UNIVERSITY OF EDUCATION, WINNEBA

FEMALE LECTURERS ENGAGED IN STEM DISCIPLINES IN SELECTED GHANAIAN UNIVERSITIES: STATUS, STATURE AND CHALLENGES

MARY WEJAAMO AYERIGA

DOCTOR OF PHILOSOPHY

2023

UNIVERSITY OF EDUCATION, WINNEBA

FEMALE LECTURERS ENGAGED IN STEM DISCIPLINES IN SELECTED GHANAIAN UNIVERSITIES: STATUS, STATURE AND CHALLENGES

MARY WEJAAMO AYERIGA

(202122595)

A thesis in the Department of Science Education, Faculty of Science Education, submitted to the School of Graduate Studies, in partial fulfilment of the requirements for the award of the Doctor of Philosophy (Science Education) in the University of Education, Winneba

DECEMBER, 2023

DECLARATION

Student's Declaration

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

Signature: ………………………………

Date: ……………………………………

Supervisors' Declaration

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

Principal Supervisor: **Prof. John K. Eminah**

Signature: ………………………………

Date: ……………………………………

Co-Supervisor: **Dr. Ernest I. D. Ngman-Wara**

Signature: ………………………………

Date: ……………………………………

DEDICATION

I dedicate this dissertation to my daughter; Mellisa Wesoamo Ayebatiina and my late brother; Mr. Jacob A. Ayeriga, I will forever remain indebted to you and all my late closed relatives.

ACKNOWLEDGEMENTS

My profound gratitude goes to the Almighty God for the gift of life and grace granted me for a successful completion of this study. I would like to also express my sincere gratitude to my supervisors, Prof. John K. Eminah and Dr. Ernest I. D. Ngman-Wara both at the Faculty of Science Education, Winneba, for their professional guidance, advice, encouragement and the goodwill with which they guided this work. I am very grateful.

I am also grateful to Prof. Apusigah Agnes, Prof. Luguthera Albert and Prof. Wilmont M. Eric. Prof. Abubakari Moses, Prof. Bonna Christopher, Dr. Kissi-Abrokwash Bernard, Mr. Maama Markwei, Mr. Jacob Adams, Mrs. Grace Bawa and Miss Mary-Immaculate Anate for their generous support and contributions to make this work better.

I also wish to express my appreciation to all staff of the SoSMTE of CKT-UTAS especially Dr. Thomas Tindan, Mr. Francis-Xavier Adams, Dr. Philip Dorsah, Mr. Fatao Abudu, Mohammed Hafis and Ms Amanda Vuurdie for their unflinching support throughout my studies. My gratitude also goes to the Dean, post graduate Coordinator, and all senior members of the Faculty of Science Education, UEW and colleague doctoral students.

Finally, I would like to show my profound appreciation to my dearest daughter for enduring my frequent absence, care and to Mr. Jacob A. Ayeriga, John B. Ayeriga, and Celestina for their diverse support throughout my academic lather.

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

AAMUSTED	Akenten Appiah-Menka University of Skills Tranining and Entrenerual Development
CKT-UTAS	C. K Tedam University of Technology and Applied sciences
CS	Computer Science
KNUST	Kwame Nkrumah University of Science and Technology
S&T	Science and Technology
SoSMTE	School of Science, Mathematics and Technology Education
SPSS	Statistical tool for social sciences
STEM	Science Technology Engineering Mathematics
UCC	University of Cape Coast
UDS	University for Development Studies
UG	University of Ghana
UMaT	University of Mines and Technology
WiSTEM	Women in Science Technology Engineering

ABSTRACT

The purpose of this study was to explore the status, stature and challenges of female lecturers in STEM disciplines in Ghanaian universities. The study was underpinned by the pragmatic philosophical paradigm. The study employed the descriptive survey design with the concurrent triangulation mixed method approach to collect data. The sample size for the study was 84 respondents. In the quantitative phase, a questionnaire was administered to (female lecturers sample in STEM disciplines) while the qualitative involved semi-structured interviews for the female lecturers in public universities. Data were collected in two phases using a five-point Likert-type scale questionnaire and a semi-structured interview guide. The descriptive function of the SPSS version was used to organize the quantitative data into frequency counts, percentages, mean scores and standard deviations. The reliability coefficient obtained using Cronbach alpha formula was 0.81. It emerged from the study that female lecturers' engagement enhanced effective STEM disciplines teaching and a significant number of female lecturers in STEM disciplines were not of higher professional ranks. Findings also revealed that there were gender discriminations at workplace which promotes biasedness in appointments with traditional perceptions that a woman's place is not the hard sciences, sexism and stereotyping of women's roles as well. Findings revealed the lack of regular conferences for the female lecturers engaged in STEM disciplines and absence of award schemes in various universities for outstanding females in STEM disciplines. It also showed that female lecturers who are engaged in STEM disciplines do not support and mentor younger colleagues' professional growth. Findings revealed that there were only few universities offering institutional support systems towards the female lecturers' academic and professional growth in STEM disciplines in Ghanaian public universities. Finally, the findings revealed that the self-efficacy beliefs of the female lecturers in STEM disciplines has impacted positively in their academic engagements particularly in the exhibition of competencies and skills to achieve academic success in STEM disciplines in Ghanaian universities. In conclusion, it is indicated that female lectures engaged in STEM disciplines play significant roles in teaching-learning processes however, majority of them were not of high professional ranks. There has been the lack of support among colleague female lecturers in STEM disciplines as well as gender discriminations at work place and female lecturers' self-efficacy beliefs encourages them to aspire for higher academic excellence. It was recommended among others that special incentives should be set aside in Ghanaian universities for females in STEM disciplines. Management of universities should tackle institutional and technical challenges through the provision of technological tools for effective instructional processes of STEM disciplines in universities. Universities should support female lectures in STEM disciplines through scholarships and fellowships programs and finally, government of Ghana through GTEC should make deliberate efforts and establish policies on enhancing gender balance and representation of females in universities in STEM disciplines.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background to the study with the purpose which explored female Lecturers' Status, Stature and Challenges in STEM disciplines in Ghanaian universities. The statement of the problem looked at the low number of female lecturers of high academic qualification engaged in the study of STEM disciplines in public universities of Ghana with six objectives and corresponding research questions stated. Finally, the constitution of the various chapters has been considered in the organization of the study.

1.1 Background to the Study

The importance of education cannot be overemphasized. Education lays the foundation for the development of the human resource of every nation. It is worth remembering that "a sound education structure leads to an enlightened society and manpower development, and economic progress" (Asare, 2011. p. 73). Education is a key component of strategies to improve individual well-being and the economic and social development of societies (Kwaramba & Mukanjari, 2013). The importance of education in development has been emphasized by a number of international conventions and treaties, like the Universal Declaration of Human Rights (1948), the Programme of Action of the 1994 International Conference on Population and Development, and the Fourth World Conference on Women held in Beijing (1995) among others. In these international and regional legal instruments and programmes, the right to education was recognized. Yet the universal right to education is a double-edged sword. The worldwide expansion of primary and secondary education over the past four decades has fueled an ever-growing demand for higher (tertiary) education. In many parts of the world, institutions of higher education have not kept pace with increasing demand. In sub-Saharan Africa, the need for higher education, particularly in science and technology (S&T), is acute.

In 1993, the Association of African Universities, acknowledged that the time was ripe to effectively discuss the issue of gender equity. The association commissioned a paper to be discussed during the AAU's 8th General conference and 25th anniversary Celebration in January 1993, in Accra, Ghana. In the debate that followed, it turned out to be clear that, most of the leaders of African universities, were mostly male and were not aware that gender parity was an issue' (Ajayi et al., 1996). Sadly, in Africa, there are far fewer women pursuing science and engineering fields at colleges than men. In situations where women are present, the huge challenge is to retain them. In addition, the few women who set out on training in scientific disciplines are prevented by discrimination and suppressed their motivation which brings about very few women scientists on the continent (UNESCO, 2013).

Enhancing women's education is both a sociocultural and economic development issue (King & Hill, 1995). The Ghanaian Constitution enshrines human rights. Nonetheless, gender disparities are prevalent in Ghana characterized by financial difficulties associated with women's education coupled with the forecast that boys will likely generate more investment returns (Appleton et al., 1996; Avotri et al., 2000; Herz et al., 1991). Sociocultural considerations, gendered social practices within households, lack of role models for girls in schools, and hostile school environments documented as sexual harassment from male students and inadequate institutional facilities (Atuahene & Owusu-Ansah, 2013; Morley et al., 2009, 2010; UNESCO, 2007). These factors fuel the perception that Ghanaian culture frowns upon the value of female education and women (Lambert et al., 2012; Senadza, 2012).

Science, technology, engineering and mathematics is a specific type of education that specializes on the subjects of science, technology, engineering and mathematics. The combination of these four is the building block of the technological advancements we experience in the world today. STEM education has been defined as “a standards-based, meta-discipline residing at the school level where all teachers, especially science, technology, engineering and mathematics (STEM) teachers use an integrated approach for teaching and learning, where discipline-specific is not studied separately but addressed and treated as one dynamic, fluid study” (Merrillin, 2009).

In Ghana, the focus of STEM education is primarily on Science and Mathematics, as it is mainly out of the applications of these two that engineering and technology are brought to life. These have therefore been inculcated in the various levels of formal education across the country. From primary, to secondary all the way to the tertiary level, there is some level of inclusion of STEM education in the various curricula. As to whether that is sufficient enough to take Ghana to the dreamland of innovation and technology she seeks only time would tell. Right from the basic schools, students are made to study some of the basic principles of Science and Maths.

The education of females in science, technology, engineering, and mathematics (STEM) is imperative from the three perspectives based on empirical studies on gender and STEM (European Commission, 2012; Lee & Pollitzer, 2016; Marginson et al., 2013). The first perspective is that of human rights-the need for all to be educated and be given equal opportunities. The second perspective is scientific-women boost scientific outcomes in terms of diversity, creativity, bias reduction, and promotion of robust knowledge and solutions. The third perspective is development-that is, the ability of men and women to acquire knowledge in and benefit from STEM opportunities. The STEM fields are prerequisites to societal and individual advancement. Traditionally, women have been underrepresented in STEM disciplinary fields (UNESCO, 2017).

STEM clinics have a strong potential for increasing girls' interest in science. Girls have a unique opportunity to interact with young female scientists and learn from the wide range of opportunities offered by the study of STEM subjects. Interactions with role models boost girls' confidence about participating in STEM-related courses and helps to challenge the negative perceptions they may have about pursuing a career in STEM. There has also been the establishment of an association in 2018 known as Women in Science, Technology, Engineering and Mathematics (WiSTEM) in Ghana with its mission to inspire, motivate, mentor and maintain the next generation of women in science careers as indicated in the figure below. However, it is sad to note that as at the time of data collection for this study, out of the 16 public universities in Ghana, only three (3) that is, Kwame Nkrumah University of Science and Technology (KNUST), C.K. Tedam University of Technology and Applied sciences (C.K.T-UTAS) and the University for Development Studies (UDS) currently operate on WiSTEM activities to meet the nations' sustainable developmental agenda.

Figure 1: WiSTEM Ghana

There are numerous tech hubs which have sprung up in Ghana today and aim to address the STEM education divide between Ghana and the rest of the world. These tech hubs seek to enhance STEM awareness amongst people by providing training in coding, software development, mobile and web app development, artificial intelligence (AI), machine learning and other technology related areas. Some of these tech hubs include the iSpace Foundation, Base Camp Initiative, Developers in Vogue, Kumasi Hive and Impact Hub Accra.

The Developer Student Club (DSC) is a Google initiative which aims to train student developers to solve real-life problems within their respective communities. Google recognizes these student clubs and provides the needed resources and support to promote their activities but does not manage the affairs of these clubs. There are six (6) institutions in Ghana with Google DSCs; Ashesi University College, Kwame Nkrumah

University of Science and Technology (KNUST), University of Education Winneba (UEW)-Kumasi Campus, University of Cape Coast (UCC), Dominion University College and Datalink Institute. The DSC chapters of the various institutions organize regular meet-ups and training programmes led by developer resource persons to equip members with the requisite skills to make a difference in their societies. Through these workshops, members of the KNUST Chapter were able to develop an AR navigation app for the KNUST Mall.

It has also been observed that the concept of STEM education programmes in Ghana did not fully materialize because some STEM beneficiaries who were expected to have gained some skills have not been able to excel to higher level of education to competently fit into the system.

Other challenges include the non-existence of STEM activities in tertiary institutions in Ghana. As part of the government of Ghana commitment to the advancement of STEM education in the country, the minister of education indicated in a press release on the 31st of January, 2022 that the government had commenced the development of 20 STEM centres, and 10 model STEM Senior High Schools across the country which were at various stages of completion. He explained that government had worked to improve the science to humanities ratio with 60:40, stressing that the introduction of the one-year pre-engineering programme would further increase the ratio.

Women's low participation and underrepresentation in STEM majors in higher education (as well as the lower levels) partly accounts for their slow integration into STEM occupations (Xie & Shauman, 2003). In comparing women in STEM research careers in Ghana, Kenya and India, Campion and Shrum (2004) concluded that gender disparities stem from systemic deficits in the acquisition of social rather than material resources. Under Article 37(1) of the 1992 Constitution, the state resolves to ensure equality for all. Article 37(2) (b) of the 1992 Fourth Republican Constitution of Ghana states that the State shall enact appropriate laws to ensure the protection and promotion of all basic human rights and freedom. Article 17(4) provides that Parliament is entitled to enact laws that are reasonably necessary for the implementation of policies and programmes aimed at redressing social, economic, or educational imbalance in the Ghanaian society. Article 16 prohibits the holding of persons in slavery or servitude among others.

Since 1992, Siemens Stiftung has been working in Ghana on teacher training and continuing education in STEM. These efforts target secondary schools and has been adapted to fit into Ghana's' national curriculum. Their aim is to support teachers in creating STEM lessons that are not only good in terms of quality, but that also demonstrate the importance of STEM education to learners and make them aware of vocational opportunities. Competencies of the future such as computational thinking, are an essential part of our cooperative work with Ghana's Ministry of Education.

When it comes to the topic of women in science, Marie Curie usually dominates the conversation. After all, she discovered two elements, was the first women to win a Nobel Prize, in 1903, and was the first person to win a second Nobel, in 1911. But Curie was not the first female scientist. Many other brilliant, dedicated and determined women have pursued science over the years. Notable among the Ghanaian female scientists are Prof. Marian Ewurama Addy and Dr. Letitia Obeng.

Prof. Marian Ewurama Addy was a Professor of Biochemistry. In January 2008 she was appointed President of the Anglican University College of Technology, a newly launched private initiative for higher technical education in Ghana. She was

Chairperson of the Policy Committee on Developing Countries (PCDC), a Committee of the International Council for Science, (ICSU), Chair of Ghana's National Board for Professional and Technicians Examinations (NABPTEX), member of WHO Regional Expert Committee on Traditional Medicine, advisor to the International Foundation for Science, Stockholm, Sweden, and Founder and First Executive Secretary of Western Africa Network of Natural Products Research Scientists (WANNPRES), established in February 2002. In the seventies, she took leave from the University of Ghana to become the Director of Programmes for the Science Education Programme for Africa (SEPA), a pan African programme for pre-tertiary science education, which was based in Accra Ghana.

Her experiences in academia were mainly in teaching biochemistry, both basic and applied, to undergraduate, post-graduate, dental and medical students at the University of Ghana, Legon and at Howard University College of Medicine in Washington DC. Her main area of research was the science of herbal preparations used by Traditional Medical Practitioners, especially their safety, efficacy and how they work. She was a member of the Kwami Committee, a Technical Committee on Polytechnic Education set up by the National Council for Tertiary Education (NCTE), to study and make recommendations that would guide the NCTE to formulate policy and advise government on polytechnic education. She was also a member of a 4-man UNDP Consultancy Team in Ghana set up in 1994 to formulate a National Action Program for Science and Technology Development.

Professor Addy was educated at the University of Ghana, where she studied towards a degree in Botany, and at the Pennsylvania State University, where she obtained Masters and Doctorate degrees in biochemistry. As head of unit or department in various institutions, Professor Addy was responsible for initiating projects, running workshops and sourcing for funds for these activities as well as for younger scientists in training.

Dr. Letitia Obeng was a Ghanaian scientist, and was the first Ghanaian woman to graduate with a bachelor's degree in science, as well as the first to be awarded a doctorate in science, which she gained at LSTM after arriving in Liverpool in the 1960s with her three (3) children aged 8, 6 and 3. She conducted her research on *Simuliidae*, or black fly, because of its relevance as the vector for onchocerciasis (river blindness),

The number of women in sciences-especially STEM-related (science, technology, engineering and mathematics) courses-is still low compared to that of men, not only in Rwanda, but globally (Timbasi, 2022). Women still shy away from STEM-related courses, which is why more effort is needed to increase that number. To better understand the situation of female science lecturers in higher education in Ghana, it is important to provide some background information of the status of women in Ghana. According to the 2021 population census provided by the Ghana Statistical Service (2022), women constitute 50.7% of the Ghanaian population of 30,832,019 million. For effective development, a nation requires at least a scientific population of about 2% (Dadson, 1988 as cited in Eminah, 2006) and of this ratio, a good proportion should be females. This imperatively shows that Ghana is of no exception since its population is female dominated. Following the influence of the several female scientists in Ghana and across the globe and other research that reveals the role of science, there is still the gap in literature regarding female lecturers engaged in STEM disciplines in Ghanaian universities. Thus, the researcher's desire to explore female lecturers' Status, Stature and Challenges in STEM disciplines in public universities in Ghana and recommend appropriate actions to improve upon the involvement of females in science related subjects towards national development.

1.2 Statement of the Problem

The problem that prompted this research is that only a few female science lecturers of high academic qualification are engaged in STEM disciplines in public universities in Ghana. This is observed regardless of the numerous government interventions such as the STEM clinics for girls and the 1990 policy on Vocational Education (Baryeh et al., 1999 as cited in Amponsah et al., 2014) to advance science and technology studies and to inspire more involvement of women. The table 1 below shows the representation of academic females engaged in science disciplines:

Table 1: Female Science Lecturers in Public Universities in Ghana

SN	Institution	Number of female science lecturers
1	Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development	4
2	C. K. Tedam University of Technology and Applied Sciences	5
3	Ghana Communication Technology University	1
4	Ghana Institute of Journalism	0
5	Ghana Institute of Languages	0
6	Ghana Institute of Management and Public Administration	0
7	Kwame Nkrumah University of Science and Technology	8
8	S. D. Dombo University of Business and Integrated Development Studies	0
9	University for Development Studies	2
10	University of Cape Coast	6
11	University of Education, Winneba	5
12	University of Energy and Natural Resources	3
13	University of Environmental and Sustainable Development	2
14	University of Ghana	7
15	University of Health and Allied Sciences	4
16	University of Mines and Technology	3
17	University of Professional Studies	0
	Total	**50**

Source: Human Resource Section of the Various Universities (2022)

Even though the STEM field is dominated by males in Ghana, it still lags in its economic emancipation. It is therefore not surprising that Forje (1989 as cited in Amponsah et al., 2014) indicated that an honest cohesive socio-economic revolution can only be realized in African countries by completely integrating women into Science and Technology Education at the tertiary level. However, the traditional perception of women's roles in Ghana is a blockade to females' participation in STEM disciplines which consequently affects Ghana's economic emancipation. Considering this, the current study aimed to investigate female lecturers' status, stature and challenges in STEM disciplines in Ghanaian universities.

Science, Technology, Engineering and Mathematics (STEM) is a fitting acronym for the backbone of advancement and development in our world today. For out of STEM, all other disciplines and vocations branch out, flourish and take form. Without sufficient and effective STEM education, the nation's economy is sure to lag behind whilst the rest of the world evolves around us with fresh new trends and innovations. It is out of proper STEM education and inclusion that the so-called advanced and developed nations thrive with new innovations. Besides the usual Science, Mathematics, and IT taught in the Senior High School system, another initiative which seeks to enhance the appreciation and perception of STEM disciplines amongst Ghanaians is the National Science and Maths Quiz (NSMQ) produced by Primetime Limited. The NSMQ is an annual inter-high school quiz competition solely based on Science and Maths content. Since its inception in 1993, the quiz competition has nurtured the love for STEM amongst many students, urging them on to pursue STEM related fields and courses as they climb on to higher levels of education, technologies coming up every now and then.

The Ghana science clinic for girls was the brainchild of the accomplished educationist J. S. Djanmah, former Director General of the Ghana Education Service. The gender imbalance in science and mathematics classes, and the paucity of girls' participation in these studies was likened to a malaise. Once diagnosed as such, a remedy was prescribed, which included the special holiday camps or clinics. The science clinics for girls in Ghana were such a successful initiative that the concept quickly gained currency and was adopted outside Ghana, particularly in West African countries. The annual programme attracted participants and resource persons throughout the African continent.

The concept of science clinics for Girls in Ghana gave rise to a paradigm shift in the inclusion of girls in science education. One generation later, a review by the American Institute of Physics conference indicates that progress has been made in the effort to mainstream women into science studies and careers, mainly as a result of the changes that took place through this intervention strategy (Andam et al. 2015). The retention rate for girls in science from primary to university has risen considerably and performance is higher (Andam et al. 2015). In the early years, girls were selected from secondary schools from the clinics on the basis of their performance, teacher recommendations, and commitment to a science-based career. But in 1990, the clinics programme was widened to include primary school girls who had yet to settle on a final choice of subjects, to counter a tendency of some girls to change courses midway through their education because of the length of time it takes to qualify for some jobs such as doctoring.

February 11 has been ear marked as the International Day of Women and Girls in Science which serves as reminder that today, many women and girls continue to be excluded from participating fully in science education and careers.Girls' participation in Science, Technology, Engineering, and Mathematics (STEM) subjects in secondary schools is still lower than that of boys. There are many factors that influence girls' participation in science, including a false belief among girls that science-related subjects are more suited for boys. UNESCO (2016), in collaboration with the Girls' Education Unit of the Ghana Education Service organised their first STEM clinic in the Jasikan District of the Volta Region, which is among the lowest performing districts for girls' participation in STEM. To increase girls' participation in STEM-related courses in secondary schools and higher levels of education, the UNESCO Accra Office and partners are organising STEM clinics in selected districts in Ghana. These run on a quarterly basis to sensitise girls to various STEM-related careers that girls can pursue (e.g. teaching, medicine, laboratory work, or telecommunications, engineering).

My involvement and experiences in science teaching at the university and other higher institutions of education in the Northern part of Ghana has noted that females engaged and those studying STEM disciplines is low in both public and private universities. This observation exist despite the array of STEM activities and programmes employed by various stakeholders. It has been found that there is the gap in literature regarding female lecturers engaged in STEM disciplines in tertiary institutions in which the dominant male science specialists still remains.

Insufficient female role models in science disciplines at various levels of education has also been observed. Experienced, but unmotivated, female scientists as well can equally be a setback to female lecturers' engagement in science related courses in academia in Ghana. There is limited research on female professors' doctoral journey in STEM disciplines in Ghana and as a result, there exists insufficient information to serve as a basis for improving the deep-rooted gender imbalances in higher education. Ultimately, these experiences underscored the my quest to explore female lecturers' status, stature and challenges in STEM disciplines in academia in Ghana and advance the appropriate recommendations to achieving the national and global goals of STEM education.

1.3 Purpose of the Study

This study sought to:

Explore female lecturers' status, stature and challenges in STEM disciplines in Ghanaian public universities as well as the steps to be taken to improve females' representation in STEM disciplines.

1.4 Objectives of the Study

The specific objectives of the study were to:

1. Investigate the representations of female lecturers in STEM disciplines in Ghanaian public universities
2. Ascertain the social, institutional/technical and cultural challenges hindering the academic and professional growth of female lecturers in STEM disciplines in public universities in Ghana.
3. Assess cross-institutional collaborations that can enhance the career aspirations of Ghanaian female lecturers in STEM disciplines.
4. Find out the influence of networks of both local and international role models on the female lecturers in STEM disciplines in public universities of Ghana
5. Find out the institutional commitment and support systems that are in place to boost the confidence and capabilities of female lecturers in STEM disciplines.
6. Ascertain the self-efficacy beliefs of the female lecturers in STEM disciplines and the influence of the beliefs on academic and professional growth.

