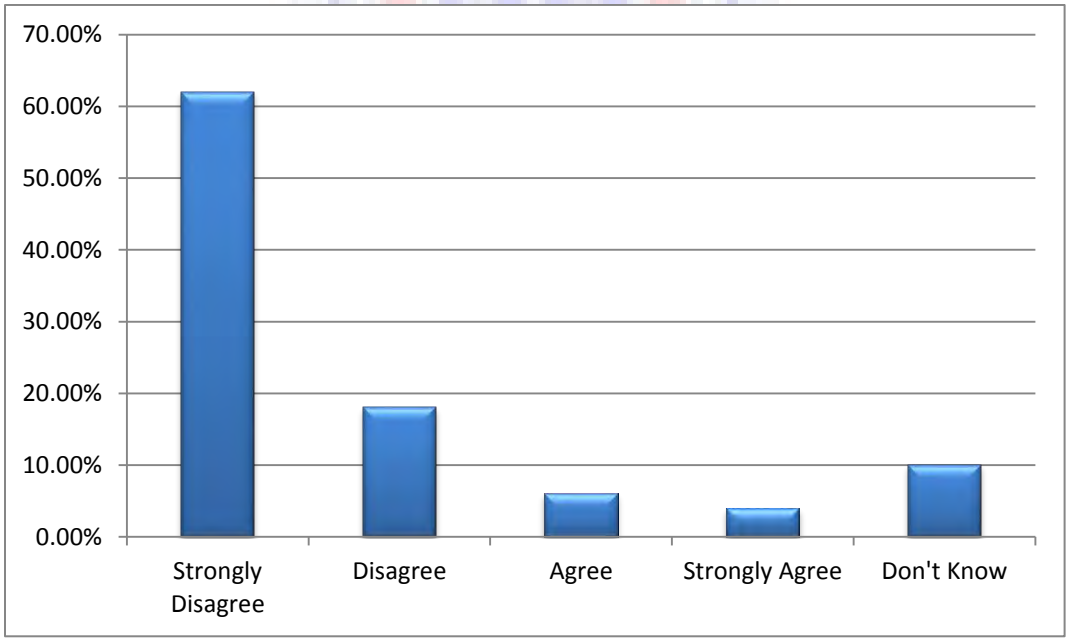

Figure 4.15: Do women in engineering and technical field can't have children? Respondents believe the statement is not true

4.1.16 Women do not have the strength to offer engineering and technical education

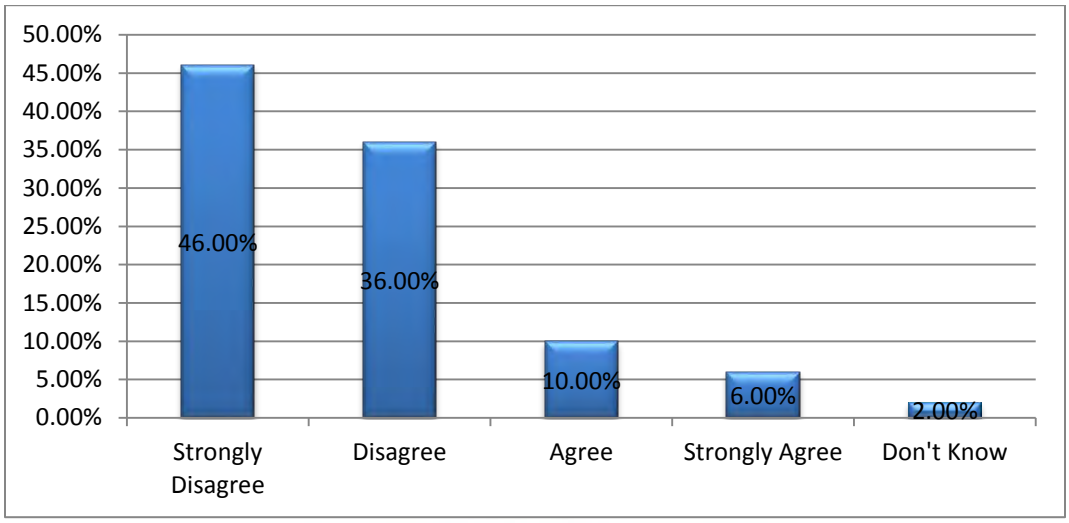

Figure 4.16: Women do not have the strength to offer Engineering and Technical Education

In view of Figure 4.16 above, respondents strongly disagree to the statement that, women do not have the strength to offer engineering and technical education.

4.1.17 Girls are not good in science and engineering related courses

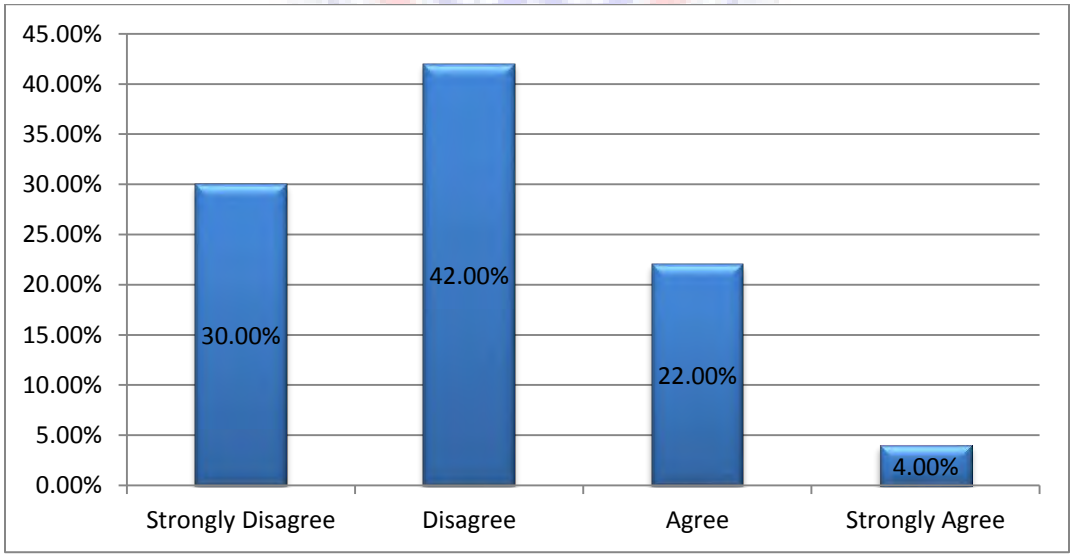

Figure 4.17: Girls are not good Science in Engineering Related Courses

Responses from respondents in respect to the above statement, it is believed that, girls are good in science and engineering related courses.

CHAPTER FIVE

PRESENTATION AND DISCUSSION OF FINDINGS

5.0 Introduction

Most often in the educational research, it is simply not possible for the researcher(s) to undertake true experiments. At best they may be employ something approaching the true experimental design on which they have control over what Campbell and Stanley (1963) refer to as "the who to whom measurement" but luck of control over "the when and to whom exposure" or the randomization of exposure. As we may be aware, the fundamental purpose of experimental design or research is to impose control over conditions that would otherwise cloud the true effect of the independent variable upon the dependent variable to enhance effective teaching and learning.

Clouding conditions that threaten to jeopardize the validity of research or experiments have been identified by Campbell and Stanley (1963), Bracht and Glass (1968). They are of the view that, conditions incidentally that are of greater consequence to the validity of the research more typically in educational research in which random assignment to treat through questionnaire occur and where both treatment and measurement can be more adequately controlled by the researcher.

The following summaries adapted by Campbell and Stanley, Bracht and Glass distinguish between "internally validity" and "externally validity". Internally validity is concern with the question, do the research, in fact, make a difference in the research under inspection. External validity, on the other hand, ask the question, given these demonstrable effects, to what populations or settings can they be generalized. Generally, the items were structured towards obtaining responses to research questions as stated in Chapter One.

5.1 Results of Data

The results were based on the data obtained from questionnaires sent to Parents, Teachers, Female students and Teachers. A tentative statistical data obtained from the field were coded and fed into Statistical Package of Social Science (SPSS16.0 version) programme. The outcomes of the interviews of students were used to buttress point in the findings.

5.2 Background Analysis of Data

As already mentioned, questionnaires, interviews were used to obtain information. A total of 61 items were sent out and a 100% responses were recorded. To ease interpretation, simple percentages were used to enhance understanding of responses.

5.2.1 Research Question One

What is the dropout rate of women in the Applied Science and Natural Science education? The finding to research question one is indicated in tables 5.1, 5.2 and 5.3

Table 5.1: The responses to whether female students drop out from applied science (engineering) education

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Technical education is preserve for boys	52%	32%	6%	8%	2%
Parents discourage their girl children from	(26)	(16)	(3)	(4)	(1)
undertaking technical education	8%	20%	42%	28%	2%
	(4)	(10)	(21)	(14)	(1)

In Table 5.1 the research seeks to find out whether engineering and technical education is the preserve for only boys. The responses indicate that 26 respondents representing 52% strongly disagree to the assertion made, 16 respondents represent 32%, (3) respondents represent 6% agree to the assertion, whilst (4) out of 50 respondents represent 8% strongly agree. Meanwhile only one person did not know anything about the statement.

Again in Table 5.1, the researcher wants to find out whether parent discourage their girl child from undertaking engineering and technical education, 35 respondents representing 62% agree to the statement as against 14 respondents who represent 28% disagree, only (1) respondent representing 2% did not know anything concerning the dropout rate of young women studying applied science (engineering) and natural science education.

Comparing the two statements, respondents are of the view that, though they do not see technical education as a preserve for boys, their parents discourage them from enrolling as engineering students.