1.5 Research Questions

The following research questions guides the study:

1. How are female lecturers represented in STEM disciplines in Ghanaian public universities?
2. What are the social, institutional/technical and cultural challenges hindering female lecturers' professional and academic growth in STEM disciplines in Ghanaian public universities?
3. What cross-institutional collaborations have been designed to enhance the career aspirations of the Ghanaian female lecturers in STEM disciplines?
4. To what extend has network of local and international role models influenced the female lecturers in STEM disciplines in public universities of Ghana?
5. What institutional commitment and support systems are in place or being envisaged to boost the confidence and capabilities of female lecturers in STEM disciplines?
6. What self-efficacy beliefs do female lecturers engaged in STEM disciplines have and the influence of the beliefs on academic and professional growth?

1.6 Significance of the Study

With the rising need for women in STEM fields, Ghanaian Universities could provide women an education that will allow them to thrive and flourish in the male-dominated fields. While the number of women working in STEM disciplines has moderately increased, women are still vastly underrepresented in the majority of STEM fields (Hill, 2010) Universities could become a viable solution to the women in STEM issues. This study aimed at helping universities to provide an environment where women feel included, supported, have role models, do not feel discriminated against, and have mentors to shepherd them through the STEM disciplines and into fields where co-educational institutions are currently and have historically struggled (Morganson et al., 2010; London & Gonzalez, 2011; Syed & Chemers, 2011). The study will enable females gain a better understanding of the environments and thrive in male-dominated STEM disciplines which is of paramount importance.

This study aims to provide evidence that can be used to further the efforts to produce more women who are prepared to enter these fields by exploring the status, stature and challenges of female lecturers in STEM disciplines in Ghanaian universities. Women become less engaged in the classroom by feeling marginalized, given less opportunity, less praise, and having fewer female role models and professors (Carlone, 2004; Hall & Sandler, 1982; Jones et al., 2000; Leggon, 2006; Olitsky, 2006; Sadker et al., 2009; Zohar & Bronshtein, 2005). Finally, this research will help all educational stakeholders, government of Ghana and international bodies advocate more for STEM disciplines particularly females at all levels of education so as to attain the scientific requirements for socio-economic development of the country and the world at large.

1.7 Delimitation of the Study

The study sought to explore female lecturers in STEM disciplines; their status, stature and challenges in public universities in Ghana. The study covered six (6) public universities that offer STEM disciplines in Ghana. The universities were Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), C.K. Tedam University of Technology and Applied Sciences (CKT-UTAS), Kwame Nkrumah University of Science and Technology (KNUST), University of Cape Coast (UCC), University of Ghana (UG) and University of Mines and Technology (UMaT).

Female lecturers in these public Universities were the main respondents because the study is focused on females who are engaged in STEM disciplines Again, the study concentrated on these universities because they were the oldest public universities that currently offer STEM disciplines. The selected universities were also geographically distributed across the country and for the purpose of exploring female lecturers' status, stature, challenges in STEM disciplines, the concurrent triangulation mixed-method design was employed to have fair understanding of the case. This design enabled me collect, analyse and triangulate both quantitative and qualitative concurrently.

1.8 Limitations of the Study

The main limitation of the study was the selection of 84 female lecturers in STEM disciplines from public universities in Ghana. I being a regular academic staff in one of the selected universities under the study posed a lot of stress during data collection period with higher sample size. In addition, limitation may be due to the commitment levels of the female lecturers to offer information required. I ensured that participants were given the necessary information about the impact of the study on their academic growth. However, diligence and commitment was exhibited by me during data collection to obtain relevant and adequate data for the study.

1.9 Operational Definition of Terms

Female lecturers: Academic female staff teaching STEM disciplines

Representation: Proportions of female lecturers engaged in STEM disciplines

Status: Demographic characteristics and ranks of females teaching STEM subjects

Stature: Refers to qualities the female lecturers in STEM disciplines possess which include academic, content knowledge, discipline, pedagogical knowledge, awareness creation and advocacies.

Challenges: Factors hindering female lecturers' professional and academic growth

Academic: Used in this context, refers to institutions of higher learning and/or the university community.

STEM disciplines: Four specific subjects (Science, Technology, and Engineering Mathematics)

Socio-Academic engagement: This represents an important way in which social and academic knowledge is transferred into the industrial domain.

Higher Education: Refers to postsecondary education, including but not limited to universities, colleges and technical training institutions. In Ghana, it is commonly referred to as tertiary education.

1.10 Organization of the Study

The research was organized into six chapters. Each chapter begun with a brief overview dealing with what the chapter entails followed by the main content of the chapter.

Chapter one considered the background to the study, statement of the problem, research objectives, and questions, purpose of the study, significance of the study, delimitations, limitations and organization of the study. Chapter two, dealt with review of related literature. It covered the tropical issues raised in the research questions and the purpose of the study. It ends with a summary of literature reviewed. Chapter three covered the methodology of the study, which consisted of the research philosophy, design and approach, population, sample and sampling procedure, research instruments, data collection procedure, and finally the data analysis procedure. Chapter four, dealt with the results of the study while chapter five focused on discussion of the results. The last chapter, six presented the summary, conclusion, suggestions and recommendations from the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter discussed literature related to the subject under study. A brief description of the empirical review, theoretical and conceptual frameworks have been discussed. It also discusses the need for STEM disciplines studies especially by females to ensure socio-economic development. The literature related to this research and reviewed were as follows:

- The concept STEM
- The origin of STEM
- Theoretical framework
- Empirical review
- Women professors in STEM
- Gender Disparities in Science and Technology
- Women and Higher Education in Ghana
- Experiences of African Women in STEM fields
- Science and Gender Stereotype
- Colonial Influence on Science and Gender Biases
- The Gender Academic Organization
- Factors Hindering Female Interest in STEM Fields
- Institutional factors and female lecturers in STEM disciplines studies
- Effective Collaboration across (STEM) Fields and career aspirations of female lecturers
- Insufficient Role Models, Mentors, and the Educator Influence

- Support Systems: Peers, Faculty, Parents/Guardians
- Self-efficacy beliefs of females in STEM studies
- Relevance of STEM Education in fostering National Development
- Conceptual Framework

2.1 Concept Review

2.1.1 The concept STEM

STEM is an acronym for: science, technology, engineering and mathematics. According to Olorundare (2010), the inclusion of engineering into STEM Education can be justified by the mere fact that young children tend to be engineers first; building, making and doing projects long before they can explore scientific principles that allow their buildings to stand or "canals" between puddles to carry water.

The important contribution of STEM as an enabler for sustainable national economic growth was affirmed at the World Summit on Sustainable Development (WSSD) in 2002. According to David, Dallatu and Yusuf (2018), it is in this regard that in the framework of the New Partnership for Africa's Development (NEPAD), African leaders recognized that science and technology will play a major role in the economic transformation and sustainable development of any nation. STEM education is used in research, policy issues, teaching for innovation, problem-solving and prospects. STEM is needed towards globalization demands. The complexity of today's world requires all people to be engaged with new set of core knowledge and skills, to solve difficult problems like novel coronavirus pandemic, gather and evaluate evidence and make sense of information they receive from varied print and increasingly digital media. It is therefore clear that the learning and doing of STEM help develop skills and prepare students for a workforce where success results not just from what one knows but what one is able to do with the knowledge. STEM had been the critical instruments used to uplift not only the standard of living but the economy of any nation. Developed nations such as USA, China, Japan and UK made positive strides to the type of science and technology available to them (Wasagu, 2019).

STEM education is important in meeting societal needs like food, shelter, shelter, clothing, water, energy, employment, basic education, healthcare, defense and security, governance, etc. Modern industries depend on basic science for its supply of innovations. The support of pure science is justifiable because it will lead eventually to economic benefits through improved industrial products or processes. This is why nations continue to invest huge amount of resources in research and development in STEM education and training. This investment is seen as strategic because of the importance of these disciplines to national development. STEM –related studies global initiative has attracted several countries of the world for its development. These countries believe that with STEM knowledge, they can rise above over-dependence on developed countries technological prowess. Presently, countries in the world are classified as; developed, developing and less / under developed. The difference between the developed, developing and under-developed countries, however, rests on the ability of the developed countries to convert scientific ideas to usable technology while the developing and under-developed countries are yet to do so effectively (Sambo et al., 2018).

Science has been defined variously as: knowledge about the physical world based on testing and providing facts, or work that results in gaining knowledge (Longman Active study Dictionary, 2006). According to Igboanugo and Egolum (2017), Science is universally regarded as an organized study of natural phenomena. To Sulai et al. (2018)

Science is defined as an intellectual activity carried out by humans, designed to discover the ways in which this information can be organized to benefit human race. A scientifically literate person should possess a body of scientific knowledge in Science, Technology, Engineering and Mathematics (STEM) Education: A tool for national development, a set of scientific skills and behave scientifically in his or her day to day activities. Science holds a unique position among all aspects of school curriculum because it offers countless opportunities for students. It also helps in nation's development. One of the aims of science education is to bring about more scientifically literate citizenry and to develop more manpower to meet up with the world advancement in science and technology.

Technology is viewed as application of knowledge for development and improvement of human life. It is the branch of science with mechanical and industrial arts which involves application of science in solving human problems (Suleiman et al., 2018). According to Alabede (2017), technology is a systematic approach of applying scientific or other organized knowledge to a particular task. It is about product and process. The process is the application, while the product is the outcome of application, which includes hardware and software materials. Technology is the practical application of knowledge especially in a particular area to achieve some results. Technology simply means the practical application of scientific or other knowledge and a major source of economy expansion. Zakariyya and Bello (2018) and Adeniran and Odebode (2018) view technology as application of knowledge obtained from scientific discovery for development and improvement of human life. It is the mechanical and industrial arts which involves application of science and mathematics in solving human problems. All the definitions seem to be pointing to the development and improvement of human life. Technology therefore has economic, social, ethical and aesthetic dimensions which depends on the use to which it is put, where it is used and the circumstances that prevail at the time it is used. For example, education technology is used to help students apply scientific knowledge and concepts to better their environment, to use their brain and hands, make work easier, help them develop positive attitude towards work and productivity and to encourage critical thinking and creativity among them. Science, technology and mathematical knowledge are related in nature.

Engineering is the branch of science and technology concerned with the design, building and use of engines, machines and structures. The features of the separate disciplines in STEM are in an interconnected manner. From the foregoing explication, it is evident that STEM education has relevance in fostering national development. Salman and Adeniyi (2012), Amao (2002), Salman (2005), Adeyegbe (2008) and Opeyinka and Kehinde (2017). The world is rapidly developing technologically and of which mathematics is a required instrument because without mathematics there is no science and without science there is no technology and without technology there is no modern society.

Mathematics is seen by Inweregbuh (2015) as a branch of science which deals with numbers and their operations which revealed hidden patterns that help us to understand the world around us. To Guwam (2017), the knowledge of mathematics is very useful in our daily life. Its usefulness is seen in the enhancement of the development of a critical mind which enables man to circumvent problems like poverty, unemployment and recession that abound in the society. Lending credence to this, Usman and Ojo (2014) pointed out that mathematics is the only essential tool that is applicable in many fields like natural science, engineering, medicine, finance and social sciences, which can be relied on to generate think – tanks that can launch Nigeria on the path of sustainable economic growth and development. Mathematics is commonly referred to as the language of science (Obafemi & Ogunkunle, 2013). Study Up (2009) pointed out that, the study of mathematics at all levels is the most pronounced tool to aid science. For example, scientists studying in all fields of science interweave equations into their everyday theories. The study of physics benefits from conceptual understanding in mathematics. Physics and mathematics are actually inseparable. Obafemi and Ogunkunle (2013), further noted that, physical sciences cannot do without mathematics because many of the expressions used in these subjects are learnt from mathematics.

Mathematics Education is considered as science of counting, measuring and describing the shapes of objects (Augie 2013; Majasan 1995, Suleiman & Abdullahi 2018). The subject deals with logical reasoning and quantitative calculation and involves the science of structure, order and relation. The subject provides basis for scientific and technological advancement which is a necessary ingredient to the economic growth of any nation (Augie, 2013). Also, mathematics is the lynch pin in the task of national capacity building in science and technology. Therefore any shortcoming in the subject constitutes drawbacks to the achievement of science and technology objectives in today's technological globalization. As viewed by Fitz (2013) and Idoezu (2018), STEM in its nature is interdisciplinary since it involves other disciplines. Shaughnessy (2013) however, approached STEM through a complementary view that draw from the individual discipline. He described STEM Education as referring to problem solving techniques that harness from the models and procedures in mathematics and science while amalgamating the collaboration and design approaches of engineering using relevant technology.

2.1.2 The origin of STEM

The underlying precepts of STEM have been in existence since the dawn of human civilization. The origins of STEM, as it is known today, can be traced throughout various points of recorded history. Some of the earliest examples of technology can be found in Stone Age carving tools, hunting implements, and ancient weapons fashioned over 200,000 years ago (indeed, early humans were also artists and artisans as evidenced by cave art and jewelry made from seashells during the same era). Early African civilizations used rudimentary tools and weapons for hunting prey and for basic survival. Mesopotamian societies over 6,000 years ago engineered farming that led to the growth of agrarian communities and local commerce. Additionally, during that period, the early Greek, Egyptian, and Babylonian philosophers from the time of Aristotle, Plato, Ptolemy, and others began to question whether mathematical laws always existed and were discovered or were merely invented for human convenience. The term "technology" derives from the Greek words techne (art and craft) and logos (word and speech); in modern terms, technology defines the advancements and changes that affect our environment ("Technology," 2018). Other early examples of technology and engineering included the discovery of the wheel that led to rudimentary "vehicles" for transporting goods and people and for sport, to the architecture of the Egyptian pyramids and similar structures around the world.

The Islamic Golden Age through the medieval times (c. 800 B.C.E. to 1250 C.E.) saw scientific achievements in astronomy, mathematics, medicine and pharmacology, alchemy and chemistry, botany, cartography, optics and rudimentary image projection devices, physics, and zoology (Dallal, 2010; El-Bizri, 2005). The ancient peoples of India discovered the Golden Ratio (also known as the Fibonacci sequence, codified mathematically by Leonardo Pisano Bonacci over 1,000 years later during the Middle Ages) and the Hindu-Arabic numbers (0, 1 – 9) we use today (Livio, 2003).

The Greek Parthenon and Roman aqueducts, water filtration systems, and networks of roads are some examples of soundly engineered structures and resource conveyance systems (Hornblower, 1983; Potter, 2006; Rhodes, 2006). The ancient Greeks were credited with discovering geometric and trigonometric first principles that are as applicable today as they were in their time. A wealth of new discoveries in astronomy and mathematics followed from the late Middle Ages and throughout the periods of the Chinese Renaissance (960 – 1400 C.E.) and European Renaissance (14th to 17th centuries), that influenced societal development throughout parts of Eurasia, North Africa, and the Far East (Kuhn, 2009; Monfasani, 2016). The time between the Middle Ages and the early Renaissance periods saw the invention of gunpowder and ballistic weapons by the Chinese, followed by the Gutenberg printing press, and many other devices with counterparts found in today's modern technology arsenal. The European Renaissance period witnessed the rebirth of the Classical Age that spurred innovations in science, engineering, and art by such luminaries as Kepler, Michelangelo, and da Vinci (Isaacson, 2017). The Age of Enlightenment (Age of Reason) during the 17th and 18th centuries sparked a macro view concept of a new society and life philosophy that synthesized religion, art, science, classical philosophy, and politics that spread throughout Western Europe instigating progressive thinking and revolutionary developments in these subject areas (Enlightenment, 2018).

Numerous discoveries and innovations arising from these periods further catalyzed engineering and technological advancements. (Fuegi & Francis, 2003). Contemporaries of the time included Francis Bacon, Copernicus, and Galileo who pursued experimental science; whereas Descartes, Leibniz, and Sir Isaac Newton investigated new mathematical paradigms that survived the ages. Indeed, the new Enlightenment movement found its way to Colonial America during the 18th century. The movement soon led to the discovery of electricity and magnetism theory by Ampere and Lenz that was later mathematically codified by James Clerk Maxwell of Edinburgh, Scotland. America's interests in STEM education and studies began during the Colonial period (Salinger & Zuga, 2009; Urban & Wagoner, 2004). The Morrill Act of 1862 and the National Education Association's (NEA) Committee of ten in 1893 were the forerunners of the contemporary STEM idea that began with the formal incorporation of science in the core educational curriculum (DeBoer, 1991; Reid, 2018; White, 2014; Salinger & Zuga, 2009).

The early 1950s through 1970s saw the emergence of transistors, integrated circuits, modern computers, the launch of Sputnik, the race to space, and the 38 early age of the internet all spurred on by the Cold War (White, 2014). Research and development (R&D) in these areas was echoed at the time by the newly formed National Aeronautics and Space Administration (NASA), the Defense Advanced Research Projects Agency (DARPA), and the National Science Foundation (NSF), and later by myriad commercial companies in California's Silicon Valley in support of federal research programs for technology advancement. Eagleman (2015) referenced the work of Gordon Moore of Intel fame who in 1965 postulated "Moore's Law," which forecasted the exponentially accelerating pace of technological advancement in the modern age based on an approximate every 2-year cycle. The first cell phone became commercially available in limited use in 1983 and between 1995 and 1999, the growth in cell phone and personal computer users exploded along with the emergence of the modern Internet, ushering in the Information (Friedman, 2007; Miller, 2015).

Indeed, this historical tour of STEM as it is known today is far from complete and provides only a partial glimpse at best; however, the impact of STEM significantly contributes to the rise and fall of great nations from the perspectives of economics, politics, and military might (Kennedy, 1987; Springer & Stanne, 1999).

According to McComas (2014), Sanders (2009), and White (2014), SMET a precursor of STEM was coined and initiated by the NSF in the early 1990s (Judith A. Ramaley of the NSF was later credited for recoiling it "STEM," which became the acronym of choice. The initiative was intended to help American students develop critical thinking and creative problem-solving skills to ultimately become more marketable in the U.S. labor force. By 2008, the STEM acronym became part of the educational lexicon and continues to be recognized internationally (Loewus, 2015). Gonzalez and Kouzes (2012), Reed (2018), Sanders (2009), and "STEM Curricula" (2017) underscored the increased focus by U.S. government agencies and academia in proliferating STEM education over the past 20-25 years. Petrina (2007) described the "technoenthusiast" mindset often associated with "makerspace mania" that undermines the rigorous study of technology by diluting it with an over-infusion of activities across a broad range of school programs and cocurricular activities. According to Yaffe (2018), nearly 20 percent of public-school students in the US were enrolled in rural school districts that were severely resource limited. Yaffe cited the shortage of qualified STEM teachers as the most critical factor, further stating that the quality of STEM education varied significantly between urban and rural communities due to a lack of funding and hampered resources, resulting in inequity and unequal opportunity for some students, teachers, and school districts. Yaffe (2018) claimed that cultural factors have challenged efforts by rural school districts to encourage underserved families to embrace STEM learning and to dispel any notion of such learning as reserved to affluent or privileged groups. Ravtich (2010) asserted that schools alone cannot solve the problems of poverty and inequity in education. Ravitch suggests that the overemphasis on passing scripted state tests and not preparing students to deal with the realities of failure only exacerbate matters. Once again, the obvious strategy tried by many has been to exploit technology to the fullest to "energize" the STEM curriculum and engage students' interests. Admittedly, technology can compensate for resource shortages including the dearth of STEM teachers in rural districts via online and telecommunications tools. Notwithstanding, STEM holds promise for reviving underserved communities and providing expanded opportunities for students, educators, and school districts alike (DeBoer, 1991; Reed, 2018; NGSS, 2013).

2.3 Theoretical Framework

Babbie (2007) mentioned that theories are methodical groups of related statements planned to describe certain characteristics of social life. In order words, theories and models are used to shape the interest of answers to questions as to why what and how things are happening (Reihl-Sisca, 1989 cited in Shikongo, 2010).

Reviews in psychology on women's underrepresentation in STEM have offered many useful insights by focusing on women's attitudes, backgrounds, and educational trajectories (Ceci et al., 2009; Ceci et al., 2014; Eccles et al., 1999; Spelke, 2005). For instance, Ceci et al. (2009) reviewed which factors across development (from prenatal hormones to tenure rates) contribute to women's underrepresentation among STEM faculty. They conclude the following: [To summarize our conclusions regarding the underrepresentation of women in math-intensive fields, we note that a powerful explanatory factor is that mathematics-capable women disproportionately choose no mathematics fields and that such preferences are apparent among math-competent girls during adolescence. (Ceci et al., 2009)]. However, they do not address why these preferences are there in the first place, and why gender differences in preferences for computer science are so different from gender differences in preferences for mathematics. Our analysis shifts the lens from women's trajectories to the cultures of fields to investigate why some fields have achieved greater parity whereas others continue to have significant gender gaps in participation. In doing so, our analysis reveals that women's and men's preferences do not develop in a vacuum but are constrained and expanded by cultural factors. Culture is a dynamic system consisting of individual behaviors and psychological tendencies that influence, and are influenced by, historically derived ideas and values, everyday interactions, and societal structures (Fiske & Markus, 2012; Markus & Conner, 2014; Markus & Hamedani, 2007).

The culture of STEM is often spoken about as a uniformly hostile place for women as a "chilly climate" (Seymour & Hewitt, 1997). However, recent evidence points to the fact that STEM fields can have very different cultures from one another when it comes to gender (Cohoon, 2002; Deemer et al., 2014; Leslie et al., 2015). For instance, STEM fields differ in the extent to which they are associated with masculine stereotypes (Leslie et al., 2015; Matskewich & Cheryan, 2016). In addition, STEM cultures are located within a larger cultural context that contains a system of gender stereotypes, prescriptions, and practices (Prentice & Carranza, 2002; Ridgeway, 2001; Wood &

Eagly, 2012). Even if the culture of a STEM field is not overtly hostile to women, women will be less likely to enter, persist, and be successful in a field when there is a mismatch between the way that they wish to be seen and are expected to behave (e.g., modest) and the norms of that culture (Stephens et al., 2012). Moreover, even in the absence of deterrents to women, a culture could still cause gender disparities by disproportionally attracting men. Comparing fields to one another necessitates a sociocultural analysis in which both individual characteristics and beliefs (i.e., micro level factors) and the social worlds and structures relevant to the field (i.e., macro level factors) are investigated together to explain disparities in a particular field Stephens et al. (2012). According to Stephens et al. (2012), micro level factors are characteristics or attributes of individuals whereas macro level factors are environmental conditions. To illustrate why a sociocultural analysis that takes both individual and social and structural factors into account is useful, consider the limited explanation for women's underrepresentation provided by David Gelernter, professor of computer science at Yale, the real explanation is obvious: Women are less drawn to science and engineering than men. . .they must be choosing not to enter, presumably because they do not want to; presumably because (by and large) they do not like these fields or (on average) tend not to excel in them (Gelernter, 1999). Gelernter explains women's underrepresentation by focusing on individual preferences and abilities (i.e., women do not like science and engineering and are not very good at them). However, this account fails to explain why women and men have different preferences in the first place. Our work approaches the problem of women's underrepresentation by using a "wide-angle lens" (Fiske & Markus, 2012), investigating both micro level and macro level factors that explain gender differences in participation across STEM fields. As we will see below, students' choices are made within a larger social and structural environment in which barriers to entering some STEM fields are significantly higher for women than men. These social and structural factors operate in tandem to pull girls and women (and boys and men) toward some STEM fields while pushing them away from others. Interventions that influence individual girls and women may not be effective in reducing gender disparities if broader cultural factors that shape women's participation in the field are not also taken into account. The two (2) theories reviewed in this study are the social development theory and the cognitive development theory.

The social dimension factors accounting for the low presence of women and girls in STEM careers and fields are based on the influential roles the home, school, and society play in aligning females to feminine ideals (Erinosho, 1994; Witt & Wood, 2010). The factors have been attributed with characteristics such as "remoteness, abstractness, impersonality, detachment, and objectivity" (Birke, 1986; Hills & Shallis, 1975). These characteristics are associated with males while "passivity, coyness, and subjectivity" are attributed to females (Birke, 1986).

The social dimension is further elaborated by two theories. The first, the **cognitive-developmental theory,** attributes the social processes that produce gender identity as the source of problems women face, upon which the school context becomes the quintessence of masculine science. The general dearth of science teachers/faculty in school denies female students appropriate role models (Erinosho, 1994). School curriculum and materials are illustrative of socially held female passivity (Erinosho, 1994). These facts are consonant with the findings of Murray et al. (1999) that the STEM classroom environment, manifested in the course and curriculum structure, faculty, and male students' beliefs and behaviour hamper persistence and success of females at the post-secondary level of education.

The second, the **social development theory,** traces the problems of women relative to STEM fields to externally oriented gender-role socialization, which right from infancy assigns roles to children (Erinosho, 1994). Differentiated sex roles are sanctioned by the home, the school, and the society. At home, girls play with dolls and domestic appliances and develop verbal and nurturing skills while boys play with mechanical toys. The growth of some personality variables such as interest, attitude, and self-concept is spurred by a lot of activities (Brooks & Vernon, 1956), which gives boys a head start relative to interest in science (Meyer & Penfold, 1961). Girls are brought up to develop emotions, concern, and feelings for nature more so than for mechanistic relationships with physical objects (Erinosho, 1994). Moreover, girls are believed based on past studies to have low self- Complementing the aforementioned factors at home and in school, Savigny (2014) and UNESCO (2007, 2017) further listed factors that breed gender inequalities and inequities in STEM career settings:

Women's and men's career paths diverge as the former are promoted more slowly as they leave STEM careers into other fields. Suitable girls are not privy to information on STEM courses and careers and may turn to other fields, concepts about their abilities in science and mathematics (Erinosho, 1994).

Many girls and their advisers are stereotyped into thinking that STEM jobs are for men.

- Many talents are lost as women leave the STEM fields.
- Cultural norms militate the mingling of men and women, and as a result, women do not have social networks at work.
- Achievements of women are underrated, as women have to garner high scores in order to get promoted.

In addition to the two theories is **work and family**: Three concepts describe potential conflicts for women who attempt to balance work and family: role conflict, the demand for "ideal" workers, and tenure clock (Wolf-Wendel & Ward, 2006). Role conflict results from a combination of limited time and energy with additional roles and responsibilities that necessarily create tensions between conflicting demands and cause a sense of overload (Barnett & Marshall, 1992, 1993). This ultimately leads to physical and mental disequilibria (Fowlkes, 1987; Savigny, 2014). While the role conflict theory applies to women in all professions, the ideal worker and the tenure clock pertain uniquely to the academic environment (Wolf-Wendel &Ward, 2006; Wolf-Wendel et al., 2016). The "ideal" worker is glued to their work interminably to satiate tenure demands, a role that leaves little time for childbearing or raising and/or even marriage (Williams, 2000). The conflict between work and home demands may make female faculty, who may be a wife and/or a mother, not an "ideal" academic worker (Ward & Bensimon, 2002). The tenure clock of academic work is structured on male normative paths that insulate them from family responsibilities, disadvantaging women with families (Grant et al., 2000; UNESCO, 2017). In the larger context in Ghana, public universities do not have a gender policy and the policy frameworks are in dissonance with gender concerns. A seeming exception is the University of Cape Coast's Strategic Plan which, like the National Council Tertiary Education's (NCTE) goal of increasing female enrollments, mentions gender but does not include modalities for addressing gender inequities (Manuh et al., 2007). In Ghana, there have been few efforts geared toward ensuring the parity between men and women in tertiary education or in the Ghanaian society at large (Britwum et al., 2014). The trajectory of the faculty career from graduate school to full professor rank seems not encompass the career expected of an academic woman (Wolf-Wendel & Ward, 2006). To gain legitimacy, however, many female scientists have focused on scientific identity based on research and career achievement ignoring marriage and child-caring responsibilities (Etzkowitz et al., 1994). The disregard for the reproductive rights of women in academia is denotative of academic freedom being gendered This therefore underscored the need for this study to help make conscious efforts to address the gap in females representation in STEM disciplines studies in academia for a cohesive sustainable and economic development.

2.4 Empirical Review

2.4.1 The academic female STEM trajectory in Ghana

Educating women in STEM areas is beneficial to the society and economy. Despite the justification of female education in STEM in terms of human rights, scientific support, and developmental standpoints (UNESCO, 2007), women are marginalized in its participation. In the academic trajectory of women in STEM, the discrimination they experience varies but at the root of the discrimination is the pervasiveness of society's patriarchal clout on education and STEM (Wachege, 1992 cited in Boateng, 2017; Erinosho, 1994). Due to such beliefs, women experience less feelings of belonging and interest, and may also feel less able to succeed in STEM fields (Cheryan et al., 2009). The structural/physical composition of males in lecture halls in many STEM disciplines is a source of gender discrimination (Boateng, 2017), especially for females who had attended exclusive girls' senior high schools. However, many participants found that their male mates were supportive to them. This is incongruous to the finding that at the university level women experience a greater loss of confidence in their intelligence and men underestimate the women's ability to do well in STEM subjects (Farrell & McHugh, 2017). Patriarchy is ubiquitous as it extends to the STEM career milieu. The belief that STEM careers are only for the "brainiest" students, especially middle class males (ASPIRES, 2013), plausibly accounts for the disrespect and disdain shown to female STEM faculty by their former male mates in the university. The ubiquitous patriarchy not only extends to the academic STEM ambience in terms of teaching and research, but also to the service roles of faculty as well. Female leaders of the academic STEM are grossly disrespected even by their male juniors.

Gender and other sociocultural (ethnic and tribal) factors are interlocked in the ingrained patriarchy fostered by the Ghanaian society. Societal expectation or requirement of women as primary caregivers encourage them to adopt career paths that are congruent with raising a family (Hakim, 2002) and places them below men regardless of their status in the academic STEM workplace. The cultural division of labour stereotyping certain careers compels women, at least wives and mothers, to take careers with flexible work schedules and workloads because of their child caring and home management roles or reduced work time if they choose STEM careers (Erinosho, 1994; UNESCO, 2007, 2017). Paradoxically, these women fail to become ideal workers who must satisfy the tenure demands of the maledriven academy (Ward & Bensimon, 2002; Wolf-Wendel & Ward, 2006). The patriarchal nature of the academy constrains women in academia from maximizing their potential (Lundgren & Prah, 2009). Considering the bigger picture, there are no gender frameworks in Ghanaian public universities (Manuh et al., 2007). This is coupled with the fact that tertiary educational institutions are replete with gender contradictions partly because their leaders do not have gender equity issues as priority concerns (Acker, 2000), which is evident in the passive response relative to Ghanaian universities (Manuh et al., 2007).

Gender inequalities and inequities in education are replete in most parts of the world. Such a situation is not different in Ghana. From the gamut of all educational levels, gender gaps characterize Ghana' education system. Although there is ample literature on gender disparities concerning Ghana's education. There are few that touch on the experiences of females in the STEM fields (Campion & Shrum, 2004; Boateng, 2017), which are deemed to be male-dominated disciplinary domains. As a consequence, the objective of this study was to elicit narrative accounts of the educational and professional experiences of female STEM faculty in Ghanaian universities through in-depth semi-structured interviews. It was found that the participants throughout their schooling and career (thus far) relied on their support systems to succeed. However, the silver lining of support was smothered by gender discrimination underpinned by ingrained patriarchy in the Ghanaian society. Regardless of the feat the females have accomplished, they are perceived and actually treated as second fiddle to men. The participants' parents, especially their fathers, supported them in their education; however, their support was punctuated by their patriarchal beliefs that their daughters should relegate themselves to their male counterparts. During their STEM school years, women benefited from the support, cooperation, and collaboration of their male mates. Such support, cooperation, and collaboration plummeted as they proceeded to the STEM workplace where their former male mates became perpetrators of gender discrimination. Such patriarchal realities must be addressed by the various stakeholders in Ghana to nip gender inequalities and inequities in the bud. This underscored my quest to explore the status, stature and challenges of female lecturers in STEM disciplines in Ghanaian universities and consequently recommend appropriate steps in improving the involvement, and academic growth of females in STEM fields in Ghanaian universities.

2.4.2 Women professors in STEM

To date, less than 8% of vice-chancellors in Africa's universities are women. A comparable imbalance describes the professoriate. However, there have been some cumulative gains in the representation of women among faculty and student populations, even though this is unevenly distributed, remaining concentrated at the lower levels of the hierarchy and in less prestigious regions, even within specific fields of scholarship (Mama, 2011). Especially given the limited resources on research specifically on Ghanaian women lecturers/professors in STEM fields, it was necessary to research journal, articles, and dissertations on women STEM lecturers/professors in general. Women in STEM encounter diverse challenges in the STEM fields. Sadly, as we understand, for many women in science, technology, engineering and mathematics (STEM), the route to academia ends long before they attain a faculty position and are the "lucky" beneficiary of biased student beneficiary/evaluations (Leifer et al., 2015). There are more women in STEM fields today than any time in recent memory, though bias still influences women in STEM, and not just in student assessments/evaluations (Leifer et al., 2015). The experiences of six women professors in Ivy League colleges are told by Leifer et al. (2015). Some of the challenges these professors encountered began right from the hiring process. An extensive collection of research demonstrates that large portions of these materials, and how the women professors are assessed by search committees, reflect bias in favour of male candidates (Leifer et al., 2015). Letters of recommendation, for instance, have a tendency to have a very different character for women than for men, and their tone and word preference can influence the feeling/impression that the hiring committee forms about candidates. The professors also stated that their teaching assessments, are also one-sided and those favour men (Leifer et al., 2015). Across the United States at higher-level educational institutions, women faculty members almost perpetually remain in the minority among the tenured STEM faculty members (Rollor, 2014). At some STEM academic institutions, female faculty additionally deal with actual discrimination in their surroundings before and during their tenure decision process (Rollor, 2014). There is immediate proof that some men in STEM higher education environments are inert to the convergence of female faculty members (Rollor, 2014). At Princeton University, 24% of the women faculty in natural science and engineering stated that their associates "occasionally" or "frequently" participate in unprofessional behaviour on gender-related matters (Rollor, 2014)

2.4.3 Gender disparities in science and technology

There is little doubt that more and more professional jobs will be in the S&T fields (Schulze & Heerden, 2015). This raises concerns about current disparities in S&T disciplines where almost everywhere in the world male enrolments outweigh that of females (Zander et al., 2015). Despite the global expansion of tertiary education systems, participation rates among women in S&T higher education and in the academic workforce have substantially lagged behind those of their male counterparts (David, 2015). Recruiting and retaining women within S&T disciplines continues to challenge many higher-education institutions worldwide. In Canada, for example, in 2011 women aged 25 to 34 accounted for 39% of university graduates with an S&T degree (CNHS, 2011), compared with 66% of university graduates in non-S&T programs (Hango, 2013). In 2009 in the USA, women represented 24% of those pursuing S&T careers (Beede et al., 2011). In part, this has been due to the large numbers of female students who drop out of S&T programs (Griffith, 2010). More broadly, however, the norms, standards, organizational structures and practices in S&T

higher-education institutions are frequently mirror images of patriarchal structure and practices (Sang, 2016).

The global workforce demands and the utilisation of scientific talents of women remain an elusive undertaking (Sulaiman & AlMuftah, 2010). The limited presence of women in S&T fields is not only a breach of their rights but also a restriction on women's contribution to teaching and research (Kwaramba & Mukanjari, 2013). It will also have a considerable impact on the next generation because there are too few women in S&T to serve as role models for girls and young women (Zander et al., 2014). An effective effort to recruit and support future S&T teachers, in general and female teachers in particular, is pivotal to student learning and engagement (Watt et al., 2012).

2.4.4 Women and higher education in Ghana

I now offer a brief review of women in higher education in Ghana. Dr. J. K. Aggrey once proclaimed that, if you educate a man, you educate an individual; educate a woman and you educate a nation. Education is an enterprise in which women have a vital stake, as women are generally those on whom the responsibility of educating falls, whether in the home or in the school. Yet, Dr Aggrey's statement while widely used in Ghana since independence, does not reflect women's actual involvement in higher education.

A study conducted on gender issues at the University of Cape Coast in Ghana revealed that women academics have low statistical and political visibility and, their concerns and needs within the workplace women are not discussed (Prah, 2002). With regards to female university students, Prah (2002) concluded that "there is anecdotal evidence about women students who were intimidated by their peers, particularly (but not exclusively) men, when they decided to stand for political office at the university".

Additionally, the university itself has no gender equity unit or special department to handle gender discrimination issues, reflecting some of the challenges that Ghanaian women face at the university. The status of the Ghanaian women is shaped by cultural/societal norms and the legacies of colonialism for colonialists were biased in favor of boys, rather than girls, for schooling when they needed to train Africans to help them run the colonial governments. Bartels (1965) reveals that when the first school for girls was opened in Ghana, the aim of the missionaries who ran the school was to groom young women to become fit wives for the men they were training. Van Allen (1976) traces the sex differential education in Africa to colonialism. He writes: When they needed literate Africans to form a supportive mediating structure for colonial governments, they sought young boys for schooling. Even when girls were sent to mission schools, they often were not taught the same subjects. Girls' "training homes" taught some "domestic science" and the Bible in vernacular, thus, inequality in education is rooted in colonialism and today we see the ripple effects. It has been argued by Prah (2002) that if women should excel in any profession, then it should be teaching at the universities because teaching is supposedly women's forte and universities are assumed to be meritocratic institutions. She further asserts that Ghanaian universities are male-dominated institutions and the women within them-academics, administrators, support staff and, students-face major obstacles because of lack of attention to their specific needs and problems. According to Leney (2003), in the first year of the University College in Ghana in 1946, women accounted for just 2% of the student population, while in the year 1957, of independence, they still amounted to less than 5%. At the first phase of development of 58years of the University of Ghana, there were four residence halls for men and one for women (Leney, 2003).

In recent times, some efforts as in the case of mentorships programmes for females in universities through WiSTEM, scholarships from internet bodies such as Vodafone and MTN. For according to (Kouassi, 2016), if you are a lady and you go for sciences, you're a half-man" Policies are also in place in some universities to offer support and build the capacities of females in STEM disciplines. For instance, UEW, KNUST, UG have policies in place for females, however, these packages are still inadequate hence the need for collective supports to cater for all tertiary institutions to advance females' participation and representation in STEM disciplines.

2.4.5 Experiences of African women in STEM fields

This literature addresses some of the experiences that women in Africa encounter in pursuit of degree in Science, Technology, Engineering, and Mathematics (STEM). The encounters encompass gender stereotype, gender biases, insufficient role models, inadequate mentors, educator influences, and cultural expectations as explained below:

2.4.5.1 Science and gender stereotype

The status of females in sub-Saharan African colleges is a reflection of female's position in the nation (Adusah-Karikari, 2008). Females are underrepresented in sub-Saharan Africa colleges and the individuals who can seek higher education tend to focus on customary female fields, for example, arts, education, social science, and humanities (Adusah-Karikari, 2008). Science, Technology, Engineering, and Mathematics (STEM) have been distinguished as the foundation of wealth creation and important for nation building. It has been established that the interest of females in STM, especially in Africa, has been low. In the colleges, they experienced lack of support and/or gender biases (Boateng, 2015). One reason is because African women have been urged to seek out arts and humanities and have been discouraged from seeking out science subjects, as science is seen as a manly field (Adusah-Karikari, 2008). Adusah-Karikari pointed out a study conducted in Cameroon and Egypt (Cochran, 1992; Rathgaber, 2003). The findings from the Cameroon study indicated that females are a long way from being urged to study science and are constantly told that science is not an appropriate field of study for them (Rathgaber, 2003).

In Egypt the researcher uncovered that middle-class and upper-class women were more likely to pursue scientific and professional subjects, while lower middle class women pursued agricultural science, humanities, education, nursing, and social sciences (Cochran, 1992). Women in STEM who take interest in higher education, similar to male STEM students, go to college with their STEM backgrounds and have scholarly relationships with their colleagues, professors, etc. inside or outside the classrooms (Boateng, 2015). Analyzing their experiences to the academic relationships, they either encounter continuity of their relationships or a change towards STEM-related studies (Boateng, 2015).

2.4.5.2 Colonial influence on science and gender biases

In Africa, colonialists had a greater say as to whom gets which education (Ajayi et al., 1996; Mbow, 2000). At the point when colonial companies presented cash farming and export, technical education was offered to men to boost yield. Men were included in cash crops and women in subsistence farming (Mbow, 2000). An example cited by Adusah-Karikari (2008) is the “1935 British Commission on Higher Education in East Africa and chaired by One de la Warr was paternalistic in the extreme” (Oloka-Onyango, 1992; Tamale & Olako-Onyango, 1997). The commission affirmed that the education or training that women needed was focused on sewing, home economics and hygiene, domestic management, nursing and midwifery (Tamale & Olako-Onyango, 1997). Neither the technical arena-engineering, the general, medical and animal sciences, or agriculture-nor the 'esoteric' arts, were opened up to gender parity.

Cultural and colonial influences on female alienation from science fields is reiterated by Adusa -Karikari (2008) when she quoted Van Allen’s (1976) view on the sex differential education in Africa to colonialism. This is a clear indication on a deliberate attitude from cultural and colonial plan to prevent women from the venturing into the STEM academy. Both elements support the suppression of women and prevent them from contributing their quota to the African STEM academic society. The data solicited from participants will be beneficial for policy makers to design policies that will promote women’s empowerment and access into STEM fields.

2.4.5.3 Gendered academic organization

There has been progress of women faculty in traditionally male-dominated fields in academia (National Center for Science and Engineering Statistics, 2015). However, there remain areas of the academy where women are grossly underrepresented, and despite notable progress, the number of women in fields like the hard sciences continue to trail behind the number of men in terms of academic rank and tenure (Sturm, 2006). The reasons for this discrepancy are debated and range from assertions that women are just not as interested as men are in fields like the ‘hard sciences’ (i.e. physics, math, engineering, computer science), to women who choose an academic career in the hard sciences often depart from the field to start a family (Bailyn, 2003; Blickenstaff, 2005; Maranto & Griffin, 2011; McClelland & Holland, 2014). Whatever the reason(s), gender inequities persist and are the target of various change initiatives which include strategies such as engaging men faculty in gender equity work. Gender equity work is premised on understandings of what constitutes gender equity.

Latimer et al. (2014) define gender equity in academia as representation of women across all fields of inquiry, at all levels of rank and administrative appointments that is proportional to the availability of women candidates in those fields. Bailyn (2003) calls for a revision of conceptions of gender equity which are satisfied with equality of opportunity for women based on male-constructed norms and/or conceptions of gender equity which tout the establishment of inclusionary policies and practices. Instead, she maintains that an "ideal image of gender equity," is not only legitimates for "the private sphere of family, community, and other personal involvements," but equalizes "the value placed on economic and noneconomic activity"

Though Bailyn's (2003) admittedly idealistic conception of gender equity is easily contrasted with Latimer and colleagues' more succinct and measurable conception of gender equity, neither provide a blueprint for achieving gender equity. Indeed, (Acker, 1990; Bailyn, 2003; Morahan, Rosen et al., 2011; Ridgeway & Correll, 2000; Roos, 2008; Rosser, 2007) and tested (Ely & Meyerson, 2000; Latimer et al., 2014; Nolan et al., 2012; Sturm, 2006) myriad approaches to achieving gender equity in organizations and none have suggested that their approach offers a blueprint for every context and situation. Although a review of the various approaches to gender equity in organizations exceeds the objectives of this review, it is important to note that at the crux of each theorized and empirically tested approach is the implicit assumption that gender is entrenched in the structures and designs of organizations and in the cognitive schemata of the people who inhabit them. Taking this into consideration, a brief review of literature on the gendered academic organization it has been included as it is the organizational context for this study. The post-secondary academic organization, generally, and the academic department, specifically, represent the contexts within which gender equity work takes place. In addition to traditional notions of post-secondary institutions as slow changing bureaucracies (Kezar, 2014), it has also been suggested, that like other established organizations, institutions of higher education are gendered (Acker 1990; Britton, 2000; Parsons & Priola, 2013). Acker (1990) provides the following explanation of a gendered organization, to say that an organization is gendered means that advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female, masculine and feminine and men are almost always in the highest positions of organizational power. (Connell, 1987; West & Zimmerman, 1987; as cited in Acker, 1990) Citing, Ferguson (1984) and Leathwood (2005), Parsons and Priola (2013) explain the gendered nature of academic culture and its oppressive effects on academic women: The traditional culture of academia is based on bureaucratic hierarchical systems founded on sets of values that define and maintain a specific configuration of gender roles and relations. These relations disadvantage women in both their research and managerial careers. (Park, 1996; Priola, 2007; Thomas & Davies, 2002; as cited in Parsons and Priola, 2013) Drawing on Acker (1990), Ely and Meyerson (2000) identify four categories of social practices through which gendered organizations are sustained. These include: (1) Formal policies and procedures; (2) informal work practices, norms, and patterns of work; (3) narrative, rhetoric, language, and other symbolic expressions; and, (4) informal patterns of everyday social interaction. Maranto and Griffin (2011) describe the professoriate as "a highly gendered occupation" and point to formal and informal policies and practices as evidence. For example, a perceptible disdain for faculty with "non-work . . . responsibilities," reinforced by a time-boundless work culture, and a tenure-clock inconveniently synced with many faculty women's reproductive clocks. Acker's (1990) analysis of "the abstract worker" in gendered organizations supports Maranto and Griffin's assertion:

In organizational logic, filling the abstract job is a disembodied worker who exists only for the work. Such a hypothetical worker cannot have other imperatives of existence that impinge upon the job. At the very least, outside imperatives cannot be included within the definition of the job. Too many obligations outside the boundaries of the job would make a worker unsuited for the position. The closest the disembodied worker doing the abstract job comes to a real worker is the male worker whose life centers on his full-time, life-long job, while his wife or another woman takes care of his personal needs and his children. In her essay reflecting on lessons learned from the oft cited MIT (1999) report, Bailyn (2003) claims that senior faculty women at MIT "believe absolutely" in the notion of "the perfect academic…who gives total priority to work and has no outside interests and responsibilities." She alleges that these academic women "cannot conceive of any other way to be a first-rate scientist," which she suggests, "may explain why most of them are not married and have no children while men academics routinely have families". Van den Brink and Benschop (2003) make the point that despite the embeddedness of gendered processes at the institutional level, gendered dynamics vary in local institutional contexts (e.g. the academic department) because of differences in "core activities, financial resources, career patterns, epistemological issues and publishing strategies". Supporting their contention, Latimer et al. (2014) explain how gendered processes shape and privilege certain academic disciplines over others:

The characteristics traditionally most valued in academia (i.e. rationality and objectivity) are linked with science and masculinity and thus are seen as in opposition to non-science and femininity. As a consequence, academic disciplines are gendered based on their methods of inquiry, and those perceived to be more objective and inherently masculine are privileged. As this discussion has made clear gendered processes operate at all levels of the academic organization from the individual gendered position, to the gendered academic department and discipline, to the structures and processes which govern the larger institution. Considering this, strategic change for gender equity in the academic organization in Ghanaian universities must be viewed as a multileveled process. At each level are faculty actors who play varying roles in gender equity change.

2.4.6 Factors hindering female interest in STEM fields

Scholars explain the low presence of women and girls in STEM careers and fields, citing biological, social, and psychological factors (Erinosho, 1994) that hamper the efforts of women undertaking STEM fields in educational institutions.

2.4.6.1 Biological factors

The biological factors cited have to do with the phenotypical constitution of women with regards to their "analytical and visual spatial skills which are required for abstract reasoning in science" (Erinosho, 1994). Those who hold this view premise their conviction on gene factors (Gray, 1981); hormonal factors (Rosenkrantz et al., 1968); and brain lateralization (Sherman, 1979). This conviction has been challenged on the grounds that women's biological make-up has no direct correlation to their capabilities. Innate differences vary more in individuals than across sexes (Erinosho, 1994).

2.4.6.2 Social factors

At various levels of education in STEM, women encounter conscious and unconscious teacher/faculty bias on the basis of gender (Moss-Racusin et al., 2012) as males are given the upper hand in the education process because they are engaged more by faculty/teachers (Johnson, 2007). For instance, males are asked analytical and critical thought high order questions while females are asked to recall facts based on lower order questions (Hall & Sandler, 1982).