Table 5.2: Manufacturers prefer employing male students to their Female counterparts as a result discourages them from taking technical education

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Manufacturers prefer employing male students to their female counterparts as a result discourages them from taking technical education	6% (3)	28% (14)	46% (23)	14% (7)	6% (3)
Women see themselves as inferior students who can study engineering related courses.	4% (2)	24% (12)	60% (30)	8% (4)	4% (2)

In Table 5.2, the researcher wants to find out whether manufacturers prefer employing male students to their female counterparts as women seeing themselves as inferior students who can study engineering related courses. The responds are that 17 out of 50 respondents constitute 34% disagree with 30 respondents who constitute 60% agreeing to the statement, with only (3) respondents taking the remaining 6% having no idea. Furthermore, 34 respondents representing 68% believe that women see themselves as inferior students who can study engineering related courses as against 14 being 28% who dis-believe that the assertion is true. Here another (2) respondents (4%) did not know.

Table 5.3: Responses on the question whether female students underestimate their potentials and also gifted girls alone can study applied science and natural science

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Female student under estimate their potentials in engineering and technical education	2% (1)	16% (8)	56% (28)	24% (12)	2% (1)
Girls who are gifted alone can study technology	42% (21)	40% (20)	8% (4)	8% (4)	2% (1)

Considering Table 5.3, the research question (1), the researcher seeks to find out if female students under estimate their potentials in applied science (engineering) and natural science (Biology, Chemistry, Physics, etc. education.

The story is not different as 40 respondents; representing 80% believe that the assertion is very true, with (9) of the respondents constitute 18% disagree to it. Again (1) of the respondents had no idea. He represents 2% of the total. At the same time,

respondents believe that it is not true that only gifted who study technology. Here 41 respondents constituting 82% with only 8 who agreed and (1) not sure.

5.2.2 Research Question Two

Has there been an increase in the participation rate for the past ten (10) years?

With respect to research question two, the researcher deduced from the interview that girls interest clearly influences their participation rate in Applied Science (Engineering, Technology) and Natural Science (Biology, Chemistry, Physics etc.) classes. While there are few still lagging behind male students in certain STEM sub disciplines like Engineering, Biology, Chemistry, Physics etc. classes than are male students.

Further interviews also reveal that first – year undergraduate women majoring in STEM tend to have high levels of STEM related confidence (often based on good high school performance) but their confidence drops shortly after their entry into higher education. It was also noticed that women feeling, more specifically “isolated, insecure, intimidated’ and ask questions ‘whether they belong’ in the science at all and whether they are good enough to continue.

5.2.3 Research Question Three

What positive steps are being taken by professionals in science and engineering institutes towards ensuring increased participation of women in the field? The findings of research question (3) is indicated in Tables 5.6, 5.7 and 5.8 respectively.

In Table 5.6 the research wants to find out if the adequacy of the female technical and engineering instructor discourages them to offer engineering courses. 42 respondents

out of 50 represents 84% agreed; whilst (7) respondents constitute 14% disagree to it. One respondent did not know anything.

In another vain, the researcher asks the respondents to argue out to find out whether there are no technical bias females in higher positions to serve as role models to inspire the female students. The responses were that (4) represent 8% disagree with 45 respondents represents 90% agree. As usual (1) respondent was not sure. In effect, those two assertions it addressed will encourage more female students to enroll in natural science and applied science departments.

Table 5.4: Responses of question of whether any positive step(s) is being taking by professionals in engineering institutions towards increased participation of women in the field

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Lack of female technical instructors discourage female to offer technical courses.	4% (1)	10% (5)	28% (14)	56% (28)	2% (1)
There are no technical bias females in higher position as a role models to inspire the female students	2% (1)	6% (3)	44% (22)	46% (23)	2% (1)

Items in Table 5.4 seek to find out what can be done to attract female students to engineering. Respondents who said young women should have their engineering classes separately were 19 which denotes 38% and remaining 31 which counts up to 62% disagree to that.

Again, 17 respondents 34% agree, whilst 31 respondents 63.26% disagree with (1) respondent represent 20.4% wasn't sure. It means where the female students are not alone like girls' schools, the women should always have class with their male counterparts.

Table 5.5: Women are motivated to read engineering by their natural curiosity

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Young women should have their engineering classes separately	16% (8)	46% (23)	28% (14)	10% (5)	
Women are always motivated to take natural science and applied science seriously in class	28.6% (14)	34.7% (17)	26.5% (13)	8.2% (4)	2.0% (1)

Considering item one in Table 5.5, the research wants to find out if women are motivated to read engineering by their natural curiosity. 12 of the respondents signifying 24% disagrees but 35 out of 50 respondents which stands for 70% agree to that fact. Only (3) out of 50 respondents which correspond to 6% were not sure of the assertion.

Table 5.6: Respondents which correspond to 6% were not sure of the assertion.