Psychological obstacles are themselves wide ranging, but in explaining gender discrimination in higher education, states of anxiety and poor motivation are commonly regarded as the most psychological underpinnings for reduced numbers of women in science and technology studies. Anxiety can be defined as excessive worry and emotional experience that is characterized by panic, hostility, and the desire to quit the anxiety-causing impulse (Moeller et al., 2014). Lack of motivation on the other hand, refers to the absence of mechanisms that initiate and perpetuate goal-oriented behaviours. This can be brought about by lack of intrinsic rewards, or conversely by extrinsic factors such as belittlement or threats of social exclusion (Ryan & Deci, 2000). Recent studies have demonstrated that male and female students have the same levels of situational anxiety, but stressful situations tend to have more negative impacts on the motivation of female students than on that of male students (Moeller et al., 2014). Female students also experience less intrinsic motivation and more withdrawal motivation, which leads to disengagement when faced with traumatic situations daily. Some examples of these situations include low self-confidence, confusion, and apathy. Gender differences in science learning and negative emotions lead to unpleasant feelings such as sadness, anger, frustration, and stress (Moeller et al., 2014) in daily experiences. Low motivation also contributes to lack of student interest in S&T programs. To shed light on the issue, many scholars have investigated the factors that impede student motivation to study science and technology. For example, Schulze and Heerden's (2015) study explored six motivational factors mostly related to classroom environment: (a) self-efficacies (b) learning strategies, (c) perceptions of the value of science, (d) educational settings, (e) teaching methods, and (f) school culture. Their findings suggest that inadequate teaching methods and unwelcoming school cultures are the most critical hindrances to motivation.

Other researchers have examined the role of parents. Shin et al. (2015) demonstrated that low parent interest in science and technology influences the intrinsic motivation of adolescents and their pursuit of an science and technology career. Parents shape their children's views through their shared beliefs and encourage them to pursue specific careers rather than others. Shin et al. (2015) further revealed that gender roles affect teenagers' self-identities and career goals, especially in Eastern Asian countries like China and South Korea, where Confucian3 beliefs and traditions focus on gender roles. In many countries, women experience a similar internal dilemma over the choice of a career related to a male-dominated field (Shin et al., 2015). For instance, in South Korea this situation can activate an "internal 'tug-of-war' that can result in Korean females' low motivation, low self-beliefs, and the underrepresentation of females in male-dominant fields" Many other studies demonstrate that parents are outstanding role models and influence the career choices of their children through advice, encouragement, and financial and emotional support, among other factors. Mothers, in particular, play an essential role in the career choice of their daughters (Archer et al., 2013). Moreover, girls and women tend to value social sciences and humanities such as art, linguistics, and education, thus developing interest in professional careers traditionally assigned to women such as teaching, social work, nursing, etc. (Roy et al., 2014). According to the labour market, technical professions are suitable for men while nursing and caring professions are connected to women. Through upbringing and socialization, both boys and girls learn and internalize these differentiated gender roles and social expectations and practices. Children and adults are pressured to adhere to their gender-assigned roles. For example, girls and young women have been brought up to develop emotions, concern, and feelings for nature rather than mechanistic relationships with physical objects (Boateng, 2015). It is not surprising that quite a number of girls and women who study S&T opt for the humanistic science and technology subjects like the biological sciences.

The male-oriented model-which is often associated with rationality, objectivity, and the capacity to be technologically focused, as opposed to the people-sensitive characteristics of women-is thus used as a yardstick to measure women's involvements in science and technology. Women who undertake "hard or masculine-oriented" (Boateng, 2015) disciplines are therefore regarded as violating societal patriarchal norms concerning education and specifically science and technology. Thus, the imminent risk of setbacks deters women from pursuing a career in science and technology (Faulkner, 2000; Mlambo & Mabokela, 2016). Building on previous work related to the negative impact of emotions generated by science and technology learning environments on student rationality, Chiang and Liu (2014) investigated the emotional experiences of science and technology undergraduate students.

Chiang and Liu (2014) used psychological tests based on activation/deactivation of positive and negative emotions leading to positive and negative attitudes respectively. Academic emotions have specific impacts on learning and achievement depending on the types of attitudes that are activated during particular situations. The findings suggest that female students exhibit more negative emotions compared to male students. Numerous studies have revealed that women are regularly exposed to stereotypes and discrimination (Bella & Crisp 2016). Cheryan et al., (2009) demonstrated how stereotypes impact the retention of women in S&T fields. Gender discrimination begins early in a young girls' life and continues throughout development stages to the point where women develop less sense of belonging in S&T fields. For example, girls are often raised to develop nurturing and caring attitudes—they are given dolls and toys—while boys are encouraged to use machines and computers (Holth & Mellström, 2014). Women who experience stronger gender-science stereotypes tend to have weaker science identification and thus weaker science career aspirations (Cundiff et al., 2013). Individuals who believe that their sex-group members are defamed and treated unfairly within a specific field tend to dissociate themselves from that field (Ceci et al., 2009; Hayes & Bigler, 2013).

Society attributes women's science and technology challenges to internal causes like lack of aptitude and competence while men's science and technology setbacks are usually blamed on external factors such as inappropriate circumstances or regrettable situations (Cundiff et al., 2013). Science and technology environments are unwelcoming to women (LaCosse et al., 2016). Consequently, women internalize these negative gender stereotypes and are convinced that they have lower capabilities in science and technology disciplines than men. These beliefs support the dissociation of women from science and technology, generating lower interest in science and technology careers. Additionally, gender stereotypes related to science and technology aptitude are very detrimental to women. Hence, women are more likely to view themselves as the target of gender discrimination. Opportunities necessarily for both men and women to undertake their academic functions are unequal. For example, women who return from maternity leave are negatively assessed by their students and senior colleagues, and thereon, frosty relationships develop between them and their senior colleagues (Lundgren & Prah, 2009; Britwum et al., 2014).

2.4.7 Institutional factors and female lecturers in STEM disciplines studies

Institutional Obstacles: While psychological/cognitive and personal attitudes are believed to have contributed to women's underrepresentation in the science and technology fields, institutional obstacles also negatively affect women's pursuit of science and technology programs. Stout et al. (2011) posited that gender stereotypes and academic cultures influence women's achievements in science and technology. Girls and women are exposed to the "message that their in-group is worse in science and technology programs compared to their male peers". Science and technology disciplinary cultures are "gendered and have a gendering effect of their own" (Gilbert, 2009) because social and cultural practices, images, and identities are related to specific aspects of masculinity4-as opposed to femininity5-and thus tend to contribute to the proliferation of gender segregation in the fields of scientific inquiry (Gilbert, 2009). Throughout their schooling, girls are frequently socialized to accept science and technology fields as primarily suited to boys, a notion that is reinforced in science and technology textbooks that very rarely refer to the work of female scientists (Stout et al., 2011). Invariably, therefore, female students often view science and technology education as a hostile culture that begins early in their schooling and continues throughout higher education (Stoilescu & McDougall, 2011). "Social, ethical, and moral issues are often treated as peripheral issues by science and technology educators and teachers," (Stoilescu & McDougall, 2011), and elementary and secondary schools science and technology teaching practices often ineffectively prepare girls to succeed in science and technology learning environments (Mujawamariya et al., 2014). Hence, females and males start their undergraduate study programs with different levels of experience and exposure to science and technology. For instance, female students have less experience in computers than their male colleagues at the beginning of the science and technology educational program, and for most females, computer science is not their initial major (Stoilescu & McDougall, 2011). Cheryan et al. (2009) study revealed that the stereotypical computer science context reduces women's "sense of belonging and interest" in science and technology. It is evident that teaching/learning practices in science and technology education need to adopt a gender sensitive approach to allow both women and men to benefit from the learning environment.

2.4.8 Effective collaboration across (STEM) fields and career aspirations of female lecturers

The notion of collaborative work and interactive social learning gained much attention as catalysts for interdisciplinary pedagogy using structural relationships. The approach is the basis for an integrated, interdisciplinary active STEM learning strategy that treats mathematics as a "glue" binding and interrelating the disciplines for highly purposeful engagement. The approach exploits a method called scaffolding, which will be discussed later and refers to a framework for an interactive, immersive intervention by teachers to facilitate students' problem-solving skills development and enable interdisciplinary learning in a progressive or iterative manner.

The recognition is growing in academics and business that collaboration can build a seamless support system across the STEM fields if well harnessed**.** While collaboration is the vehicle for combining and sharing resources among STEM fields, it is imperative to understand the need for collaboration (Melton, 2002; Stowell, 2005). Consequently, it is important to note that collaboration enhances services, increases the quantity of resources available to serve clients or participating disciplines, increases better use of available resources, and increases the quality of available services.

According to Stowell (2005), a leadership skill development posited that "one of the most important things a leader needs to be able to do is to collaborate with his/her team members and create a culture where members value and listen to alternative views and seek out win-win objectives. This can be accomplished by clearly identifying common needs and objectives; and certainly, should occur on multiple occasions over time." Establishing collaborative relationships is not always natural or easy, particularly because people have different lifestyles, backgrounds, and experiences (Stowell, 2005). Since scholars across the STEM fields differ in so many ways given their diverse backgrounds, and being leaders of their respective disciplines, leadership through collaboration and harmony must be fostered. To fully anticipate collaborative activity and diverse team success, such a diverse team needs emergent interdependence, meaning that members on the team must develop the desire and expectation to work interdependently for the benefit of the team's work (Caruso & Woolley, 2008). In addition, Chi-Ying Cheng et al. (2008) proposed that reinforcing the compatibility between functional identities within a team facilitates access to functionally unique knowledge systems, which in turn increases team innovation and provides common ground to promote communication and collaboration among professionals working in STEM disciplines.

Through knowledge sharing among research collaborators, skills and competitiveness, it will be clear that the integration of STEM fields will play an important role given that "groups of people from diverse functional areas become high-collaboration teams" (Jassawalla & Sashittal, 2006). The STEM collaborations signify a good, unified system that has many advantages of facilitating cooperation with little disadvantage. STEM is a unified project, and all the faculty members who are involved in this should help each other. There must be mutual understanding between faculty members to break all of these barriers. Interaction should be fostered at different levels to make necessary improvements and to solve any problem that may arise between the members amicably so as to implement the collaboration in a disciplined manner. Since there should not be any kind of differences among these members, it behooves each and every member to cooperate and give their best to achieve and maximize the output. More importantly, collaboration has to take place first at the local level of education and then move up instead of the opposite. It is suggested that departments can come together as clusters to initiate this effort. The potential of the individual members should be quickly identified, trusted respected and encouraged. It should be noted that the contributions of the individual may differ given the nature and knowledge about the project or program to be developed. Regardless, synergism should be fostered by tapping into the individuals' strength rather than focusing on their weaknesses. That is why brainstorming for creativity and new ideas and initiatives should be encouraged so as to pool knowledge. For example, highly interdisciplinary and relevant activities on new industrial revolution at the Nigerian Universities, have synergized many disciplines such as physics, chemistry, biology, mathematics, technology and engineering with focus on the strength of the participants. This has led to the development and implementation of research clusters across the STEM fields with their subgroups reflecting the interdisciplinary areas of strength of the participants. Collaboration among scholars to form cluster groups in the university will enable further knowledge sharing with effective cost saving in the preparation of the future workforce for the emerging fields that will be developed by the integration of STEM disciplines.

2.4.9 Insufficient role models, mentors, and the educator influence

The dearth of female scientists and female science teachers as role models and mentors (Ofosu-Mireku, 2004) for women starts from K-12. Science classrooms are dominated by male students, teachers and professors (Ofosu-Mireku, 2004). The exclusion of girls from science subjects begins at the elementary school level, when school children are exposed to images that perpetuate gender stereotypes and pass on the message that science and technology are not for girls (Pandor, 2011). Educators in some rural parts of Africa are still of the view that boys will go to university and will enroll in fields such as medicine, engineering, architecture and so on, while girls will only pursue education to become secretaries, teachers, designers and so on (Angeline, 2011). This perception or mentality of educators informs how they teach and attend to the girls in classes, particularly in mathematics and science, and this ends up influencing the performance of the girls (Akinsowon & Osisanwo, 2014).

Barley's (2000) study in Ghana provides the evidence that numerous girls lack role models and auxiliary teachers to guide them to higher accomplishments. Also, gender disparity emerges as women in academia do not have senior mentors or adequate networks to help them navigate through the inconsistencies exuding from these ambiguities and men subjectively use standards and expectations based on their encounters without any regards to the barriers and difficulties women in academia face (Etzkowitz et al., 2000; Morimoto et al., 2013). Interests of female students in STEM are disregarded by male faculty (Murray et al., 1999). Many females in science and engineering graduate fields report that male faculty and students engage together in extra-curricular activities that improve the advancement of friendly mentoring relationships with the avoidance of women (Murray et al., 1999). Role models may be particularly essential to women in light of the fact a lack of female role models in nontraditional careers (engineering, science) has been distinguished as an obstruction for women who select to enter these professions (Basoc & Howe, 1979; Betz, 1994; Betz & Fitzgerald, 1987; Hackett et al., 1989; Nauta et al., 1998, cited in Quimby & DeSantis, 2006). Undeniably, researchers have demonstrated that female students see role models to be particularly essential for women who want to seek nontraditional careers (Gilbert, 1985; Smith & Erb, 1986). Female professors in STEM serve as role models for female students. According to findings from Carrell et al. (2010) female students perform considerably better in their mathematics and science courses when their professor or teacher is a woman. Carrell et al. (2010) assertion is supported by findings from Young et al. (2013) which state that female STEM professors presented several advantages to women without disadvantaging men, and all students assessed female STEM professors as more supportive role models than male professors. For women, seeing a female professor as a role model was connected to increased implicit science identity and decreased implicit gender stereotyping. Consequently, female role models may be most productive at the automatic (implicit but not explicit) level when women respect them and view them as identical to themselves (Rudman et al., 2001).

2.4.10 Support systems: peers, faculty, parents/guardians

Support systems can be defined as seeking help through any means of communication in times of distress, providing psychological assistance to the individual by acting as an external coping resource that can reduce stress-related impediments within academic fields (Gottlieb, 1979; Rosenthal et al., 2011).

The progress of women faculty in traditionally male-dominated fields is remarkable (National Center for Science & Engineering Statistics, 2014). However, there remain areas of the academy where women are grossly underrepresented, and despite notable progress, the number of women in fields like the hard sciences continue to trail behind the number of men in terms of academic rank and tenure (Stake, 2006). The reasons for this discrepancy are debated and range from assertions that women are just not as interested as men are in fields like the hard sciences (i.e. physics, mathematics, engineering, computer science), to women who choose an academic career in the hard sciences often depart from the field to start a family (Bailyn, 2014; Blickenstaff, 2005; Maranto & Griffin, 2011). Whatever the reason(s), gender inequities persist and are the target of various change initiatives which include strategies such as engaging men faculty in gender equity work. Gender equity work is premised on understandings of what constitutes gender equity. Latimer et al., (2014) define gender equity in academia as representation of women across all fields of inquiry, at all levels of rank and administrative appointments that is proportional to the availability of women candidates in those fields. Bailyn (2003) calls for a revision of conceptions of gender equity which are satisfied with equality of opportunity for women based on male-constructed norms and/or conceptions of gender equity which tout the establishment of inclusionary policies and practices which acknowledge "an academic's outside life" as evidence gender equity has been achieved. Instead, she maintains that an "ideal image of gender equity," not only legitimates "the private sphere of 80 family, community, and other personal involvements," but equalizes "the value placed on economic and noneconomic activity". Though Bailyn (2003) admitted that idealistic conception of gender equity is easy, it is contrasted with Latimer and colleagues' that more succinct and measurable conception of gender equity, neither provide a blueprint for achieving gender equity. Indeed, scholars have theorized (Acker, 1990; Bailyn, 2003; Morahan et al., 2011; Ridgeway & Connell, 20009; Rooser, 2008; Rosser, 2007) and tested (Ely & Meyerson, 2000; Latimer et al., 2014; Nolan et al., 2012; Sturm, 2006) myriad approaches to achieving gender equity in organizations and none have suggested that their approach offers a blueprint for every context and situation. Although a review of the various approaches to gender equity in organizations exceeds the objectives of this review, it is important to note that at the crux of each theorized and empirically tested approach is the implicit assumption that gender is entrenched in the structures and designs of organizations and in the cognitive schemata of the people who inhabit them. Taking this into consideration, a brief review of literature on the gendered academic organization has been included as it is the organizational context for this study.

Gender and Academia: The post-secondary academic organization, generally, and the academic department, specifically, represent the contexts within which gender equity work takes place. In addition to traditional notions of post-secondary institutions as slow changing bureaucracies (Kezar, 2014), it has also been suggested, that like other established organizations, institutions of higher education are gendered (Acker 1990; Britton, 2000; Parsons & Priola, 2013). Acker, (1990) provides the following explanation of a gendered organization. To say that an organization is gendered means that advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female, masculine and feminine and men are almost always in the highest positions of organizational power. (Connell, 1987; West & Zimmerman, 1987; as cited in Acker, 1990 Citing, Ferguson (1984) and Leathwood (2005), Parsons and Priola (2013) explain the gendered nature of academic culture and its oppressive effects on academic women: The traditional culture of academia is based on bureaucratic hierarchical systems founded on sets of values that define and maintain a specific configuration of gender roles and relations these relations disadvantage women in both their research and managerial careers. (Park, 1996; Priola, 2007; Thomas & Davies, 2002; as cited in Parsons & Priola, 2013) Drawing on Acker (1990), Ely and Meyerson (2000) identify four categories of social practices through which gendered organizations are sustained. These include: (1) Formal policies and procedures; (2) informal work practices, norms, and patterns of work; (3) narrative, rhetoric, language, and other symbolic expressions; and, (4) informal patterns of everyday social interaction. Maranto and Griffin (2011) describe the professoriate as "a highly gendered occupation" and point to formal and informal policies and practices as evidence. For example, a perceptible disdain for faculty with "non-work responsibilities," reinforced by a time-boundless work culture, and a tenure-clock inconveniently synced with many faculty women's reproductive clocks. Acker's (1990) analysis of "the abstract worker" in gendered organizations supports Maranto and Griffin's assertion:

In organizational logic, filling the abstract job is a disembodied worker who exists only for the work. Such a hypothetical worker cannot have other imperatives of existence that impinge upon the job. At the very least, outside imperatives cannot be included within the definition of the job. Too many obligations outside the boundaries of the job would make a worker unsuited for the position. The closest the disembodied worker doing the abstract job comes to a real worker is the male worker whose life centers on his full-time, life-long job, while his wife or another woman takes care of his personal needs and his children. In her essay reflecting on lessons learned from the oft cited MIT (1999) report, Bailyn (2003) claims that senior faculty women at MIT "believe absolutely" in the notion of "the perfect academic…who gives total priority to work and has no outside interests and responsibilities." She alleges that these academic women "cannot conceive of any other way to be a first-rate scientist," which she suggests, "may explain why most of them are not married and have no children while men academics routinely have families.

Van den Brink and Benschop (2012) make the point that despite the embeddedness of gendered processes at the institutional level, gendered dynamics vary in local institutional contexts (e.g. the academic department) because of differences in "core activities, financial resources, career patterns, epistemological issues and publishing strategies". Supporting their contention, Latimer et al. (2014) explain how gendered processes shape and privilege certain academic disciplines over others. The characteristics traditionally most valued in academia (i.e. rationality and objectivity) are linked with science and masculinity and thus are seen as in opposition to non-science and femininity. As a consequence, academic disciplines are gendered based on their methods of inquiry, and those perceived to be more objective and inherently masculine are privileged. As this discussion has made clear gendered processes operate at all levels of the academic organization from the individual gendered position, to the gendered academic department and discipline, to the structures and processes which govern the larger institution. Considering this, strategic change for gender equity in the academic organization must be viewed as a multileveled process. At each level are faculty actors who play varying roles in gender equity change.

2.4.11 Self-efficacy in STEM

Belief in one's ability to perform a specific task is referred to as self-efficacy. Self-efficacy is defined as a judgment about one's ability to organize and execute the courses of action necessary to attain a specific goal. Self-efficacy judgments are related to specific tasks in a given domain (Bandura, 1997; Pajares, 2005; Zimmerman, 2000).

Self-efficacy is goal directed and its assessments direct respondents to rate their level of confidence for attaining a specific goal. Self-efficacy influences the choices individuals make in term of goal choice, the effort expended to reach those goals, and persistence when difficulties arise (Bandura, 1997; Pajares, 2005). Self-efficacy is a significant predictor of both the level of motivation for a task and ultimately task performance (Bandura & Locke, 2003); on average, individuals with high STEM self-efficacy perform better and persist longer in STEM disciplines relative to those lower in STEM self-efficacy. Moreover, it positively predicts performance beyond prior performance and ability (Bandura, 1997; Bandura & Locke, 2003).

Because self-efficacy is more directly related to performance on a specific task, it is generally a better predictor of task-specific performance than self-concept (Bong & Skaalvik, 2003; Britner & Pajares, 2006; Zimmerman, 2000). Self-efficacy is thought to influence task performance through goal setting and self-regulation during performance (Bandura, 1991; Pintrich, 2003; Zimmerman, 2000). Self-regulation includes self-monitoring or assessing one's performance during task execution as well as monitoring the outcomes of performance. Research suggests, for example, that high self-efficacy is related to greater cognitive engagement in a task (Pintrich, 2003).

2.4.11.1 The development of STEM self-efficacy

Self-efficacy beliefs are developed through the interpretation of task outcomes and the circumstances surrounding task experiences. Self-efficacy beliefs are based on four primary sources of information: mastery experience, vicarious experience, social persuasion, and physiological reaction (Bandura, 1997; Gist & Mitchell, 1992; Pajares, 2005).

Mastery experience: This refers to previous task experience and performance. Mastery experiences are opportunities to learn and practice the rules and strategies necessary to perform a task effectively. Moreover, mastery experiences provide evidence of whether an individual has the capability to succeed. If a student earned an A on his last test, then he is likely to feel confident that he can earn a high grade on his next mathematics test; however, if he earned a D on his last test, then he is more likely to doubt his ability to do well on the next mathematics test. Typically, successful outcomes boost self-efficacy whereas failures lower it.

Vicarious experience: It refers to learning through observing others perform tasks. For example, while observing a more advanced student, a novice thinks, “If she can design and construct a working robot, so can I.” Role models are especially influential when they are perceived as similar to the observer, suggesting that interaction with female faculty members and advanced students in STEM would positively affect the self-efficacy of female STEM students. Indeed, research suggests that vicarious experience is a particularly powerful determinant of girls’ and young women’s STEM self-efficacy (Seymour, 1995; Zeldin & Pajares, 2000).

Social persuasion: This refers to others’ judgments, feedback, and support. Positive feedback and encouragement, especially from influential others (e.g., parents, teachers), enhances self-efficacy. Negative feedback erodes self-efficacy. Although almost any negative remarks will decrease self-efficacy, not just any positive comments will increase it. Positive feedback and praise is most effective when it is aligned with past performance and actual ability. The receiver of the feedback must perceive the feedback to be genuine. Furthermore, social persuasion is particularly powerful when it accompanies a mastery experience (Bandura, 1997)-that is, feedback about task-related strengths and weaknesses is more informative when it is tied to a specific learning experience or previous performance (Betz & Schifano, 2000; Pintrich, 2003). For example, research has shown that when women received positive feedback related to specific events in training, their self-efficacy for the trained tasks was increased (Betz & Schifano, 2000).

Physiological reaction: This affects self-efficacy whereby an individual interprets his or her emotional and physical states to determine his or her self-efficacy beliefs. If "butterflies," nervousness, and a fear of failure occur during task preparation, an individual is likely to doubt his or her ability to succeed, and the increased anxiety is likely to have a detrimental effect on performance.

2.4.11.2 Importance of STEM self-efficacy

STEM self-efficacy predicts academic performance beyond one's ability or previous achievement because confident individuals are motivated to succeed. Students with high science self-efficacy set more challenging goals and work harder to accomplish those goals than students with low science self-efficacy. Additionally, high self-efficacy is associated with greater self-regulation, including more efficient use of problem-solving strategies and management of working time (Zimmerman, 2000). In addition to expending greater effort, efficacious individuals persist longer to complete a task, particularly in the face of obstacles and adversity (Pajares, 2005; Zimmerman, 2000). Therefore, on average STEM self-efficacy is positively related to STEM task performance.

The adoption of more difficult goals requires greater effort, which will positively affect performance. Successful performance with the new, more difficult, goal will, in turn, lead to even greater self-efficacy and thus the cycle continues (Bandura, 1997). Because of the reciprocal self-efficacy-performance relationship, it is important that beliefs about one's capabilities are accurate (Bandura, 1997; Pintrich, 2003). Being over- or under confident can undermine performance.

Self-efficacy is also positively related to interest and engagement (Schunk & Pajares, 2002), and this relation is reciprocal as well. Self-efficacy predicts initial engagement and task performance; in turn, success leads to greater intrinsic interest and a greater likelihood of engaging in that task in the future, often at a more challenging level. In fact, individuals with high self-efficacy enroll in more challenging courses than do individuals with low self-efficacy (Watt, 2006) because they perceive demanding tasks as challenges rather than threats. Highlighting the importance of perceptions of abilities rather than actual abilities for influencing motivation, research shows that interest is more highly related to self-efficacy than actual ability (Bandura, 1991).

2.4.12 Relevance of STEM education in fostering national development

Scientist engaged in scientific inquiry, discovery and exploration to understand the world. In schools, colleges and universities, curriculum courses like biology, chemistry and astronomy aim to make students understand the specific aspects of what the world holds. Technology is concerned with what can be designed, made and developed from materials and substances in natural world to satisfy human needs and wants. It alters the natural world through inventions, innovation and practical problem-solving as well as design processes. Engineering applies mathematical and scientific knowledge to develop ways of economically utilizing the materials and forces of nature in order to benefit man-kind. It draws from technology to produce resources such as energy uses through creativity and logic. Technology and engineering disciplines are strongly connected.

Finally, mathematics is the science of patterns and relationships [numerically and symbolically expressed] and provides specific language for technology, science and engineering. Actually, the practices of scientist, technologist and engineers are STEM integrated. Mathematics is the core of science and technology, engineering inclusive. According to Charles-Ogan, et al. (2017), every nation needs technology to develop its economic, human, material and natural resources. They posited that, if mathematics education is faulty, the basis for both scientific and technological development becomes faulty. A massive boost to national development is seen in the way mathematical concepts have facilitated the revolution in electronics which has changed the way we think and live. Information and Communication Technology (ICT) has changed the world into a global village. This advance in science and technology which has helped to sustain the development of our nations has been made possible through the application of mathematical concepts. Mathematics education ensures that the knowledge of the subject gained is applied to all areas of life, such as business, economics, finance, engineering, farming, sports, sciences, and arts and ensures that everybody excels in his/her area of specialization. Chado and Bala (2014) pointed out that mathematics education has effectively been an agent of sustainable development and self-reliance. Mathematics is an effective tool for developing life-long skills which makes an individual self-reliant. Lending credence to this, Ogunkunle (2014) posited that mathematics is filled with unending skills and confidence that working with mathematics concepts will improve one's practice daily, which gives support and encouragement. Notable among these skills are communication, manipulative ability, estimation ability, computation and problem – solving skills. It pre-supposes therefore that an individual with the aforementioned skills will be able to build a good inter-personal relationship which enhances unity and builds the nation. In the words of

Abakpa and Agbo-Egwu (2014), mathematics education has the potential of developing life-long skills in an individual that will enable him to add significantly to the development of the society in which he lives. In the same vein, Momoh and Yusuf (2012) and Charles – Ogan et al. (2017) stated that mathematics has been recognized as a tool for solving every day's challenges faced by individuals and ensures national stability. Branches of mathematics such as college algebra, trigonometry and statistics underscore the importance of truth and honesty and analytical thinking that can tackle the problem of bribery and corruption. That is why the need for promoting the subject and building students' proficiency is urgent if we must ensure a better future for the nation and the next generation that will inherit it.

2.5 Conceptual Framework

The conceptual framework is constructed by me in relation to the research questions of the study and a review of the theoretical models of Herrera et al. (2012) and Master and Meltzoff (2016) who applied Bandura's general social cognitive theory (Bandura, 1999) to gauge into female lecturers engaged in STEM disciplines in Ghanaian universities and are influenced by the interactions of variables as status, stature and challenges. The model is presented in Figure 2.

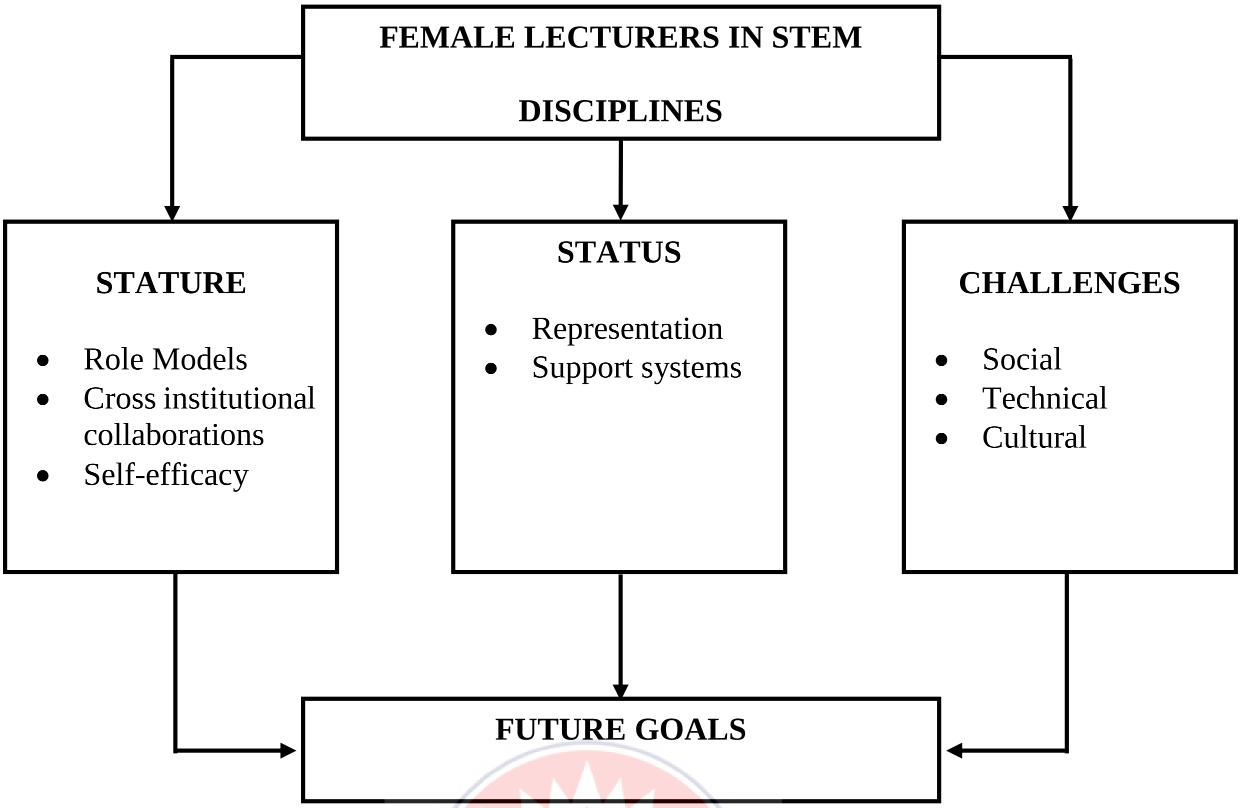

Figure 2: Conceptual framework of female lecturers engaged in STEM disciplines

Source: Researcher's own Construction

Note(s): The independent variable of the model is female lecturers engaged in STEM disciplines at the University. The dependent variables are status, stature, challenges, role models and future goals.

Status: demographic characteristics of the female lecturers from the model constituted their personality traits which play critical roles as academics. These traits include personal profiles in terms of age, education level and marital status.

Under the personality traits of the female lecturers in STEM disciplines include the academic background and experiences in terms of academic engagement which are also factored into the female lecturers' representation in STEM disciplines in Ghanaian universities. Severiens and Ten Dam (2012) attribute low enrolment in STEM education to gender differences in learner's characteristics, external and institutional factors.

The status in the study also include institutional and parental support and the availability of role models. In connection, various theories on contextual concerns were reviewed. For instance, the social role theory suggests that gender stereotypes emerge in response to the observation of women and men in different social roles and in role-linked activities related to occupational choices (Wood & Eagly, 2012; Koenig & Eagly, 2014). This is also termed as gendered socialization whereby men and women are seen as being socialized differently (Leaper, 2014). Socialization starts at home where parents' beliefs and perceptions impact children's outcomes and education choices, for instance, in STEM areas (Reinking & Martin, 2018). As bipolar constructs, gender stereotypes relate STEM with males more than with females (Cheryan et al., 2015). Two stereotypes are intertwined: a "cultural fit" stereotype (the belief that '"STEM is for males") and an "ability" stereotype (the belief that males have more ability to solve STEM problems than females) (Master & Meltzoff, 2016). Cultural and ability stereotypes impact negatively on females' motivation to opt for STEM disciplines. When young women compare themselves to these stereotypes, they feel a mismatch that indicates they do not "belong" in STEM fields (Masteret al., 2016). Gendered socialization and stereotypes at a young age influence career path as they undermine confidence, interest and willingness to engage in STEM (Cvencek et al., 2011).

Another explanation under the status within the institutional/ environmental factors is the peer group theory. Adolescents depend on peers and their judgments to know what to do and how to engage in their school or community. When few women are engaged in STEM disciplines, the peer feedback, through words or inaction, is perceived as negative (Reinking & Martin, 2018). In support, Leaper et al. (2011) show that female students' motivation in mathematics and science courses during the adolescent years is positively associated to peer support. However, the peer group influence acts as a deterrent if their "in group" does not academically succeed in STEM courses which invariably can lead to underrepresentation of female lecturers engaged in academia. Colleagues and friends may also play an important role, in supporting or disapproving of the adoption of gender conforming behaviours (van der Vleuten et al., 2018). Studies show that if friends reinforce gender-stereotypical behaviours and penalize non-conformity (Kessels, 2015), adolescents may conform to these traditional roles and this can lead to a lower likelihood of young women choosing STEM fields. Furthermore, within the environmental dynamics, STEM professions seem to be male-dominated so much that women are leaving the STEM pipeline before entering the STEM profession (Dasgupta & Stout, 2014). The pipeline model explains the underrepresentation of women in STEM via two channels: the flow of female students entering STEM education or careers and the leakage, or attrition of women who have already entered STEM disciplines or professions. The leakage problem arises when there is gender disparity when hiring women into STEM professions and/or when women leave the discipline in the middle of their careers (leaky pipeline). In addition, educational institutions when unable to support and help the few females engaged in STEM disciplines through capacity building, scholarship to boost their academic and professional development growth may invariably lead to the underrepresentation of female lecturers in Ghanaian universities. The current lack of visible representation and role models in STEM fields further explains the quest of this study to unearth the support systems that are needed to be envisaged to address the gap of females' underrepresentation in STEM disciplines in universities in Ghana. Finally, all of the above factors are currently present in academia and can thus frustrate female lecturers engaged in STEM disciplines. It is then necessary for such challenges to be overcome to enable academic excellences among the female lecturers in STEM disciplines in Ghanaian universities.

The stature: next this variable relates to self-efficacy beliefs which talks about the ability of an individual to carry out tasks with competence. These occur in terms of competence beliefs where gender stereotypes have an influence on the perceived ability, interest and motivation for females to participate and engage in STEM disciplines. Their systematic underestimation of how well they will do (Ehrlinger & Dunning, 2003) affects their output in STEM disciplines. Self-efficacy that is the belief that one cannot succeed in a given domain (here STEM) seems to be more apparent amongst females. Existing research has revealed major gender differences, favouring men, in STEM self-efficacy and in the probability of success in STEM fields (Schunk & Pajares, 2002). It has been postulated that females' underrepresentation do exist in STEM disciplines because of a greater lack of confidence amongst females compared to their male counterparts the researcher's desire to ascertain the female lecturers' self-efficacy beliefs in relation to their engagement in STEM disciplines in the universities.

Challenges: hindrances faced by female lecturers engaged in STEM disciplines as follows:

Disparity and underrepresentation of females engaged in STEM disciplines is as a result of gender roles and social practices within the young women's environment (Alon & DiPrete, 2015; van der Vleuten et al., 2018). These challenges include social, cultural and gender norms that influence the way men and women are brought up, learn and interact with parents, family, friends, teachers and the wider community. Ghana being a multicultural society, cultural attitudes and gender norms are deep-rooted in the population and gendered obstacles based on conservative norms limits young women's ability and freedom (Rambaree & Knez, 2016). Aumeerally (2005), young girls in Mauritius are conditioned by various agents and institutions to accept the dogmas of their cultural systems based on patriarchal moral norms and values. Gender norms may hinder participation in STEM-related subjects so much that STEM is viewed as a perfect match for male gender role behaviour while it is seen as contrasting with female behaviour. Traditional gender role beliefs tend to push young women away from STEM fields as it is often believed that it is better for women to get into secure jobs in the public sector with regular working hours to better undertake their domestic and care responsibilities.

The socio-cultural and institutional factors within the female lecturers' environment that affect their participation and engagement in academic activities of STEM disciplines occur where the environment in which females are work and shapes their cultural beliefs about "appropriate" male and female behaviours. Traditional gender norms postulate that young women have better social skills, and are more focused on children and family (Konrad et al., 2000). By contrast, young females are seen as being good at mathematics and science and more concentrated on financial gains and status (Diekman et al., 2010).

Incorporating the variables of the various dimensions appropriately would lead to more representations of female lecturers in academia who would invariably serve as role models for younger females to venture into STEM disciplines. Also, future goals, more numbers of females, aspirations for higher academic pedestals. Career opportunities for the quest of more involvement of females in STEM disciplines could be achieved.

2.6 Chapter Summary

The review of literature has provided a fair idea on STEM, origin of STEM, experiences of women in higher education and specifically African women in STEM higher education, female role models in STEM studies and institutional supports. The studies showcase that women are underserved educationally wise through the neglect of females in STEM studies compared to their male counterparts. Additionally, their neglect climbs to higher education. Culturally, more importance is placed on education of men than women. Even in universities and colleges, the literature draws our attention of the lack of mentors and role models for female students. It will be a disadvantage not to address the issue of postcolonial effect on women education and how the patriarchy system in postcolonial countries still dwells on such practices to suppress women education. It is important to pay higher attention to the numerous experiences of women in the classrooms so as to close the gender gap in STEM and also to seal the leaky STEM pipeline. The review of literature uncovered that there are few research studies that target specifically the experience of Ghanaian female STEM students' journey and none that target specifically doctoral experiences. There were other studies that analyzed data in multiple countries without settling on one country. Most of the research studies focused on what factors discourage Ghanaian or African high school female students from pursuing STEM education in higher education or the experiences of Ghanaian or other African national's women in STEM undergraduate programs. Also, the theoretical framework and empirical study reviews were centered on females' underrepresentation in STEM-related subjects. The conceptual framework of the study constituted an interaction of various variables pertaining female lecturers engaged in STEM disciplines in Ghanaian universities. The reviews indicated that there are gaps that exist with regards to Ghanaian females academics in STEM disciplines particularly at the university level. It is therefore imperative on this study to explore the status, stature and challenges of Ghanaian female lecturers in STEM disciplines in universities in order to make appropriate recommendations aimed at improving the representations, advancement and academic growth and development of females in STEM disciplines at the universities as the highest education academic ladder.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This section outlined the philosophical foundation of the study, research approach, research design, instrumentations, population and sampling technique, procedure, validity and reliability of the instrument.

3.1 Philosophical Foundation of the Study

The philosophy underpinning this study is within the concepts of pragmatic worldview concerning how knowledge will be gained and used in the study (Creswell, 2014). In the same vein, Patton (1990) concluded that philosophical processes in research give a clear procedure meaning on how the researcher should apply knowledge gained in the study. Pragmatism as a research paradigm finds its philosophical foundation in the historical contributions of the philosophy of pragmatism (Maxcy, 2003) and, as such, embraces plurality of methods. As a research paradigm, pragmatism is based on the proposition that researchers should use the philosophical and/or methodological approach that works best for the particular research problem that is being investigated (Tashakkori & Teddlie, 1998). It is often associated with mixed-methods or multiple-methods (Biesta 2010; Creswell & Plano Clark, 2011; Johnson & Onwuegbuzie 2004; Maxcy, 2003; Morgan, 2014; Teddlie &Tashakkori, 2009), where the focus is on the consequences of research and on the research questions rather than on the methods. It may employ both formal and informal rhetorics (Creswell & Plano Clark, 2011). A major underpinning of the pragmatist philosophy is that knowledge and reality are based on beliefs and habits that are socially constructed (Yefimov, 2004). The pragmatist epistemology is that knowledge is always based on experience. Pragmatist researchers do not push aside philosophical arguments, particularly the metaphysical arguments, to get their research done. Rather, they have come to a conclusion, after careful consideration of the effort and involvement, that the broader philosophical arguments can never be solved because, meaning is inseparable from human experience and needs and is dependent upon context (Dillon et al., 2000).

A methodological challenge of this philosophy is the aspect of pragmatism that is a part of a researcher's worldview and therefore can influence the way researchers conduct their project. Kuhn's (1962; 1970) concept of paradigms has also been explored as a set of shared beliefs among a research community to elaborate on what counts as most important research questions and the most appropriate research methodology (Morgan, 2007). This is important as not all research questions are fundamentally important, nor are the methodologies automatically appropriate. Ultimately, it is the researcher who makes the choices and decides which question is important and what methodology is appropriate, and those choices are certainly influenced by the aspects of socio-political location of the researcher, his/her personal history, and his/her belief system (Morgan, 2007).

3.2 Research Approach

Mixed method approach was chosen for the study. This was done because the philosophical foundation of the study was the pragmatic paradigm which is in line with mixed method approach. Mixed methods may be defined as research in which the investigator collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches in a single study (Tashakkori & Creswell, 2007).

Many reasons have been identified for conducting a mixed methods research study. Following a review of theoretical and empirical literature, Greene et al. (1989) identified five purposes for conducting mixed methods research designs. These are triangulation, complementarity, development, initiation and expansion. The main rationale or benefits proposed for undertaking the mixed methods study were for triangulation and completeness. Triangulation allows for greater validity in a study by seeking corroboration between quantitative and qualitative data. Completeness uses a combination of research approaches provides a more complete and comprehensive picture of the study phenomenon. Many authors argue that utilising a mixed methods approach can allow for the limitations of each approach to be neutralised while strengths are built upon thereby providing stronger and more accurate inferences (Bryman, 2006; Creswell, et al., 2003). Answering different research questions: Creswell and Plano Clark (2007) argue that mixed methods research helps answer the research questions that cannot be answered by quantitative or qualitative methods alone and provides a greater repertoire of tools to meet the aims and objectives of a study. Furthermore, Sale et al. (2002) identify how a combination of research approaches is useful in areas such as nursing because of the complex nature of phenomena and the range of perspectives that are required. Mixed methods studies can use one research approach (i.e., quantitative or qualitative) to explain the data generated from a study using the other research approaches. This is particularly useful when unanticipated or unusual findings emerge. For example, findings from a quantitative survey can be followed up and explained by conducting interviews with a sample of those surveyed to gain an understanding of the findings obtained. Illustration of data: using a qualitative research approach to illustrate quantitative findings can help paint a better picture of the phenomenon under investigation. Bryman (2006) suggests that this is akin to putting 'meat on the bones' of dry quantitative data. A qualitative phase of a study may be undertaken to develop hypotheses to be tested in a follow-up quantitative phase. A qualitative study may generate items for inclusion in a questionnaire to be used in a quantitative phase of a study. These points identify the usefulness that a mixed methods research approach can have in answering a particular research question. However, it has been noted that mixed methods research may have more practical benefits in terms of attracting research funding (Giddings, 2006). Increasingly, agencies funding large research projects are showing an interest in interdisciplinary research which involves collaboration between various disciplines in a certain field. This is particularly so in health sciences where collaboration on large research projects between nursing, medical and paramedical professionals is increasingly promoted and encouraged. Different disciplines bring with them different research histories with medicine more traditionally associated with positivist or quantitative paradigms and methods and nursing more associated with more interpretivist or qualitative ones. Therefore, the utilisation of a mixed methods research approach helped to meet the requirements of funding agencies that look for interdisciplinary research using a variety of methods.

3.3 Research Design

The research design for this project was the descriptive survey that employed the concurrent triangulation mixed-method (Creswell et al., 2003) as both quantitative and qualitative data were collected and analysed in concert to answer the study's research questions. In this concurrent triangulation approach, the researcher collected both quantitative and qualitative data at the same time and then compared the two databases to determine if there was convergence, differences, or some combination (Fig 3). Some authors refer to this comparison as confirmation, disconfirmation, cross validation, or corroboration (Bird, & McCormick, 1992; Greene, Caracelli, & Graharn, 1989; Morgan, 1998)

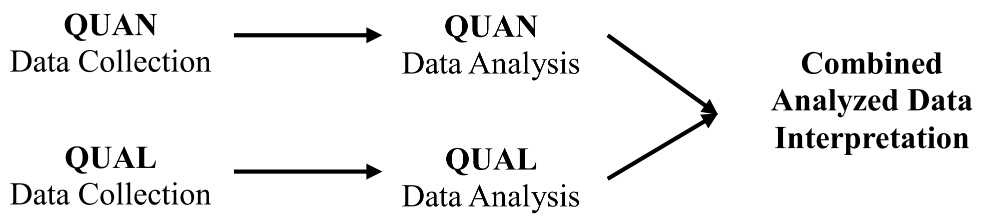

Figure 3: Concurrent triangulation design by Creswell, Plano Clark, Gutmann, and Hanson (2003)

This design typology helps to clarify how data was collected, how data was analyzed, and how research questions were addressed. This classification convention builds upon earlier mixed methods research design classification frameworks by (Creswell et al., 2003; Teddlie & Tashakkori, 2003). Where appropriate, both quantitative and qualitative analysis are given equal weight in answering the research questions guiding this study as the intent was not only to evaluate the perceived influence of STEM on female lecturers' engagement in academia. Concurrent explanatory design which represents a two-phase mixed method design was employed where data of both phases were collected at the same time and analysed separately. Results of the two phases were then integrated and explained to provide meaning to the findings of the study (Creswell et al., 2003). This design was a great asset to the study in which the researcher needed to explain some essential or surprising results (Morse, 1991).

3.4 Population

The population of the study consisted of individual traits that the researcher is interested in (Creswell & Creswell, 2018). For the purpose of exploring female lecturers' status, stature and challenges in STEM disciplines in Ghanaian universities, the target population was all female lecturers in STEM disciplines in Ghanaian Universities. Appendix B shows the distribution of the target population of the study.

The target population of the study was heterogeneous and made up of female lecturers engaged in STEM disciplines in all Universities in Ghana. There were 17 public Universities in Ghana at the time of the study. Out of this, 15 of them offer STEM disciplines. The accessible population consisted of female lecturers engaged in STEM disciplines in public universities.

The researcher was interested in universities that offer STEM disciplines and female lecturers teaching such disciplines because she believes they share similar intentions about their status, stature and challenges in STEM disciplines throughout their journey in reaching this higher height in academia. The accessible population consisted of female lecturers engaged in STEM disciplines in public universities.

3.5 Sample and Sampling Techniques

This section described the procedure the researcher used to arrive at the sample size. Since the methodology was mixed-method approach, it was appropriate to show the procedure used to arrive at the sample and sub-sample for the quantitative and qualitative phases of the study respectively. The next section discusses the sampling procedure for both quantitative and qualitative phases.

3.6 Sample

A sample is the part of the population which the researcher is interested in for the study (Patten & Newhart, 2017). However, Creswell and Creswell (2018) asserted that a sample is a subset of the population which the study findings is applicable to. For the purpose of the study, it was important to select an adequate sample that reflected the entire population. Purposive sampling technique was used to select 62 female lecturers engaged in STEM disciplines from six public universities for the quantitative phase of the study. Convenient sampling technique was used to select a sub-sample of 22 participants for the qualitative phase. Selection of the 22 participants was to ensure that detailed analysis of the data would be carried out since qualitative responses usually reveal varied views through open-ended questions. Table 2 and Table 3 show the distribution of the participants for the study for the quantitative and qualitative phases.