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Women are motivated to read engineering related programs by their natural curiosity of engineering discipline.	2% (8)	22% (23)	44% (14)	26% (5)	6% (3)
Young women are motivated into engineering related programs by their high science ability	6% (2)	2% (1)	64% (32)	26% (13)	2% (1)

In another development where respondents were to share their views on whether young women are motivated into engineering related programs by their high science abilities, (4) persons 8% debunk the notion, but 45 of the 50 respondents indicate that it is through the young women ability that motivate them to read engineering related programs, with (1) person represent a meager 2% was not sure.

5.3 Suggestions of Improve the Participation of Women in Applied Science and Natural Science

The four groups of respondents interviewed, suggested that girls should be encouraged at an early age of life to develop interest in science which they belief are the main recipe for engineering. They advised that women should be encouraged to get rid of the notion that engineering is too difficult and is a preserve for men.

Again women should be encouraged not to attribute their failure to their feminist or luck of ability. They should be encouraged to think positively. Women must be encouraged to know their potentials. In all, they suggested that male engineers must be tolerant and welcome their female counterparts.

In view of the suggestions from the respondents the researcher wants to conclude that more and more girls must be encouraged to study applied science and natural science, join clubs' of these subjects, be made to take executive positions when they are with their male counterparts; and at last but not least, guidance and counseling units should be established in Senior High Schools to explain to female students the options available to the Universities, and emphasize that girls can enter into the traditionally male dominated careers.

5.3.1 Research Question Four (4)

Is there a strong career progression for women in engineering?

Table 5.7: Respondents of advancement of women in engineering

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
There is a strong career progression for women in engineering.	28% (14)	24% (12)	24% (12)	20% (10)	4% (2)
Women in engineering do not progress in engineering	34% (17)	34% (17)	18% (9)	8% (4)	6% (3)

With respect to research question (4) and Table 5.8, the researcher seeks to know whether there is career progression for women in engineering. The first item on the table asking of strong career progression, 26 of the respondents signifying 52% disagree, meaning there is nothing like strong career progression. Also, 22 persons representing 44% responded in affirmative and (2) of the 50 respondents constituting 4% were not sure. Considering item two in the Table, 34 out of 50 which adds up to 68% disagree to that assertion, meaning women in engineering progress, whereas 13 respondents which represents 26% agree to the statement. Because the question was negatively asked, the 26% believe that there is no such progression. Only 6% which represent (3) respondents were not sure.

The items in Table 5.7 is looking out for how does the society see the female engineer. In all 50 persons responded, 24 out of the total number which signify 48% disagree to the fact that society mocks at the female engineer, but 26 respondents, constitute 52% agree to the assertion.

Table 5.8: Students response to the question of how does the society see the female engineer?

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Society mock at women who offer applied science and natural science education	12% (6)	36% (18)	40% (20)	12% (6)	
Female students are not skillful to manipulate heavy mechanical tools and equipment.	30% (15)	46% (23)	18% (9)	4% (2)	2% (1)

In another development the research seeks to find out how skillful the young women are, in the area of manipulating mechanical tools and equipment's'. It was revealed that 38. It was revealed that 38 respondents, representing 76% to the statement, meaning girls after vigorous training are skilled in manipulating tools and equipment's. again 11 persons constituting 22% agree with (1) person who was not sure.

5.3.2 Research Question Five (5)

How will the perception influence their choice of engineering profession or careers?

Table 5.9: Young women's response as how this perception influences their choice of engineering as a profession or career

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Young women do not have interest in science	34% (17)	28% (14)	28% (14)	10% (5)	
Women in applied science (engineering) education cannot have children	52% (31)	18% (9)	6% (3)	4% (2)	10% (5)

Present educational policy in Ghana allows for female enrollment in all programs, including non – traditional women's program like engineering. This gives women equal access to education and training as men. It is in this case that the research seeks to find how this perception influences the young women's choice of engineering. The respondents were asked whether young women do not have interest in science. Thirty-one 31 of the respondents who constitute 62% disagreed to the statement, meaning it is not true that girls do not have interest in science. Nineteen 19 of the respondents who represent 38% believe that the assertion is true.

Furthermore, respondents were asked to consider whether women in technical education cannot have children? Here 40 of the respondents who constitute a greater percentage of 80 debunk that assertion. The remaining ten (10) represent five (5) agree five (5) were not sure.

In Table 5.10, item one addresses the issue of whether women do not have the strength to offer technical education. The responses indicate that 82% of the respondents, which represent 41 out of 50 represents, disagree to the assertion, meaning young women have all the strength to offer technical education.

Table 5.10: Female students' responses on the strength of young women

Statement	Percentage (%) Responses				
	SD	D	A	SA	DN
Women do not have the strength to offer applied science (technical and engineering) education	46% (23)	36% (18)	10% (5)	6% (3)	2% (1)
Girls are very good in engineering related courses.	30% (15)	42% (21)	22% (11)	6% (3)	

5.4 Perception of Male Students

Some male engineering students were asked about their perception of how their female colleagues experienced their courses. Some of their views are summarizes below;

- ❖ Inability for girls to carry out "rugged" assignment which their male counterparts do.
- ❖ Luck of respect from field workers during practical's
- ❖ They are always victims of male lectures.
- ❖ Inability to discuss female issues in class.
- ❖ Inability to discuss academic problems with others out of class.
- ❖ In practical classes, there are occasions were physical exertion is required and female students may want to avoid them especially in the presence of male students.

5.4.1 Perceptions of Teachers on strategies to attract females to the Engineering Profession

Respondents were asked to give suggestions on possible means of attracting more women into engineering. Seminars, symposia, career talks and counseling were recommended. This, as argued, should be geared towards making women realize that engineering does not necessarily involve their being away from their home and family all the time. Others suggested that special attention should be paid to improving performance of women in applied science and natural science. Teaching standards should be improved in order to attract girls to the basic subjects needed to specialize in engineering.

Also suggested were;

- Introduction of catch – them – young programs at both the primary and secondary schools. This would arrest the setting of stereotypes before "minds are set"'
- Female engineers, particularly Association of Professional Women in Nigeria (APWEN) members, must be more visible by serving as role models to female students.
- Proper orientation of people in the society through radio jingles, newspaper highlights, etc. in order to discourage further stereotyping about engineering as a male profession.

5.5. Attitude of Industry and Employers

The National Research Council (New York Times, 1994) reported that women working as scientists and engineers were making little progress in breaking into industry, and that the companies were to blame. As at 1994, women made up 45 percent of the work force, but only 12 percent of the scientists and engineers working in industry. However, the research council committee in 1994 stated in its report that women must contend with sexist attitudes and unequal pay as companies were doing little to help them juggle career and family.

However, some major companies in the US embarked on the following programs among others;

- Sponsorship and mentorship to recruit women.
- Publicized job openings
- Equal salaries

- Developed maternal leave policies
- Frequently held meetings to gather feedback from female scientists.

In terms of wages paid, female engineers had a lot of complaints (Business Week, 1989). As reported, studies show that although men and women begin at comparable levels, women earn 25 percent less than men with similar experience after being out of school for 10 years.

The National Research Council (an arm of the National Academy of Sciences) found that other factors served to discourage women from the field. The report stated that; "The median salary of female scientists with bachelor's degrees and up two years' experience was 73% that of their male colleagues in 1990. $21,00 vs $29,500. Those with doctorates made 88% of the median male salary, $35,500 vs $40,400…" (New York Times, 1994)

The following problems were also highlighted;

- Paternalism to women by older male members of the profession.
- Companies make it difficult for women to learn about job openings because scientific jobs are often filled through "good old boy" networks.
- Unwillingness of corporation to accommodate women with children. They fail to provide quality day care and flexible work schedules.
- Absence of regular re – entry provisions.
- Lack of interest in promoting women's participation through the provision of scholarships, mentorships, publicized job openings, equal salaries, etc.

5.5.1 Wage Gap

Betty Woody (reported in Business Week, 1989; 87) found that female engineers complained that they were often shunted to less desirable assignments because male counterparts resist working with them on teams. This ultimately affected their wage and promotion potentials since "engineering and design teams are proving grounds for technical managers".

Suzanne Jennisches, acting President of the Society of Women Engineers was reported as stating that as time goes on, the disparity in earning between men and women with similar experience grow.

5.5.2 Coping and Survival of Female Engineers

Many found that sexism and lack of advancement were the major problems that they had to cope with. Female engineers said that they circumvented some of the barriers by launching companies of their own. Of those reported by Business Week, some like Balaz started her company after reaching a dead end in the semi – conductor industry. She found that since then, men put her under a different scrutiny and recognized the move as daring. This as reported helped to reduce discrimination put in their way.

Others were determined not to allow prejudice to get them down. Others were of the opinion that choices have to be made. Such choices may mean under achievement professionally if a female engineer decided to have a family. However, as others found it, such choices do not have to impose final limits on a woman's career (Science, 1993: 401). This is because the woman's career can progress as the children grow up.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the summary, recommendations and the final conclusion of the study based on the key findings. Specifically, appropriate recommendations have been made to address the factors that have affected female participation in secondary education as discussed in Chapters Four and Five in a bid to achieve a sustainable level of female participation in Senior High School education. The recommendations made are based on the set objectives outlined in the study.

6.1 Summary

The study has revealed that the number of women studying and practicing engineering in Ghana is very low compared to their demographic percentage and high commercial activities. This situation is due to the lack of counseling in senior high schools, difficulties in understanding science and engineering concepts, criticism and discouragement from people, and a low number of female lecturers, among others.