Table 2: Distribution of Sample for Quantitative Phase

SN	Institution	Science	Stem Related Disciplines Technology	Engineering	Mathematics	Grand Total
1	Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development	5	2	2	2	11
2	C. K. Tedam University of Technology and Applied Sciences	3	1	0	2	6
3	Kwame Nkrumah University of Science and Technology	5	3	2	4	14
4	University of Cape Coast	4	2	0	2	8
5	University of Ghana	5	3	2	4	14
6	University of Mines and Technology	3	2	2	2	9
	Total	**25**	**13**	**8**	**16**	**62**

Source: Field Data (2022)

Table 3: Distribution of Sub-Sample for Qualitative Phase

SN	Institution	Science	Stem Related Disciplines Technology	Engineering	Mathematics	Grand Total
1	Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development	1	1	1	1	4
2	C. K. Tedam University of Technology and Applied Sciences	1	1	0	1	3
3	Kwame Nkrumah University of Science and Technology	1	1	1	1	4
4	University of Cape Coast	1	1	0	1	3
5	University of Ghana	1	1	1	1	4
6	University of Mines and Technology	1	1	1	1	4
	Total	**25**	**13**	**8**	**16**	**22**

Source: Field Data (2022)

3.7 Instruments

Research instrument refers to any tool that a researcher may use to collect or obtain data that is relevant to the subject of the research. After carefully examining the research questions and the purpose of the study, I employed the use of a self-constructed questionnaire and semi-structured interview to collect data for the quantitative phase and qualitative phase respectively.

3.7.1 Questionnaire

A questionnaire was used to collect data for the quantitative phase of the study. Questionnaire are data collection research instrument used to contain different question items and are used to solicit information from respondents (Pattern & Newhart, 2017). In the same vein, Nardi (2018) asserted that a questionnaire is a research instrument which provides wide variety of questions for respondents to choose options that reflect their opinions on the items. The questionnaire was the appropriate tool for the quantitative phase because it allows the researcher to quantify large results by using software.

The questionnaire consisted of 71 items distributed among seven sections (Appendix C). Section A constituted eight items to collect background information of respondents which were used. Section B consisted of eight items used to elicit information on female science lecturers' representation in the STEM disciplines in public universities in Ghana while section C with 24 items assessed the institutional, technical and cultural challenges that hinder their professional and academic growth. Section D consisted of eight items which were used to collect data on current cross-institutional collaborations designed by the relevant stakeholders to enhance the career aspirations of the Ghanaian female science lecturers. This was then followed by section E with eight items to obtain information on network of local and international role models available for the female science lecturers in public universities of Ghana. Section F consisted of eight items which sought information on institutional commitment and support systems put in place or being envisaged to boost the confidence and capabilities of female science lecturers in STEM disciplines in Ghanaian public universities. Finally, section G made up of eight items solicited information on the self-efficacy beliefs of the female lecturers and how these beliefs influence their academic and professional growth. Each item consisted of a statement followed by five weighted options namely: Strongly disagree (=1-1.5), Disagree (=1.6-2,5), Neutral (=2.6-3.5), Agree (=3.6-4.5) and Strongly agree (=4.6-5.0). Fig 4 is a summary of the questionnaire used to collect data for the study.

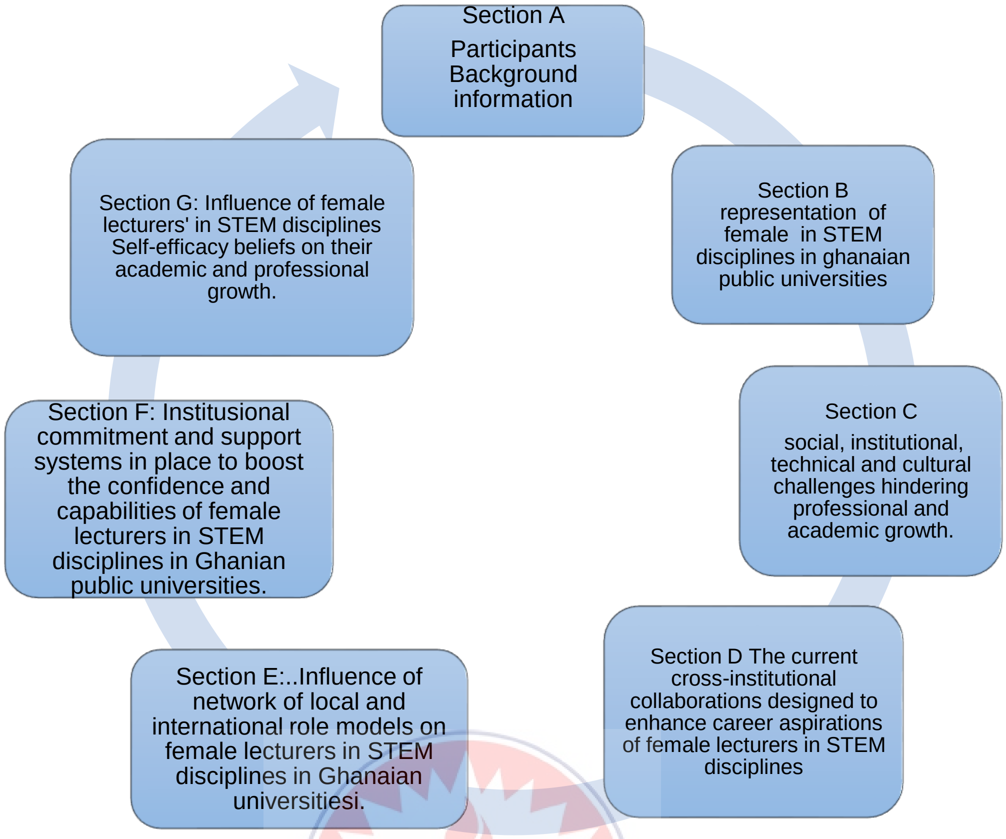

Figure 4: Summary of Questionnaire

Mirahmadizadeh et al. (2018) proposed an approach to which the range of mean values can be used to interpret data analyzed from a Likert Scale. They assert that a mean value of 1.0 - 1.5 indicates a strong disagreement (SD), or strong negative sentiment, which means that respondents strongly disagree with the statements and hold a negative attitude towards the subject. A mean value of 1.6 - 2.5 **i**ndicates a disagreement (D), or negative sentiment, which implies that respondents of the study generally disagrees with the statements and have a negative attitude towards the subject. A mean value of 2.6 - 3.5 also **i**ndicates a neutral (N) or ambivalent sentiment with its interpretation being that respondents neither strongly agree nor disagree with the statements proposed. That is the respondents might have mixed feelings or lack a clear opinion about the question being asked. Furthermore, a mean value of 3.6 - 4.5 indicates an agreement (A) or a positive sentiment, with an interpretation that respondents generally agree with the statements and have a positive attitude towards the subject. Finally, a mean value of 4.6 - 5.0 indicates a strong agreement (SA) or strong positive sentiment revealing that respondents strongly agree with the statements and hold a positive attitude towards the subject. Notwithstanding, there seems to be some concerns as to whether Likert-type scales are a good instrument for measuring attitude (Gal & Ginsburg, 1994). However, other researchers (Robson, 2002; Neuman, 2000) favour the use of Likert-type scales.

3.7.2 Semi-structured interview

An interview is the interaction between two or more people where one individual (referred to as the interviewer) asks questions to others (interviewee or interviewees) to extract information (Nicholls & Ormston, 2013). Interview can be conducted through different media such as face-to-face, telephone and internet (Silverman, 2015) and can be categorized into unstructured, structured and semi-structured (Creswell & Creswell, 2018; Kusi, 2012). At the qualitative phase, a semi-structured interview guide was used for data collection (Appendix D). A semi-structured guide allows for probing of interviewee's responses to unearth issues not listed in the interview guide (Dawson, 2019). The interview was to seek clarification on the issues raised in the quantitative phase.

I adapted Castillo-Montoya's (2016) procedure for preparing an interview protocol. The interview protocol was developed with the guide from research questions. The researcher introduced and explained the purpose and procedure required before the conduct of the interview.

3.8 Reliability and Validity of the Instruments

Reliability and validity are fundamental elements in measuring how instruments were used to gathered data (Creswell, 2014; Dennick, & Tavakol 2011). The terms validity and reliability may appear identical, but they have entirely different meanings when it comes to the measurement of concepts in research (Bryman, 2012).

3.8.1 Reliability

Silverman (2015) defines reliability as the degree to which research produces the same results when repeated by different researchers in different contexts. However, Kusi (2012) asserted that the essence of reliability was replicability of research findings. In the study, a test-retest reliability procedure was used during pilot testing. The researcher collected two (2) sets of data within two (2) weeks from the same respondents to check if the result was consistent for the quantitative phase. Test-retest criteria gave the instrument consistent scores when taken by the same participants at different times (Creswell & Creswell, 2018; Teddlie & Tashakkori, 2011). This study yielded a reliability coefficient value at an alpha level of 0.81 which showed that the instrument was reliable. Ikart (2019) indicated that if an instrument yields an alpha level above 0.7 then the indication was that the instrument has high reliability.

3.8.2 Validity

Tashakkori and Teddlie (2010) define validity as the degree to which a concept or the values of the questionnaire accurately or truly measured what was supposed to be measured (Tashakkori & Teddlie, 2010). Cohort researchers like Creswell and Creswell (2018); Creswell (2014) and Kusi (2012) asserts that validity represents the degree to how test results accurately reflect the social phenomena under study. This current study's validity was checked for both quantitative and qualitative phases when the instruments were given to experts in research to assess the questions. Based on the feedback received from experts, the questions were modified to suit the content of the study (Creswell & Creswell, 2018; Welman & Kruger, 2001).

There are three ways of ensuring trustworthiness for mixed-method studies. These criteria are data triangulation or respondent triangulation, reflexivity and analytical adequacy (Creswell & Creswell, 2018; Kusi, 2012 Pattern & Newhart, 2017). The choice of the concurrent triangulation mixed-method design was underpinned by the pragmatism research paradigm. There was flexbiltlity in the research process because during data collection, multiple source or participants were involved in the study. These included respondents (questionnaire and interview). However, data triangulation was used to cross-check findings from the method used to ensure trustworthiness (Creswell & Creswell, 2018; Kusi, 2012; Smith, 2005). Reflexivity refers to understanding the researcher's feedback in consciously co-constructing the situation to be analyzed (Creswell & Creswell, 2018; Pattern & Newhart, 2017). In the research process, the subjectivity of the researcher and those being examined were important. My training in education, gender, supervisor of pre-service teachers and mentoring afforded me the knowledge to assess the status, stature and challenges of female lecturers in STEM disciplines in Ghanaian universities. The researcher was familiar with the situation of female lecturers in STEM in Ghana. The background of the researcher helped in exploring the issue of female lecturers in STEM. However, the researcher did not relate her knowledge and opinions but allowed the voice of the respondents to reflect in the data. The researcher's background knowledge was only drawn on probing questions during the interview session to make an in-depth assessment of the case.

After a successful data collection, the way and manner by which the data were analyzed had implications on the rigours of both quantitative and qualitative components (Creswell & Creswell, 2018). Analysis of data had strong implications, especially on the internal validity or credibility of the research (Silverman, 2015). If the data is analyzed correctly, it would ensure that the findings are accurate and credible. In this study, the first strategy I employed to achieve validity, reliability and trustworthiness was providing a detailed procedure in the analytical process (Silverman, 2015). This ensures that readers are left with no doubt in their minds as to who did the qualitative analyses and how the data analysis was done (Creswell & Creswell, 2018). Another strategy that was also used was that of inter-rater reliability for the quantitative and qualitative phases where two lecturers who are experienced in data analysis were given the data and their results were compared and this has helped reduce subjectivity in the analysis whereby increasing credibility and dependability (Creswell & Creswell, 2018; Pattern & Newhart, 2017).

3.9 Pilot Testing of Instruments

The instruments for data collection were pretested in a purposively selected public university. Pre-tests of the instruments were administered at different stages with four female lecturers chosen for the interview whereas twenty female lecturers completed the questionnaire. The purpose of piloting the instrument was to check for consistency, accuracy, reliability and applicability of the instrument. Piloting was also done to identify instructions that respondents might misunderstand which could prevent reliable data gathering.

3.9.1 Pilot testing of questionnaire

Two weeks after the first questionnaire was administered to the respondents, a second one was administered to same group. The procedure used for checking reliability of the quantitative instrument was test-retest. The Cronbach's alpha was used to determine the reliability and internal consistency of the questionnaire. The results of the analysis are presented in Table 4 below.

Table 4: Distribution of Cronbach Alpha Reliability Coefficient among Sub-scales of the Questionnaire

Sub-scale	Test 1	Test 2
Section B	0.81	0.79
Section C	0.83	0.81
Section D	0.74	0.75
Section E	0.84	0.84
Section F	0.85	0.86
Section G	0.81	0.80

Source: Field survey, (2022)

Table 4 showed that test 1 and test 2 were consistent. For instance, section D, E, F and G showed a consistent result (0.74, 0.84, 0.85, 0.81 and 0.75, 0.84, 0.86, 0.80) respectfully for both tests. The test-1 yielded an alpha level of 0.81 while alpha level for the second test was also 0.81. However, the overall alpha level for the instrument was 0.81. The Alpha levels of the instrument and that of the sub-scales were reliable since the values were greater than the recommended value of 0.7. Ikart (2019) indicated that if an instrument yields an alpha level above 0.7 then the indication was that the instrument has high reliability.

3.9.2 Pilot testing of interview

Piloting of the interview took about 30 to 45 minutes to complete each interview. For the interview protocol, the researcher applied Castillo (2016) Montoya's methodology. The researcher observed all ethical concerns before beginning data collection and before performing the interviews. The following processes were used when pilot testing the instruments: 1) The original interview questions were reworded because they were too many, ambiguous, verbose, and difficult for the respondents to understand. Following the pilot testing, more succinct interview questions were created; 2) The researcher noticed a pattern in the interviewees' tendency to leave most sentences unfinished while listening to the interview tapes; and 3) The interview questions were reviewed prior to data collection at the study site.

I followed Castillo (2016) Montoya's step for piloting interview instrument:

- Rewording of interview questions: The initial interview questions were too many, ambiguous, verbose, and too complex for the respondents to understand. A more concise set of interview questions were developed after the pilot testing.
- Sharpening of interview skills: For instance, listening to the interview tapes the researcher realized that most of the sentences were not completed by interviewees.
- The review of interview questions was done before data collection at the study area and this heled to obtain credible data for analysis.

3.10 Trustworthiness of the Study

Issues of trustworthiness were arguably fundamental critical issues that need to be addressed in research, particularly in mixed-method studies (Montuschi, 2014). The core reason was based on the argument that qualitative research was subjective and value-laden (Montuschi, 2014). The traditional ways of checking the rigour of research studiesare normally validity and reliability (Creswell & Creswell, 2018; Teddlie &Tashakkori, 2011). However, there are fundamental ways of ensuring rigour research. These are dependability, confirmability, credibility and transferability (Silverman, 2015).

3.10.1 Transferability

The first element adapted to ensure trustworthiness was the transferability of findings in the qualitative phase which was equivalent to external validity in the quantitative phase that is the extent to which the findings of the study can be applied to other studies in a broader context (Silverman, 2015). In concurrent triangulation mixed-method design, the generalization of the quantitative findings was not difficult but for the qualitative finding it was difficult. For example, the problem under study may be similar to that of other countries. The purpose of the study was not to generalize the findings but to show readers about the current state or situation of female science lecturers in STEM disciplines. However, if readers find commonality between the contexts and their context of the study, then they can transfer the findings to their contexts.

3.10.2 Credibility

Credibility refers to the extent to which trustworthiness and believability of findings are often associated with the internal validity of quantitative studies that is the degree of confidence with which the results from a study are conclusive and cannot be influenced or changed by other factors (Teddlie & Tashakkori, 2011). The researcher adapted Kusi's (2012) procedures for checking the credibility of the study.

- The instruments were used to obtain data using a language that was understood by both the researcher and research participants to avoid misunderstanding.
- The researcher ensured that no distortion took place while the interview was conducted to allow the free flow of information.
- Regular checks by my supervisor helped to correct errors and problems that occurred during data collection and analysis in the study.

- Lastly, three (3) scholars with knowledge about the research area, administration and data analysis were given the research instruments to peruse for mistakes in the procedure for reporting the findings and research process in general.

3.10.3 Dependability

The first step the researcher used in checking dependability was the request that the participants approve or disapprove of their comments after the interview session. Secondly, the researcher gave the work to three (3) independent raters who are not connected to the present study. After comparing the notes from these independent raters, their agreement on the questions, themes and findings was rated as 85%. The researcher presumes that the work was consistent and similar results were obtained when the instruments were pre-tested in the selected public university in the Northern region.

3.10.4 Confirmability

Confirmability was also defined as the measure of objectivity in evaluating research results (Teddlie & Tashakkori, 2011). Credibility refers to the extent of trustworthiness and believability of the findings, and it was often associated with internal validity (Creswell, 2014). The confirmability of qualitative data corresponds with the objectivity of data in the quantitative phase. The principle highly depends on evaluation techniques such as assessment of the research process at all times and checking for background knowledge of the researcher. I remained unbiased and ensured that the constructions of research findings that emerged directly from the data were presented without altering the results.

3.11 Data Collection Procedure

An introduction letter (Appendix A) was obtained from the faculty of Science Department in the University of Education and used to obtain permission from the selected universities to carry out the study. The researcher on her part as a staff of one of the universities discussed with colleague female lecturers about the research and sought for their support on the distribution and retrieval of the questionnaire. The respondents from the various universities were also briefed on the intended research and the date of questionnaire administration was communicated to them. Respondents were assured of their confidentiality and the benefit of the study to them. The questionnaires were administered and conducted within the comfort of respondents to facilitate easy and prompt retrieval since some of the respondents were busy with academic engagements. The researcher conducted the interview at the respondents' place of convenience to ensure full participation. The interview session with a participant lasted for 25-30 minutes. Finally, the completed questionnaires were collected after the respondents indicated that they had responded to all the items. Recordings of the interview were transcribed into themes in relation with the research questions of the study.

3.12 Data Analysis

Data analysis is defined as refined findings that expand knowledge, influence policy and practice, and also broadens theory and literature (Creswell & Creswell, 2018). Since the study is a concurrent triangulation mixed-method design, different analytical tools and procedures were used in analysing both quantitative and qualitative data before it is merged.

3.12.1 Quantitative data analysis

At the quantitative phase, the descriptive statistics have been used for the data analysis. The descriptive statistics function of the Statistical Package for Social Sciences (SPSS) version 25.0 software was used for the analysis process. The descriptive statistical tool was used to organize and analyze the data obtained. The background information of the respondents with frequencies, percentages were presented in tables and means and standard deviation which were to answer the research questions. The mean score can be calculated by the sum divided by the number of scores (Mcmillan & Schumacker, 2010; Ofori & Dampson, 2012; Tredoux & Durrheim 2013). Ofori and Dampson (2012) confirms that standard deviation measures the variability of scores from a group. The findings from the research questions were explained with the help of Mirahmadizadeh et al. (2018), format for interpreting score values (FIG 5). The interpretation was also done with very low= SD, low= D, moderate –N, high=A and very high=SA. In addition, high percentages of the individual statements of respondents from the results were used alongside the means and standard deviations for data interpretations because they correspond with the means.

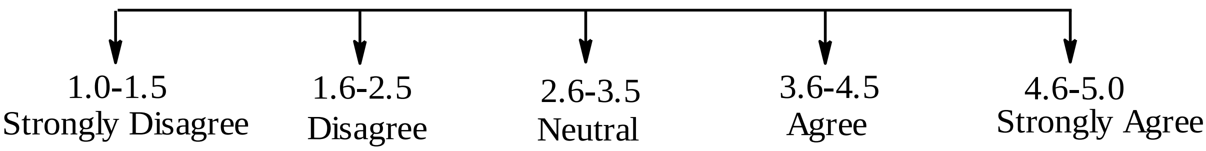

Figure 5: Represents the scoring range used by the researcher in the study

3.12.2 Qualitative data analysis

The researcher adapted content data analysis to organize the qualitative data into interpretable forms on the research questions to summarise the results.

The audio recorded interview were transcribed verbatim. Data were then thematically analyzed. The results of the analysis were used to answer the relevant research questions. The interview transcription of participants' comments was assigned with serial codes. In addition, anonymity was observed by using the initials of the name of institution as participants' identities. Interviewees from Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AMUSTED) had these codes (AM1), (AM2), (AM3) and (AM4), where as those from C. K. Tedam University of Technology and Applied Sciences (CKT-UTAS) were assigned (CK1), (CK2) and (CK3), interviewees from Kwame Nkrumah University of Science and Technology (KNUST) had codes as (KN1), (KN2), (KN3) and (KN4) whilst those from University of Cape Coast (UCC) were coded as (UC1), (UC2) and (UC3) with interviewees who were from University of Ghana (UG) being coded as (UG1), (UG2), (UG3) and (UG4). Finally, interviewees from University of Mines and Technology (UMaT) were assigned: (UM1), (UM2), (UM3) and (UM4). The next section presents the ethical considerations.

3.13 Ethical Considerations

Patten and Newhart (2017) asserted that research ethics aim to protect participants right which build trust and integrity in the research process. In all academic research, researchers are advised to follow some professional rules and regulations that provide confidence and ensure privacy to the participants (Nardi, 2018). The following ethical consideration are discussed before the data collection process began: permission, anonymity, informed consent and confidentiality.

Prior to data collection, I submitted the proposal to the Institutional Review Board (IRB) at the University of Education, Winneba (UEW) before carrying out the study. Again, the researcher ensured that she obtained permission from all the six (6) public universities and the respondents before data collection process took place (Appendix

A). After securing permission from authorities in various public universities, the researcher then discussed the purpose/aim and research process with the respondents and sought their consent (Appendix A) before the data collection process began.

Magwa and Magwa (2015) define informed consent as ethical consent, which allows participants to participate or not to participate after the purpose of the study has been given to them. In this study, the researcher observed informed consent by allowing or giving the respondents the liberty to choose to participate or not to participate after the purpose of the study has been explained to them.

I also assured the participants about their obligation to keep their personality in private (Creswell, 2014). In addition, I ensured participants' data was not shared with outside user but for academic purpose which helped protect the identity of the respondents.

3.14 Chapter Summary

This chapter of the study constituted the methodology that provided an insight into what and how the study has been conducted. The chapter begun with the philosophical foundation which is the pragmatic worldview that underpinned the study. The chapter showcased the mixed method approach with the descriptive survey design in which data were collected through the concurrent triangulation method. The population, sample and sampling techniques were carried out through the purposive and convenient sampling techniques to obtain 84 female lecturers for the study. The research instruments employed were questionnaire and interviews which were piloted and their reliabilities and validities determined with trustworthiness were considered. Data collection procedure and analysis plan were also considered. Finally, ethical considerations in the forms of permission, anonymity, informed consent and confidentiality were looked at in this chapter.

CHAPTER FOUR

RESULTS

4.0 Overview

The purpose of the study was to explore the status, stature and challenges of female lecturers in STEM disciplines in Ghanaian public universities. This chapter presents how data for the quantitative and qualitative procedures were analyzed. Data was analyzed and presented into three sections. The first section presented data on the quantitative phase while the second section presented data on the qualitative phase whilst the comparative analysis of both quantitative and qualitative data was also done. Below are the research questions:

1. How are female lecturers represented in STEM disciplines in Ghanaian public universities?
2. What are the social, institutional/technical and cultural challenges hindering female lecturers' professional and academic growth in STEM disciplines in Ghanaian public universities?
3. What cross-institutional collaborations have been designed to enhance the career aspirations of the Ghanaian female lecturers in STEM disciplines?
4. To what extend has network of local and international role models influenced the female lecturers in STEM disciplines in public universities of Ghana?
5. What institutional commitment and support systems are in place or being envisaged to boost the confidence and capabilities of female lecturers in STEM disciplines?
6. How do female lecturers' self-efficacy beliefs influence their academic and professional growth in STEM disciplines?

4.2 Presentation of Results

4.2.1 Analysis of quantitative data (Demographics)

The quantitative data was gathered through questionnaires. Descriptive statistics was used to analyze the data. The demographic data was organized into frequency counts, percentage and were presented in tables. The analysis was carried out based on the research questions. The analysis was done to investigate the status, stature and challenges of female lecturers in STEM disciplines in Ghanaian universities. The overall survey of 62 respondents participated in the quantitative phase. The researcher used descriptive statistics to analyze the data.