Both male and female engineering students as well as female practicing engineers and lecturers, support the idea of increasing the female enrolment in Applied Science (Engineering, Technology etc.) and natural science (Biology, Chemistry, Physics etc.) programs in the country. It was revealed that natural curiosity, and science ability and influence from family and non – family members were the major motivating factors for female students and practicing applied Science (Engineering) and Natural Science

(Biology, Chemistry, Physics etc.) programs. A number of suggestions have been made by respondents to motivate more women in Upper East Region and Ghana at large to enter the field of engineering and science related courses.

6.2 Conclusion

Women are highly underrepresented in STEM field professions. Many would credit this to biological differences between men and women, like brain size and functions (Boaler, 2008). However, there is more evidence that societal factors are to blame. Some of these factors include stereotypes, media messages, and the chilly climate of engineering and science fields. Historically, women have been stereotyped as being untalented at mathematics. This unwarranted stereotype still exists, and greatly impacts women's interest and pursuit of engineering and science subjects.

This starts early on in a women's life, as girls are gently pushed and pressured away from careers and interests in STEM fields. These stereotypes are ingrained in society because they are promoted by the media through toys, clothing, news reports, etc. This study has attempted to generate data on institutions that are representative of others in order to reveal the rate of participation of women in science and engineering. The study showed and confirmed the low rate enrolment and graduation of women in science and engineering. It also revealed practices in institutions and in industry that discourage women from staying in science and engineering education. Though societal beliefs and practices seem entrenched, concrete efforts should be made to alleviate the barriers.

It is worthwhile concluding that more girls should be attracted, retained through positive interventions, and encourage to practice the profession at the end of the day through the cooperative effort of all members of society. Examples of developed countries and their universities would have to be followed.

Generally, the society should see it as extremely important to recognize that there is a need for women's participation in engineering. It is then that the stage can be set for positive policy making geared towards full participation of both men and women in all fields of applied science and natural science.

Once women are in the STEM workplace, there are various strategies that could increase female retention, like more family-oriented policies for parents with young children. However, in order to fully reach a level of equality in the workplace, the stigma of being an outsider and the societal stereotypes need to be dismantled. Because female STEM professionals are currently underrepresented, girls have few female role models, which can be very discouraging for them (Marx & Roman, 2002). However, as more women enter these fields, the hope is that this will change. With more women working in STEM fields, there will be more female role models for girls interested in math and science. When girls see someone who is like them and who has overcome stereotypes to be successful in her field, they are less likely to be affected by stereotype threat and they will have higher math achievement (Shapiro & Williams, 2012).

The under representation of women in STEM fields is an important issue, and addressing this problem is critical. Having more women working in STEM fields could greatly benefit technological developments globally and lessen the gender gap in the U.S. There is already a great deal of research surrounding the factors impacting women's

participation, and understanding the issue is the first step in finding a solution. It is complex, and there is not going to be one straightforward answer, but there have been some improvements over the past few decades. The next step is to implement the various strategies outlined previously in order to fully execute a change. If these changes happen, then the future will look optimistic for increased female representation in STEM fields.

6.3 Recommendations

Women have made impressive gains in science and engineering but are still a distinct minority in many Science and Engineering fields. The following six research findings, taken together, suggest that creating environments that support girls' and women's achievements and interest in science and engineering will encourage more girls and women to pursue careers in these vital fields.

- More women engineering lectures and doctors should be invited and attracted to teach Science and Engineering courses in our universities.
- There are still room for promoting a nation-wide campaign towards female scientist and engineers. Such campaign should also be targeted towards disabusing the minds of people labeling science and engineering "masculine".
- The government, through women's professional bodies should launch comprehensive and systematic campaign to enlighten families on the importance of preparing their daughters for the applied science and natural science profession. Such campaigns would reduce the sexiest stereotyping of children at a very young age, and thus create a stable background for positive socialization of females.

- Employers should be encouraged to hire women scientist and engineers and make special provision for their existence in their establishments.
- Guidance and counseling departments should be introduced in each faculty of science and engineering in our universities to take care of problems of female students in particular and students in general.
- Women's universities should be established, this should lay emphasis on the production of female scientist and engineers.

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APPENDICES

APPENDIX A

QUESTIONNAIRE FOR STAFF

Dear Colleagues,

The aim of this research study is to find out about the factors influencing female students' involvement in Science and Engineering Courses in Second Cycle Institutions in the Bawku Municipality. The data to be collected is purely for academic purpose. I would therefore request that you answer honestly. I assure you that the answers you provide will be treated as confidential.

The findings of this study may contribute to the improvement of women's access and retention in Natural Science (Physics, Chemistry, Biology etc.) and Applied Science (Engineering, technology) education.

Thank you in advance for your help and co-operation.

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SECTION ONE: BACKGROUND INFORMATION

Please tick (√) the appropriate choices below.

1. School [ ] Bawku Senior High School
   [ ] Bawku Senior High Technical School
   [ ] Bawku Technical Institute
2. Course: ……
3. Form: [ ] Form One [ ] Form Two [ ] Form Three
4. Age: [ ] Less than 15 years [ ] 15 – 20 [ ] 20 or more

Please indicate your degree of agreement or disagreement with each item using the following scale:

(1) Strongly disagree
(2) Disagree
(3) Agree
(4) Strongly agree
(5) Don't know

(Circle one response for each item)

	Strongly Agree			Strongly Disagree	Not Sure
1. There is a strong career progression for women in engineering	[ ]	[ ]	[ ]	[ ]	[ ]
2. Women in engineering do not progress in engineering	[ ]	[ ]	[ ]	[ ]	[ ]

3. Young women do not have interest in science courses.

   [ ] [ ] [ ] [ ] [ ]

4. Girls were not motivated to the fullest as compared to their male counterparts.

   [ ] [ ] [ ] [ ] [ ]

5. Young women are always motivated to take science related subjects seriously in class.

   [ ] [ ] [ ] [ ] [ ]

6. Young women should have their science class separately.

   [ ] [ ] [ ] [ ] [ ]

7. Lecturers / Teachers teaching physics have a mastery over the subject which motivated me to lead it. [ ] [ ] [ ] [ ] [ ]

8. Women are motivated to read engineering related programs by their natural curiosity of engineering discipline. [ ] [ ] [ ] [ ] [ ]

9. Young women are motivated into engineering related programs by their high science and engineering abilities. [ ] [ ] [ ] [ ] [ ]

10. Young women do engineering due to the support and influence from their parents.

    [ ] [ ] [ ] [ ] [ ]

11. Lack of Female Technical Instructors discourage female students to offer technical courses. [ ] [ ] [ ] [ ] [ ]

12. There are no technical bias females in higher positions as role to inspire the female students. [ ] [ ] [ ] [ ] [ ]

13. Female students under estimate their potentials in technical education.

    [ ] [ ] [ ] [ ] [ ] [ ]

14. Women in technical education cannot have children.

[ ] [ ] [ ] [ ] [ ] [ ]

15. The girl child study technical education when she is motivation when she is motivated.

[ ] [ ] [ ] [ ] [ ] [ ]

16. Women do not have the strength to offer technical education

[ ] [ ] [ ] [ ] [ ] [ ]

17. Teachers concentrate on boys in technical education than girls.

[ ] [ ] [ ] [ ] [ ] [ ]

18. Girls cannot work effectively in engineering than their male counterparts.

[ ] [ ] [ ] [ ] [ ] [ ]

19. Society mock at women who offer technical education.

[ ] [ ] [ ] [ ] [ ] [ ]

20. Female students are not skillful to manipulate heavy mechanical tools and equipment.

[ ] [ ] [ ] [ ] [ ] [ ]

21. Technical education is the preserve for men.

[ ] [ ] [ ] [ ] [ ] [ ]

22. Parents discourage their girl children from undertaking technical education.

[ ] [ ] [ ] [ ] [ ] [ ]

23. Manufactures prefer employing male students to their female counterparts as a results discourages them taking technical education.

[ ] [ ] [ ] [ ] [ ] [ ]

24. Women see themselves as inferior students who can study pure science and applied science related courses.

[ ] [ ] [ ] [ ] [ ] [ ]

25. Girls who are gifted alone can study pure science and applied science related courses.

[ ] [ ] [ ] [ ] [ ] [ ]

26. Girls are not very good in studying pure science and applied science related courses.

[ ] [ ] [ ] [ ] [ ] [ ]

27. Some Government Policies do not permit young women to partake in technical education. [ ] [ ] [ ] [ ] [ ]

[ ]

28. Some behaviors of some teachers deter female students to take to pure science and applied science related courses.

[ ] [ ] [ ] [ ] [ ] [ ]

29. Male students demand for sex as a reward in assisting the female student to undertake her research or task.

[ ] [ ] [ ] [ ] [ ] [ ]

30. Government should sponsor the female science and engineering education to tertiary level. [ ] [ ] [ ] [ ] [ ] [ ]

31. Do you related well to any female who went to University/Polytechnic to pursue and Science and Engineering programme? Yes [ ] No [ ]

32. If yes which programme did she pursue?

Pure Science		**Applied Science**	
[ ]	Physics	[ ]	Architectural Engineering
[ ]	Chemistry	[ ]	Building Engineering
[ ]	Biology	[ ]	Civil Engineering
[ ]	Clothing and Textile	[ ]	Catering and Fashion Design
[ ]	Food and Nutrition	[ ]	Electrical Engineering
[ ]	Elective Mathematics	[ ]	Mechanical Engineering
[ ]	Information Communication Technology		

33. Was she able to complete the programme? Yes [ ] No [ ]

34. Do you personally encourage female students to take to science and engineering related courses or programmes? Yes [ ] No [ ]

35. . Is female education important in the development of this country? Yes [ ] No [ ]

If "yes" why is it important? …….

……....

APPENDIX B

QUESTIONNAIRE FOR STUDENTS

I am studying for a Master's Degree in Mechanical Engineering Technology at the University of Education, Winneba Kumasi Campus. As a condition for the award of my degree, I am to conduct a research in an academic discipline.