The first part of this section presents findings from respondents' sociodemographic profile of the study. The sociodemographic data of respondents include name of the university, age, marital status, educational qualification, educational rank, STEM subjects taught by lecturers and number of years of teaching experiences. The results showed that all female respondents completed the questionnaire and there was 100% retrievals. The next section explains how respondents were distributed among the six universities.

4.2.1.1 Universities of respondents

Table 5 shows the distribution of the respondents among the public universities who participated in the study.

Table 5: Distribution of Respondents among the Selected Universities

Type of university	Frequency	Percentage
KNUST	14	22.6
UG	14	22.6
AAMUSTED	11	17.7
UMaT	9	14.5
UCC	8	12.9
CKT-UTAS	6	9.7
Total	**62**	**100**

Source: Field data, Ayeriga (2022)

It was revealed that KNUST and UG had the highest and equal number of respondents. 14 (22.6 %). This could be due to the fact that they run all the four STEM disciplines and are also the oldest public universities in the country. The third institution with a larger number of respondents was AAMUSTED with 11 (17.7 %) followed by UMaT with 9 (14.5 %). UCC followed with 8(12.9 %) respondents whilst CKT-UTAS had the least number of respondents of 6 (9.7%). Even though CKT-UTAS was affiliated to UDS for over two decades running science and technology programmes, the least number could be attributed to the fact that it gained its autonomy just two years ago. The next section presents age distribution of the respondents.

4.2.1.2 Age distribution of respondents

The section presents the age distribution of the respondents which is presented in Table 6.

Table 6: Age Distribution of Respondents

Age range	Frequency	Percentage
31-40	25	40.3
41-50	14	22.6
51-60	14	22.6
20-30	6	9.7
Above 60	3	4.8
Total	**62**	**100**

Source: Field data, Ayeriga (2022)

From Table 6, the dominant age group was within the range of 31-40 years with a percentage of 25 (40.3%) of the sample. This was followed by the age range of 41-50 and 51-60 with a percentage of 14 (22.6 %) of the respondents respectively. This implies that a significant number of respondents were nearing retirement. The range of 20-30 had a percentage of 6 (9.7 %) and finally, Participants above the age of 60 years were in the minority 3 (34.8%). The results showed that the dominant age of respondents was within the middle age group. The younger age group from 20-30 represented only 6 (9.7 %(). Though the respondents above the age of 60 years were few3 (4.8 %.) they could still be of great support to universities through mentoring services to the younger generations in STEM studies.

4.2.1.3 Marital status of respondents

This section discusses the marital status of respondents who participated in the study, Respondents were either single, married or divorced.

Table 7: Marital Status of Respondents

Marital status	Frequency	Percentage
Married	42	67.7
Single	18	29
Divorced	2	3.2
Total	**62**	**100**

Source: Field data, Ayeriga (2022)

The results showed that majority of the respondents were married 42 (67.7 %) whilst 18 (9.9 %) of the respondents were single. The remaining percentage of 3 (3.2 %() was divorced. It implies that majority of female lecturers engaged in STEM disciplines were married.

4.2.1.4 Educational level of respondents

This part considers the educational level of respondents in the study. Table 8 shows the distribution of the educational level of respondents in the study.

Table 8: Distribution of Respondents' Educational Level

Variable	Frequency	Percentage
PhD	47	75.8
Master's degree	15	24.2
Total	**62**	**100**

Source: Field data, Ayeriga (2022)

Table 8 revealed that 47 (75%) of female lecturers obtained PhD as their highest educational level whilst 15 (24.2%) were at the master's level.

4.2.1.5 Professional rank of respondents

This section considers the professional rank of respondents in the study. Table 9 shows the distribution of the professional ranks of respondents in the study.

Table 9: Distribution of Professional Ranks among Respondents

Professional rank	Frequency	Percentage
Snr. Lecturer	25	40.3
Lecturer	23	37.1
Assist. Lecturer	8	12.9
Asso. Prof	4	6.5
Full Prof	2	3.2
Total	**62**	**100**

Source: Field data, Ayeriga (2022)

The results showed differences among the professional ranks of respondents. Majority of respondents 25 (40.3 %) were Senior lecturers and only 2 (3.2 %) were of full professorial status. The bulk of the respondents (84.3%) were lecturers and senior lecturers.

4.2.1.6 STEM disciplines taught by respondents

This section presents the specific STEM-related subject taught by respondents. Table 10 shows the distribution of STEM subjects taught by the respondents.

Table 10: Distribution of STEM Disciplines Taught by Respondents

STEM subjects taught	Frequency	Percentage
Science	25	40.1
Mathematics	16	25.8
Technology	11	17.7
Engineering	10	16.1
Total	**62**	**100**

Source: Field data, Ayeriga (2022)

Table 10 revealed that a good number of the respondents 25 (40.1%) were teaching science. This was followed by mathematics with 16 (25.8 %,) of the respondents while technology had 11 (17.7%). Engineering had the least percentage of female lecturers 10 (16.1%). This showed that among the STEM disciplines taught, science is the most popular among the respondents whilst engineering was the least popular among respondents. From the data it implies that engineering is not popular among the respondents perhaps, it is not attractive to them.

4.2.1.7 Years of working experience of respondents

This part explained the number of years respondents had taught in the universities. Table 11 shows the distribution of respondents by their years of teaching experience.

Table 11: Respondents' Years of Experience of Teaching

Years of experience	Frequency	Percentage
11--15	27	43.5
6--10	18	29
Less than 5	6	9.7
21--25	5	8.1
16--20	4	6.5
Above 25	2	3.2
Total	**62**	**100**

Source: Field data, Ayeriga (2022)

The respondents' years of teaching experience ranged from less than 5 years to above 25 years. The range of 11-15 years of teaching experiences had the highest percentage of 27 (43.5%). About 2 (3.2%) of the respondents had above 25 years of teaching experience. Further details are provided in the table.

Majority of the respondents (79%) had less than 25 years of teaching experience. This was significant towards the participation of female lecturers in STEM-related programmes since they still have a lot years ahead of them.

4.2.2 Further presentation of results based on research questions

This section provides a summary of data collected to answer research questions. The descriptive data from the questionnaire was coded and analyzed with the help of statistical package for social sciences (SPSS) version 25.0. The descriptive function of the SPSS was used to compute the statistics (frequencies, percentages, mean and standard deviation).

4.2.2.1 Research Question 1

How are female lecturers represented in STEM disciplines in Ghanaian public universities?

This research question sought to find out the representation of Ghanaian female lecturers in STEM subjects in public universities. In this section, respondents were given a series of statements to indicate whether they agreed, disagreed or were uncertain on issues pertaining to the representation of female lectures in STEM subjects in universities. Table 12 shows the descriptive statistics of the representation of female lecturers in STEM disciplines.

Table 12: Descriptive Statistics of Representations of Female Lecturers in STEM Disciplines

SN	Statement	SD	D	N	A	SA	M	SD
		f(%)	f(%)	f(%)	f(%)	f(%)		
1	Involvement of female lecturers as role models in STEM disciplines enhanced effective teaching of STEM subjects.	3(4.80%)	3(4.80%)	6(9.70%)	34(54.80%)	16(25.80%)	3.92	1.00
2	Women in STEM disciplines do not have higher qualifications compared to men.	2(3.20%)	7(11.30%)	16(25.80%)	28(45.20%)	9(14.50%)	3.56	0.99
3	Difficulty in securing positions in same geographical area as men	1(1.60%)	12(19.40%)	10(16.1%)	32(51.60%)	7(11.30%)	3.52	0.99
4	Proportions of female lecturers in STEM disciplines is encouraging	6(9.70%)	17(2.70%)	24(38.70%)	6(9.70%)	9(14.50%)	3.21	1.30
5	Career path of most successful female lecturers has motivated more females to advance into STEM disciplines	3(4.80%)	24(38.70%)	21(33.90%)	10(16.10%)	4(6.50%)	2.81	0.99
6	Perceived lack of commitment among females in STEM compared to men	10(16.10%)	23(37.10%)	12(19.40%)	15(24.20%)	2(3.20%)	2.61	1.12
7	Females in STEM disciplines are of higher ranks	13(21. 0%)	24(38.70%)	12(19.40%)	10(16.10%)	3(4.80%)	2.45	1.14
8	Gender representation in STEM subjects is in a balanced scale as men.	7(11.30%)	33(52.20%)	13(21.0%)	7(11.30%)	2(3.20%)	2.42	0.95
	Mean of means						**3.06**	**1.06**

Source: Field data, Ayeriga (2022) N=62

Table 12 indicated that female lecturers had no opinion on their representation in STEM since the overall mean of means and standard deviation were M=3.06 and SD=1.06. However, responses on individual statements; with item 1, "involvement of female lecturers as role models in STEM education in the past years has enhanced effective teaching of STEM-related subjects" recorded mean score of 3.96 (SD=0.1.00) and 54.80% which is high and represented agreement and it was revealed as one of the highest response rate among the eight items seeking to ascertain the representation of female lecturers in STEM disciplines. This indicated that most of the respondents are in agreement that female lecturers serving as role models in STEM education in the past years has enhanced effective teaching of STEM-related subjects.

Again, the results in Table 12 showed that the issue of "Women in STEM disciplines are not possessing higher academic qualifications compared to men in the university." recorded mean score of 3.56 (SD=0.99) and 45.20% that is moderate and was a neutral response to statement posed. With regard to "difficulty in securing positions in the same geographical area as their male colleagues" a response rate recorded mean score of 3.52 (SD=0.99) and 51.60% that is moderate and represented a neutral or uncertain response. The statement "the proportion of female lecturers in STEM disciplines are encouraging," recorded mean score of 3.21 (SD=1.30) and 38.70% indicating that most of the respondents had no opinion on the sentiment about the nature of proportion of female lecturers in STEM disciplines. In addition, the statement "Career path of most successful female lecturers haven to have encouraged or motivated more females to advance into STEM subjects in academics" recorded mean score of 2.81 (SD=0.99) and 38.70% which is moderate and indicated that the respondents were uncertain to the question statement. Also, "Perceived lack of commitment among women as compared to men" recorded mean score of 2.61 (SD=1.12) and 37.10% represented no opinion by respondents. However, the table reported a disagreement that "Females in STEM disciplines are of higher educational ranks." with mean score of.2.45, (SD=1.14) and

38.70% which suggested that most women engaged in academic work compared to men in STEM disciplines are not of higher professional ranks. Finally, the question statement "Gender representations in STEM disciplines is currently in a balanced scale with the men" also recorded mean score of 2.42 (SD=0.95) and 52.20% which was low response rate and a disagreement to the statement.

4.2.2.2 Research Question 2

What are the social, institutional/technical and cultural challenges hindering female lecturers' professional and academic growth in STEM disciplines in Ghanaian public universities?

This research question sought to find out the challenges that hinder female lecturers' professional and academic growth in STEM disciplines in Ghanaian public universities. This section presents the analysis of research question two (2). A list of statements were provided under three sub-scales for respondents to express their opinions. The three challenges were social, institutional/technical and cultural factors. Table 13 shows the descriptive statistics of the social challenges hindering the professional and academic growth of female lecturers in STEM disciplines.

Table 13: Descriptive Statistics of Social Challenges that Hinder Professional and Academic Growth of Female Lecturers in STEM Disciplines

SN	STATEMENT	SD	D	N	A	SA	M	SD
		f(%)	f(%)	f (%)	f(%)	f(%)		
1	Lack of role female models in STEM disciplines discourages professional and academic growth.	2 (3.20)	5 (8.10)	14 (22.60)	28 (45.20)	13 (21.0)	3.73	0.99
2	Society perceive STEM disciplines as male dominated careers path, discourages females from pursuing it.	3 (4.80)	9 (14.50)	5 (8.10)	31 (50.0)	14 (22.60)	3.71	1.12
3	Unsupportive attitude of colleague females in STEM disciplines hinders professional and academic growth.	2 (3.20)	12 (19.40)	12 (19.40)	26 (41.90)	10 (16.10)	3.48	1.08
4	Less praise for female lecturers engages in STEM disciplines hinders professional and academic growth.	6 (9.70)	13 (21.0)	5 (8.10)	26 (4190)	[12 (19.40)	3.40	1.29
5	Unfriendly attitudes by most faculty members hinders female lecturers' professional and academic growth in STEM	2 (3.20)	22 (35.50)	4 (6.50)	27 (43.50)	7 (11.30)	3.24	1.15
6	Masculinity associated with creativity discourages females' involvement in STEM activities.	12 (19.40)	10 (16.10)	6 (9.70)	26 (41.90)	8 (12.90)	3.13	1.37
7	Female lecturers feel less marginalized and less professional opportunities given them	5 (8.10)	21 (33.90)	14 (22.60)	17 (27.40)	5 (8.10)	2.94	1.13
8	Female lecturers in STEM disciplines are labelled as non-fashionable	14 (22.60)	17 (27.40)	3 (4.80)	22 (35.50)	6 (9.70)	2.82	1.39
	Mean of means						**3.31**	**1.19**

Source: Field data, Ayeriga (2022) N = 62

In Table 13, the mean scores ranged from 2.82 (SD=1.38) to 3.73(SD=0.99) with an overall mean score of (M=3.31, SD=1.19) which represented a moderate response rate and uncertain position by the respondents However, 'Lack of role models in the field of STEM studies discourage females' professional and academic growth." recorded mean scores of 3.73 (SD=0.99) and 45.20% which indicated high response rate and agreement. Following this question statement was "Society perceive STEM disciplines fields as male dominated careers path, discourage most females from pursuing it which affect their professional and academic growth" recorded mean of 3.71 (SD=1.12) and 50.0% which represented an agreement. The next question; "there is unsupportive attitude of female colleagues in STEM disciplines which hinders the professional and academic growth of female lecturers" recorded mean of 3.41 (SD=1.08) and 41.90% which represented no opinion. Again, "Less praise is given female lecturers who are involved in STEM education and this hinders their professional and academic growth." recorded mean of 3.40 (SD=1.29) and 4190% as uncertain and moderate response rate. "Unfriendly attitudes by most faculty members hinders female lecturers' professional and academic growth", recorded mean of 3.24 (SD=1.15) and 43.50% which represented a moderate uncertain response. Furthermore, "Masculinity associated with creativity so female involvement in STEM activities are not encouraged." Recorded mean of 3.13 (SD=1.37) and 41.90% for a moderate uncertain response. "Female lecturers feel less marginalized and less opportunities are given to them to develop professionally and academically." recorded mean of 2.94 (SD=1.13) and 33.90% represented an uncertain response. "Female lecturers in STEM disciplines are labelled as not being fashionable preventing the professional and academic growth in the field." had mean of 2.82 (SD=1.39) and 35.50% as moderate or uncertain response by the respondents. The results indicate that social challenges moderately affect female lecturers in STEM disciplines.

Table 14 presents the descriptive statistics of the institutional and technical challenges hindering the professional and academic growth of female lecturers in STEM disciplines.

Table 14: Descriptive Statistics of Institutional and Technical Challenges that Hinder Professional and Academic Growth of Female Lecturers in STEM Disciplines

SN	STATEMENT	SD	D	N	A	SA	M	SD
		f(%)	f(%)	f(7&)	f(%)	f(%)		
1	Lack of female mentors engaged in STEM disciplines.	4(6.50%)	10(16.10%)	1(1.60%)	35(56.50%)	12(19.40%)	3.66	1.16
2	Complex work schedule, long working hours makes it hard to manage work-family balance	5(8.10%)	16(25.80%)	32(51.60%)	30(48.40%)	16(10%)	3.39	1.26
3	Lack of quality assessment tools, and knowledge of STEM are barriers to females' representation	5(8.10%)	14(22.60%)	7(11.30%)	31(50.0%)	5(8.10%)	3.27	1.15
4	Inadequate institutional capacity to support STEM disciplines	5(8.10%)	25(40.30%)	5(8.10%)	25(40.30%)	2(3.20%)	2.90	1.23
5	Administrative constraints in accessing material for STEM	10(16.10%)	22(35.50%)	5(8.10%)	20(32.30%)	5(8.10%)	2.81	1.28
6	Gender disparity at workplace	16(25.80%)	33(53.20%)	2(3.20%)	13(21.0%)	4(6.50%)	2.48	1.18
7	Lack of quality assessment tools, planning impedes STEM	13(21.0%)	26(41.90%)	6(9.70%)	15(24.20%)	2(3.20%)	2.47	1.17
8	Lack of pedagogical models for STEM disciplines	13(21.0%)	35(56.50%)	0(0%)	10(16.10%)	4(6.50%)	2.31	1.16
	Mean of means						**2.91**	**1.20**

Source: Field data, Ayeriga (2022) N = 62

Table 14 presents range of mean scores from 2.31, (SD=1.16) to 3.66(SD=1.16) and an overall mean score of 2.91 (SD=1.20) which implied an uncertain or moderate response rate by respondents on the question. On the other hand, "lack of mentors (women engaged in STEM disciplines)" in tertiary institutions recorded mean of 3.66 (SD=1.16) and 56.50% that indicated a high response rate with agreement by respondents. "Complex work schedule with long working hours makes it hard to manage family and establish work-family balance coupled with unsupportive employers." reported mean 3.39 (SD=1.26) and 51.60% that represented moderate and uncertain response rate. Furthermore, "lack of quality assessment tools, planning time, and knowledge of STEM disciplines are challenges and barriers to females' representation in academia' had mean score of 3.27 (SD=1.15) and 50.0% which represented no opinion. "Inadequate institutional capacity to support STEM subjects in the form of resources, workloads like many students in university settings, equipment etc affects females in STEM disciplines" also recorded mean of 2.90 (SD=1.23) and 40.30% that represented moderate and uncertain response rate. "There are administrative constraints in accessing adequate content material for teaching STEM subjects" recorded mean score of 2.81 (SD=1.28) and 35.50% which represented an uncertain and moderate response. "Gender disparity at workplace -transfers to other places, promotions based on gender, men get paid more than females, profiling female by marriage status and number of children occur in educational institutions." Recorded a mean of 2.48, (SD=1.18) and 53.20% that represented a low or disagreement by respondents "lack of quality assessment tools, and planning time impede STEM disciplines studies in tertiary institutions" recorded mean score of .47 (SD=1.17) and 41.90% indicated a disagreement. Finally, "there is lack of pedagogical models on how to teach STEM in an attractive way' recorded mean score of 2.31 (SD=1.16) and 56.50% represented disagreed response rate from respondents. The results on institutional challenges faced by the female lecturers in STEM disciplines were low with few moderate ones.

Table 15 presents the descriptive statistics of the cultural challenges hindering the professional and academic growth of female lecturers in STEM disciplines.

Table 15: Descriptive Statistics of Cultural Challenges that Hinder Professional and Academic Growth of Female Lecturers in STEM Disciplines

SN	Statement	SD f(%)	D f(%)	N f(%)	A f(%)	SA f(%)	M	SD
1	Traditional perceptions that a woman's place is not the hard sciences,	13(21.0%)	29(46.80%)	2(3.20%)	16(25.80%)	2(3.20%)	3.69	0.98
2	Patriarchy is responsible for the masculine image of STEM.	15(24.20%)	27(43.50%)	10(16.10%)	10(16.10%)	0(0%)	3.27	1.01
3	Casting females into supportive roles due to socio-cultural norms.	5(8.10%)	19(30.60%)	4(6.50%)	27(43.50%)	7(1130%)	3.19	1.23
4	Parents perceive wards involvement in STEM disciplines prolong marriages.	7(11.30%)	20(32.30%)	2(3.20%)	32(51.60%)	32(51.60%)	3.11	1.24
5	Hegemonic masculinity influenced by socio-cultural values and beliefs plus organizational gender inequality perceptions among both males and women in STEM disciplines.	9(14.50%)	20(32.30%)	3(4.80%)	23(37.10%)	7(11.30%)	3.00	1.17
6	Insufficient women in decision making positions.	4(6.50%)	13(21.0%)	7(11.30%)	38(61.30%)	0(0%)	2.98	1.32
7	Sexism and stereotyping of women's roles	2(3.20%)	8(12.90%)	6(6.70%)	37(5970%)	9(14.50%)	2.44	1.18
8	Negative traditional beliefs about women inferior to men contributes to girls' lack of enthusiasm for STEM disciplines	7(11.30%)	18(29.0%)	3(4.80%)	29(46.80%)	5(8.10%)	2.24	1.00
	Mean of means						**2.99**	**1.14**

Source: Field data, Ayeriga (2022) N = 62

Table 15 presents range of mean scores from 2.24 (SD=1.00) to 3.69 (SD=0.98) with an overall mean 2.99 (SD=1.14) which implied a moderate or uncertain response rate by respondents on the cultural challenges. Furthermore, "Traditional perceptions that "a woman's place" is not the hard sciences," recorded mean of 3.69 (SD=0.98) and 46.80% which represented an agreement. "Patriarchy is responsible for the masculine image of STEM." With mean score of 3.27 (SD=1.01) and 43.50% represented an uncertain response rate. Again, "Casting females into supportive roles due to socio-cultural norms." Recorded mean score of 3.19 (SD=1.23) and 43.50% represented no opinion by respondents. Furthermore, "Parents perceive their wards involvement in STEM subjects to prolong their marriages." had mean score of 3.11 (SD=1.24) and 51.60% "Hegemonic masculinity influenced by socio-cultural values and beliefs plus organizational gender inequality perceptions among both males and females affect women pursuing STEM disciplines" revealed mean and 3.00, SD=1.17) and 37.10% that represented no opinion. "Insufficient women in accessing decision making positions." Showed mean score of 2.98 (SD=1.32) and 61.30% recorded uncertain rate of responses. On the other hand, "sexism and stereotyping of women's roles exist" recorded mean score of 2.44 (SD=1.18) and 5970% which represented a disagreement whilst "negative traditional beliefs that women are inferior to men are contributing to girls'/ women's lack of enthusiasm for STEM in secondary and tertiary studies; recorded mean score of 2.24 (SD=1.00) and 46.80% which represented a disagreement or low rate of responses. Results shows that cultural challenges moderately affect the female lecturers in STEM disciplines in Ghanaian universities.

Table 16 presents the Mean of means of the three sub-scales of the challenges hindering the professional and academic growth of female lecturers in STEM disciplines.

Table 16: Mean of Means of the Three Sub-scales

Sub-scale area	Overall Mean	SD
Social challenges	3.31	1.19
Institutional/technical challenges	2.91	1.20
Cultural challenges	2.99	1.14

Source: Field data, Ayeriga (2022)

Table 16 presents a summary of the overall mean scores of the three sub-scales which sought to find out what social, institutional/technical and cultural challenges that hinder female STEM lecturers 'professional and academic growth. The results in Table 16 indicated that all the three sub-scales have moderate or uncertain response rates in an order of (M=3.31, SD=1.19), (M=2.99, SD=1.14) and M=2.91, SD=1.20) for social, institutional and cultural respectively.

4.2.2.3 Research Question 3

What cross-institutional collaborations have been designed to enhance the career aspirations of the Ghanaian female lecturers in STEM disciplines?

This part examines research question three (3) which sought to find out if there are any cross-institutional collaborations designed to enhance the career aspirations of Ghanaian female lecturers in STEM disciplines studies. This section gives insight on how cross-institutional collaborations can influence the career aspirations of female lecturers in STEM studies. The results of issues on cross-institutional collaborations on female lecturers in STEM studies are shown in Table 17.