My research topic: **Factors Influencing Low Female Students Involvement in Science, Technology and Engineering Courses in Second Cycle Institutions in the Bawku Municipality.**

I have decided to use Questionnaires to help me solicit for information from the general public to help me complete this research. Your contribution to this work will be highly appreciated and your identity will be kept exclusively to the researcher.

Thank you.

[Please answer all the questions by either ticking the appropriate box and some few written questions].

Personal Profile Section

GENDER: Male [ ] Female [ ]

AGE: 20 – 25 [ ] 26 – 30 [ ] 31 – 35 [ ]

36 – 40 [ ] 41 – 50 [ ] 50 AND OVER [ ]

Section Two: General Perceptions

1. How will you describe your current status on Science and Engineering related training programmes? (Check only one)

   Completed [ ] Continuing [ ] Drop out [ ]

2. What was/is your current or former Tertiary Institution?

   University [ ] Polytechnic [ ] Training College [ ]

3. Did you specifically apply for Science and Engineering related programme at your Tertiary Institution? Yes [ ] No [ ] Non [ ]

4. If any, what was the problem encountered when lectures started on your pure science and applied science related programme of study?

   (Tick applicable ones)

   [ ] Lack of books [ ] Lack of funds

   [ ] Lack of encouragement from friends [ ] Sexual harassment from course mates

   [ ] Lack of encouragement from parents [ ] Sexual harassment from lectures

   [ ] Lack of encouragement from lecturers [ ] None of the above

   Others i. ……

   ii. ……

   iii. ……

   iv. ……

5. Did any of the problem(s) encountered in step 4 discourage you to stop or drop out from the programme of study? Yes [ ] No [ ] Non [ ]

6. What is/was your highest level of attainment on your programme of study graduated.

   1st Year [ ] 2nd Year [ ] 3rd Year [ ] 4th Year [ ]

The next items refer to how you feel as a young woman in natural science and applied science (engineering) education. Please indicate your degree of agreement or disagreement with each item using the following scale:

Strongly Agree Strongly Disagree Agree Disagree Not Sure

7. My questions were unanswered at Lectures

   [ ] [ ] [ ] [ ] [ ]

8. I don't have problem with progression path in science and engineering

   [ ] [ ] [ ] [ ] [ ]

9. I know that male science and engineering graduated earn more than female counterpart.

   [ ] [ ] [ ] [ ] [ ]

10. I got to know when on an attachment that science and engineering related duties are difficult to perform as duties in career.

    [ ] [ ] [ ] [ ] [ ]

11. I don't think I will encourage other female colleagues to take to Engineering related careers. [ ] [ ] [ ] [ ] [ ]

12. Would you say Science related courses scared you whilst in school?

    Yes [ ] No [ ] Indifferent [ ]

13. In your opinion, do you see the study of Science and Engineering courses are only for boys? Please explain your choice of answer further.

    ……

    ……

    ……

14. In your opinion, would you rate natural science and applied science courses difficult?

    Yes [ ] No [ ] Non [ ]

15. If yes or no to question 14, kindly explain your choice?

    ……

    ……

    ……

    ……

16. How many of your friends are/were science or engineering students?

    ……

    Would you agree to the perception that studying science and engineering causes is/was very difficult? Yes [ ] No [ ]

17. Please explain your choice in question 17.

    ……

    ……

    ……..

18. What subject groupings was your favorite choice whilst in Senior High/Technical School? Business [ ] Arts [ ] Science [ ] Engineering [ ]

19. Would you say your choice was a matter of external influences?

    Yes [ ] No [ ]

20. Do you fancy the use of mobile phones? Yes [ ] No [ ]

21. If yes to question 21, what do you use it for?

    Chatting [ ] Communication [ ] Jokes/Games [ ] Studying [ ]

22. If no to question 21, why don't you use the internet?

    Personal dislike [ ] Cost of purchase [ ] Charges at the café [ ]

    Lack of interest [ ]

23. Kindly explain your choice of answer to question 21.

    ……

    ……..

24. How would you rate your use of mobile phones in the sequence of 1, 2, 3, and 5.

    Business purposes [ ] Communication [ ]

    Sharing information [ ] As a decorative gadget [ ]

25. In addition to the use of mobile phones, do you see the internet?

    Yes [ ] No [ ] Non [ ]

26. If yes to question 26, what do you use it for?

    Chatting [ ] Communication [ ] Jokes/Games [ ] Studying [ ]

27. Would you recommend the use of the internet to a colleague?

    Yes [ ] No [ ] Non [ ]

28. If yes or no to question 28, kindly explain your choice.

    ……

    ……

29. In addition to the use of mobile phones, do you use the Internet?

    Yes [ ] No [ ] Non [ ]

Thank you for your time, energy and effort in assisting to complete this questionnaire.