Table 17: Descriptive Statistics of Cross-Institutional Collaborations towards Enhancing Career Aspirations of Female Lecturers in STEM Disciplines

SN	Statement	SD f(%)	D f(%)	N f (%)	A f(%)	SA f(%)	M	SD
1	There is institutional opportunities for inter-institution collaboration for STEM disciplines.	2(3.20)	11(17.7.0)	1(1.60)	38(61.30)	10(16.10)	3.69	1.05
2	Platforms for collaborative research work among female lecturers in Ghanaian universities.	3(4.80)	7(11.30)	17(27.40)	29(46.80)	6(9.70)	3.45	0.99
3	Well-organized and frequently professional development opportunities with other institutions for STEM initiatives.	3(4.80)	15(24.20)	4(6.50)	34(54.80)	6(9.70)	3.40	1.11
4	Annual WiSTEM workshops are organized for all Ghanaian universities.	6(9.70)	16(25.80)	9(14.50)	28(45.20)	3(4.80)	3.10	1.14
5	Organized WiSTEM programmes in place for female students.	1(1.60)	15(24.20)	26(41.90)	18(29.0)	2(3.20)	3.08	0.36
6	STEM-related conferences are for only institutions that study STEM subjects.	2(3.20)	31(50.0)	5(8.10)	18(29.0)	6(9.700)	2.92	1.15
7	Seeking institutional collaborative or research materials promotes effective career aspiration among female lecturers.	5(8.10)	26(41.90)	12(19.40)	19(30.60)	0(0)	2.73	0.99
8	No regular international WiSTEM conferences for members.	17(27.40)	31(50.0)	8(9.70)	6(12.90)	0(0)	2.05	0.89
	Mean of means						**3.05**	**1.02**

Source: Field data, Ayeriga (2022) N = 62

The range of mean scores from Table 17 is from 2.05 (SD=0.89) to 3.69 (SD=1.05) and an overall mean score of 3.05 (SD=1.02) which represented an uncertain response rate by respondents on the cross-institutional issues. Furthermore, "my institution provide opportunity for inter-institution collaborations to enhance our professional growth" recorded mean score of 3.69(SD=1.05) and 61.30% that represented agreement. "There are platforms for collaborative research work among female lecturers in STEM studies in Ghanaian universities' showed mean 3.45 (SD=0.99) and 46.80% that indicated moderate or uncertain response. "Well-organized and frequently available professional development learning opportunities with other institutions for STEM initiatives are in place' had mean score of 3.40 (SD=1.11) and 54.80% which represented no opinion response rate. "Annual WiSTEM workshops are organized for all Ghanaian universities to inspire female students." showed and mean 3.10 (SD=1.14) and 45.20% hat represented moderate or uncertain response. "There are organized WiSTEM programmes in place for female students in all universities' recorded mean scores of 3.08 (SD=0.86) and 41.90% represented uncertain rate of responses. Moreover, "STEM-related conferences are limited to only institutions that study STEM subjects' recorded mean 2.92, SD=1.15) and 50.0% which represented uncertain response rate. "Seeking institutional collaborative information or research materials helps to promote effective career aspiration among female lecturers' showed mean score of 2.73 (SD=0.99) and 41.90% that indicated uncertain response rate by respondents. "There are no regular international WiSTEM conferences for members' had mean score of 2.05 (SD=0.89) and 50.0% represented a response rate of disagreement in response to the statement.

4.2.2.4 Research Question 4

To what extend has networks of local and international role models influenced the female lecturers in STEM disciplines in public universities of Ghana?

This section presents the analysis of research question four (4) which seeks to ascertain whether there exist networks of both local and international role models for the female lecturers in STEM studies in Ghanaian universities. Various list of statements were provided to the respondents on whether there are network of role models in STEM for them to tap knowledge and experiences from. Table 18 presents issues about network of role models in STEM-related subjects.

Table 18: Descriptive Statistics of Network of Local and International Role Models in STEM among Female Lecturers in Ghanaian Public Universities

SN	STATEMENT	SD f(%)	D f(%)	N Ff%)	A f(%)	SA f(%)	M	SD
1	Award schemes in place for outstanding females in STEM disciplines.	0(0)	4(6.50)	11(17.70)	44(71.0)	3(4.80)	3.74	0.65
2	Female role models in STEM disciplines are sufficient in Ghana's public universities.	10(16.10)	14(22.60)	4(6.50)	22(35.50)	12(19.40)	3.19	1.41
3	Female scientists are not of good economic standing.	11(17.70)	24(38.70)	17(27.40)	8(1290)	2(3.20)	2.45	1.04
4	WiSTEM branches exist in all public universities in Ghana.	14(22.60)	23(37.10)	14(22.60)	7(11.30)	4(6.50)	2.42	1.15
5	Female mentors in STEM disciplines support younger colleagues' professional growth.	14(22.60)	24(38.7 0)	13(21.0)	11(17.70)	0(0)	2.34	1.02
6	Majority of female lecturers in STEM disciplines are academic professors in Ghanaian universities.	10(16.10)	37(59.70)	5(8.10)	8(12.90)	2(3.20)	2.27	0.99
7	Regular exchange progrommes for females in STEM disciplines are in place.	17(27.40)	26(41.90)	11(17.70)	6(9.70)	2(3.20)	2.19	1.05
8	Female lecturers in STEM disciplines occupy top positions in my university.	17(27.40)	27(43.50)	12(19.40)	6(9.70)	0(0)	2.11	0.93
	Mean of means						**2.59**	**1.03**

Source: Field data, Ayeriga (2022) N = 62

Table 18 presents range of mean scores from 2.11 (SD=0.93) to 3.74 (SD=0.65) with an overall mean score of 2.59 (SD=1.03) which represented disagreement response rate to the research question by respondents. Furthermore. "Award schemes are in place for outstanding females in STEM disciplines studies' recorded mean score of 3.74, (SD=0.65) and 71.0% which indicated an agreement. "There are no adequate female science mentors in STEM disciplines in Ghanaian universities' recorded mean score of 3.19 (SD=1.41) and 35.50% which indicted uncertain rate of responses. "Female scientists are not of good economic standing' recorded mean score of 2.45 (SD=1.04) and 38.70% for disagreed by respondents. "WiSTEM branches exist in all public universities in Ghana" recorded mean score of 2.42 (SD=1.15) and 37.10% for disagreed. Furthermore, "Female mentors in STEM disciplines support younger colleagues' professional growth" recorded mean score of 2.34 (SD=1.02) and 38.7 0% which represented disagreement. "Majority of female lecturers in STEM disciplines studies are academic professors in Ghanaian universities." had mean score of 2.27 (SD=0.99) and 59.70% which represented disagreement of the responses. "There are regular exchange progrommes for females in STEM studies in all universities' recorded mean score of 2.19 (SD=1.05) and 41.90% represented disagreement and finally 'Female lecturers in STEM disciplines studies occupy top positions in the universities" had mean score of 2.11 (SD=0.93) and 43.50% which represented disagreement of responses from respondents.

4.2.2.5 Research Question 5

What institutional commitment and support systems are in place or being envisaged to boost the confidence and capabilities of female lecturers in STEM disciplines?

This section presents analysis of responses by female lecturers in STEM disciplines studies in Ghanaian universities. The analysis in this section concerns research question five as stated above. The respondents' responses can be found in Table 19.

Table 19: Descriptive Statistics of Institutional Commitment and Support Systems in Place or Being Envisaged to Boost the Confidence and Capabilities of Female Lecturers in STEM Disciplines

SN	STATEMENT	SD	D	N	A	SA	M	SD
		f(%)	f(%)	f%)	f(%)	f(%)		
1	Professional societies and universities could provide structured professional development opportunities, for women in STEM to navigate and predict important decision points.	2(3.20)	6(9.70)	8(12.90)	39(62.90	7(11.30)	3.69	0.92
2	Academic departments should recruit senior women in STEM disciplines to present their technical work as part of department colloquia, brown-bags.	0(0)	8(12.90)	13(21.0)	33(53.20)	8(12.90)	3.66	0.87
3	Fostering an inclusive environment encourages research or collaborations between junior and senior faculty, increase professional and personal interactions).	0(0)	10(16.10)	13(21.0)	32(51.60)	7(11.30)	3.58	0.90
4	Empowers teachers to in turn empower their students to challenge prevailing views about STEM disciplines	0(0)	14(22.60)	8(12.90)	33(53.20)	7(11.30)	3.53	0.97
5	Adapting classroom science for more engaging and interactive, that emphasizes social and societal connections.	1(1.60)	14(22.60)	5(8.10)	37(59.7)	5(8.10)	3.50	0.99
6	Policies to ensure gender balance – laws to support policy of representation are in place.	0(0)	14(22.60)	12(19.40)	34(54.80)	2(3.20)	3.39	0.88
7	Foster a sense of belonging among women in STEM disciplines and encourages female students.	1(1.60)	15(24.20)	10(16.1)	34(54.80)	2(3.20)	3,34	0,94
8	Financial support and scholarships for females in STEM disciplines in place in universities	10(16.10)	20(32.30)	10(16.10%	18(29.0)	4(6.50)	2.77	1.22
	Mean of means						**3.43**	**0.96**

Source: Field data, Ayeriga (2022) N = 62

The range of mean scores from Table 19 is from 2.77 (SD=1.22) to 3.69 (SD=0.92.) and an overall mean score of 3.43 (SD=0.96) which represented an uncertain response rate by respondents on this research question. Furthermore, the first statement "professional societies and universities could provide structured professional development opportunities, so women can anticipate some of these barriers, plan how to navigate them, and predict important decision points, such as reduced fees for society membership and conference registration" recorded mean score of 3.69 (SD=0.92) and 62.90% indicated agreed. "Academic departments should recruit senior women in STEM fields to present their technical work as part of department colloquia, brown-bags, and other special events, providing opportunities for these speakers to meet and mentor students" recorded mean score of 3.66, (SD=0.87) and 53.20% represented agreed. "Fostering an inclusive environment can encourage research or teaching collaborations between junior and senior faculty, increase professional and personal interactions, and reduce professional isolation experienced by new faculty' recorded mean score of 3.58 (SD=0.90) and 51.60% represented uncertain response rate. "Empowers teachers so that they can in turn empower their students to challenge prevailing views about teaching as a last option." Had mean score of 3.53 (SD=0.97) and 53.20% for uncertain response rate. Furthermore, "Adapting classroom science to make it more engaging and interactive, encouraging relational and collaborative learning, and presenting science in a way that emphasizes social and societal connections." had mean score of 3.50 (SD=0.99) and 59.7% that represented uncertain response rate. "Policies to ensure gender balance, laws to support policy of representation are put in place in various universities' recorded a mean score of 3.39, (SD=0.88) and 54.80% which was uncertain response rate. "Fostering a sense of belonging among women in STEM disciplines and encouraging female students to attend diversity conferences and professional society meetings which invest in students' success recorded a mean score of 3.34 (SD=0.94) and 54.80% that represented uncertain response rate. "There is financial support in the form of scholarships for females engaged in STEM-related studies in Ghanaian public universities" showed mean score of 2.77 (SD=1.22) and 32.30% which represented uncertain response rate to the question.

4.2.2.6 Research Question 6

How do female lecturers' self-efficacy beliefs influence their academic and professional growth in STEM disciplines?

Research question 6 sought to determine female lecturers' self-efficacy beliefs in STEM disciplines and how those beliefs influence their academic and professional growth in Ghanaian universities. Table 20 shows the responses about the influence of female lecturers' self-efficacy beliefs about STEM disciplines studied in universities.

Table 20: Descriptive Statistics of Self-Efficacy Beliefs of Female Lecturers in STEM Disciplines and How those Beliefs Influence their Academic and Professional Growth

SN	STATEMENT	SD	D	N	A	SA	M	SD
		f(%)	f(%)	f(%)	f(%)	f(%)		
1	My self-efficacy belief helped me to remain calm when facing difficulties	0(0)	0(0)	9(14.50)	31(50.0)	22(35.50)	4.21	0.68
2	My self-efficacy belief has influenced me to do activity in the classroom with confidence with STEM disciplines	0(0)	0 (0)	5(8.10)	40(64.50)	17(27.40)	4.19	0.57
3	My self-efficacy belief has helped me to develop the competence and skill to achieve academic success in STEM disciplines	0(0)	0(0)	3(4.80)	45(72.60)	14(22.60)	4.18	0.50
4	My professional development growth has helped me understand the dignity and worth of every student.	0(0)	0(0)	9(14.50)	7(59.70)	16(25.80)	4.11	0.63
5	My self-efficacy belief influenced my quality of instructions delivery in STEM disciplines	0(0)	0(0)	8(12.90)	40(64.50)	14(22.60)	4.10	0.59
6	My self-efficacy belief helped me to handle whatever comes my way as a female scientist.	7(11.30)	9(14.50)	5(8.10)	29(46.80)	12(19.40)	3.48	1.28
7	My self-efficacy belief helped to solve most problems academically and professionally.	5(8.10)	12(19.40)	2(3.20)	37(59.70)	6(9.70)	3.44	1.15
8	My self-efficacy belief helped to deal with unexpected events.	4(6.50)	16(25.80)	6(9.70)	25(40.30)	11(17.70)	3.37	1.23
	Mean of means						**3.89**	**0.83**

Source: Field data, Ayeriga (2022) N = 62

The range of mean scores from Table 20 is from 3.37(SD=1.23) to 4.21 (SD=0.68) and an overall mean score of 3.89 (SD=0.83) which represented agreed response rate by respondents on their self-efficacy beliefs. Furthermore, “My self-efficacy belief helped me to remain calm when facing difficulties because I can rely on my coping abilities” showed mean score of 4.21, SD=0.68) and 50.0% that indicated agreement. “My self-efficacy belief has influenced me to do activities in the classroom with confident.” recorded mean score of 4.19 (SD=0.57) and 64.50% that represented an agreement to the question. “My self-efficacy belief has helped me to develop the competence and skill to achieve academic success’ resulted into amen score of 4.18 (SD=0.50) and 72.60% which represented agreed. “My professional development growth has helped me understand the dignity and worth of every student” recorded mean score of 4.11 (SD=0.63) and 59.70% for agreed. “My self-efficacy belief has influenced my quality of instructions delivery for student academic and professional growth” recorded mean score of 4.10 (SD=0.59) and 64.50% that represented agreed. “My self-efficacy belief helped me to handle whatever comes my way as a female scientist.” recorded mean score of 3.48 (SD=1.28) and 46.80% which represented uncertain response rate by respondents. “My self-efficacy belief has helped me to solve most problems for my academic and professional growth” recorded mean score of 3.44 (SD=1.15) and 59.70 % represented uncertain response rate. “My self-efficacy belief helped me to deal with unexpected events’ recorded mean score of 3.37 (SD=1.23) and 40.30% which represented uncertain rate of responses by respondents.

4.2.3 Summary of findings of quantitative phase

The research questions were analyzed using percentages, means and standard deviations and were presented in Tables. It was revealed that female lecturers' representations, challenges faced, cross institutional collaborations and support systems were all moderately scored by the respondents. The influence of networks of both local and international role models scored low response rate whilst the influence of the female lecturers'' self-efficacy beliefs showed high response rates. The next stage presents the qualitative findings of the study.

4.2.4 Presentation of qualitative findings

This section presents the qualitative data of the study. In concurrent triangulation mixed-method design, it is appropriate to describe the findings that represent the qualitative phase (Creswell & Creswell, 2018). The data was collected from Ghanaian female lecturers engaged in STEM disciplines using semi-structured interviews. The interviews were conducted with 22 participants who were conveniently selected. The researcher used thematic analysis to analyze the interview data (Creswell & Creswell 2017; Kusi, 2012). Table 21 shows the distribution of the sociodemographic profile of the participants.

Table 21: Sociodemographic Profile of Participants

Participant I.D.	Age	Marital status	Educational qualification	Educational rank	STEM subject	Years of teaching experience
AM1	41-50	Married	PhD	Snr. Lecturer	Sci.	11-15
AM2	31-40	Single	PhD	Snr. Lecturer	Tech.	Less than 5
AM3	Above 60	Married	PhD	Asso. Prof.	Maths	11-15
AM4	41-50	Married	Masters	Lecturer	Eng.	06-10
CK1	41-50	Married	PhD	Snr. Lecturer	Sci	Less than 5
CK2	31-40	Married	PhD	Lecturer	Tech.	11-15
CK3	41-50	Single	PhD	Snr. Lecturer	Maths	06-10
KN1	51-60	Divorced	PhD	Snr. Lecturer	Sci.	21-25
KN2	31-40	Married	PhD	Snr. Lecturer	Tech.	Less than 5
KN3	41-50	Married	PhD	Asso. Prof	Maths	11-15
KN4	51-60	Single	PhD	Prof.	Eng.	21-25
UC1	31-40	Married	PhD	Prof.	Sci.	11-15
UC2	31-40	Married	PhD	Snr. Lecturer	Tech.	11-15
UC3	20-30	Single	Masters	Lecturer	Maths	Above 25
UG1	31-40	Married	PhD	Lecturer	Eng	06-10
UG2	51-60	Married	PhD	Snr. Lecturer	Sci.	21-25
UG3	31-40	Single	PhD	Lecturer	Tech.	16-20
UG4	41-50	Married	PhD	Snr. Lecturer	Maths	06-10
UM1	41-50	Married	PhD	Snr. Lecturer	Sci.	11-15
UM2	51-60	Single	PhD	Lecturer	Tech.	06-10
UM3	31-40	Married	Masters	Asst. Lecturer	Maths	06-10
UM4	51-60	Married	PhD	Asso. Prof	Eng.	Less than 5

This part of the section presents the participants' sociodemographic profile of the study. From Table 21 the dominant age groups were within the range of 31-40 and 41-50 years with seven interviewees each. This was followed by the age range of 51-60 with (5). The ranges of 20-30 and above 60 had the least number of interviewees. The results showed that the dominant age of interviewees was within the middle age groups. However, interviewees within the age group of 51-60 years had also showed a second higher value of 6. These results might encourage the younger generations to venture into STEM disciplines and become more experienced professionals in the universities.

With regard to marital status, the results showed that majority of the interviewees fifteen (15) were married fifteen whilst few interviewees six (6) were singles and the remaining one (1) was a divorcee. The results suggested that marital status varied among females lecturers engaged in STEM disciplines studies. In the case of the participants' educational level, nineteen (19) held Doctoral degrees whilst three (3) interviewees were master's degree certificate holders. The results also showed differences in professional ranks of interviewees. Senior lecturers were ten whilst five were lecturers. Associate professors were three whilst full professors were two. There was only one Assistant lecturer. The results suggest that majority of female lecturers in STEM discipline studies had not attained professorial ranks.

Table 21 revealed that science, technology and mathematics being taught by females had the highest number of six (6) interviewees whilst engineering had four (4). The results suggest that majority of female lecturers were lecturing Science, technology and mathematics whilst the least were for engineering. This could be due to the fact that most tertiary institutions do not run engineering courses.

The data in Table 21 revealed various years of work experience among the female lecturers in STEM disciplines. The duration of 11-15 years were seven interviewees.

The range of 6-10 recorded six interviewees. Four interviewees taught for less than 5 years. The range of 21-25 had three interviewees. The range of 16-20 and above 25 years had one interviewee each. The next section presents the findings from the qualitative data analysis.

4.2.4.1 Main theme 1.0: representations of female lecturers in STEM disciplines in Ghanaian universities

This section presents the responses of interviewees on female lecturers' representations in STEM disciplines in Ghanaian universities. In this quest, the following views were sought for 1) Numbers of female lectures engaged in STEM disciplines studies. 2) The scale of ratio between female and male lecturers engaged in STEM disciplines 3).The perceived lack of commitment among women compared to men in STEM disciplines.

Sub-theme 1.1: Numbers of Female Lecturers in STEM Disciplines in Public Universities

Most of the participants indicated that female lecturers engaged in STEM disciplines were fewer than the male lecturers. However, few of the participants indicated that their institutions currently recorded significant increase in number of female lecturers compared to previous years. Below are some examples of the participants' responses.

Participant-UC3 indicated that "*The rationale of STEM education since its inception in Ghana in the 1990's aimed at increasing females' participation and to motivate many of them to venture into STEM disciplines careers. However, the proportions of female lecturers engaged in STEM disciplines is low".* Similarly, participant CK1 and KN1 pointed out that *the idea of female participation has not fully been realized since current statistics in institutions shows low representation of females in the four specific subjects of STEM.*

Participant KN2 suggested that;

> *"It is expected that the few females engaged in STEM disciplines studies in tertiary institutions would have achieved higher professorial ranks through their engagement in STEM disciplines studies in order to motivate the younger generations to emulate such moves but data within tertiary institutions showed that the highest professional ranks in these institutions rather have fewer numbers as against the non-professorial ranks"*

In contracts, participants-UG3 and UG2 asserted that *the engagement of female lecturers in STEM disciplines studies in tertiary institutions had over the years seen a gradual increase in the numerical strength as a result of the increasing interventions implemented by various stakeholders in STEM disciplines.* UG3 however stated that *"there is still more room for improvement to achieve the goals and aims of attaining equal females' participation in STEM disciplines as the males in Ghanaian universities"*

Sub-theme 1.2: The Scale of Ratio between Female and Male Lecturers Engaged in STEM Disciplines in Ghanaian Universities

Majority of the interviewees pointed out that female lecturers engaged in STEM disciplines are not in a balanced ratio with the males. Despite this assertion, a participant revealed that responsibilities or opportunities are equally opened to both male and female lecturers though this is not done on deliberate bases. Participant-AM3, indicated that "*the employment ratio of females and males in STEM disciplines is not in a balanced ratio in Ghanaian universities and this does not meet the concerns of equality by stakeholders in STEM education in Ghana".* Participant UM2 argued that "*employers mostly do not make deliberate attempts in the search of female employees in STEM fields in tertiary institutions which would have otherwise served as a motivation for more qualified females to be engaged in STEM disciplines"*

Participants-CK3, KN3 and UG4 asserted that *STEM education through its rationale and aims has offered job skills and knowledge to individuals for the socio-economic development of the society and the nation at large.* However, participant CK3 further commented that "*STEM education programmes targeted more participation of girls to invariably increase the enrolment of girls in order to bridge the gap of the dominance of males in STEM disciplines in tertiary institutions". Participant UC1 indicated that "STEM education has given them equal chances of securing higher job positions as their male counterparts in the Ghanaian tertiary institutions"*

Sub-theme 1.3: Perceived Lack of Commitment among Female Lecturers Compared to Male Lecturers in STEM Disciplines

Most of the participants asserted that there was so much perceptions in society and even in some tertiary institutions that female lecturers engaged in STEM disciplines did not exhibit strong commitment in their mandate of advancing STEM education. Some participants however disputed the notion of perceived lack of commitment towards education by female lecturers in STEM disciplines. For example Participants- AM2 advanced that "*Females' involvement and engagement in STEM disciplines over the years has been perceived by the general public of not giving out adequate work output as compared to their male counterparts in tertiary institutions"* AM4 revealed that *"the perception about female lecturers not being well committed towards STEM education as compared to the males stifles their efforts in the advocacy for the involvement of more females in STEM disciplines studies and careers".*

On the contrary, participant- UM1 indicated that;

> "*There are no perceptions about lack of commitment among female lecturers engaged in STEM-related studies at higher educational institutions since female employees in STEM disciplines work assiduously as their male colleagues to achieve the stipulated goals of STEM education"*

Participant UC2 asserted that "*parents of young girls who wish to venture into STEM studies usually discourage them as they perceive girls as not fit for such studies because those subjects are masculine*". UM3 revealed that "*parents belief girls studying STEM subjects go through prolong schooling which can affect child bearing and thus do not see the need to sponsor the education of the girl child in STEM studies*"

KN4 added,

> *"Social norms and stereotypes frequently influence how people view women's roles and skills. It may be assumed that women are less dedicated to these disciplines due to the preconception that they are better suited for nurturing positions than technical ones like STEM"*.CK2 pointed out that, *"Unconscious bias can influence how people view the accomplishments and actions of women. Women may experience more scrutiny or skepticism regarding their commitment to STEM fields, giving the impression that they are less dedicated than their male counterparts"*.

UC3 said that,

> *"It may be assumed that women are less committed due to their underrepresentation in STEM professions, Systemic impediments, unpleasant workplaces, and a lack of role models may in fact deter women from entering and staying in these industries"*. UM4 added: *"When it comes to commitment, women could face different expectations. The perceived imbalance is as a result of a woman's dedication possibly being questioned more frequently than a man's, while a man's dedication is frequently taken for granted"*.

AM1 shared her view as,

> *"Prejudices about women's capacity to balance work and family obligations may contribute to the idea that they lack commitment. These presumptions may unjustly question the level of commitment among women. Again, subtle acts of discrimination known as microaggressions can send the message that women don't belong in STEM areas. Such encounters can affect how people perceive commitment and cause them to feel alone"*.

The comments of interviewees suggest that the numerical strength female lecturers engaged in STEM disciplines in Ghanaian universities is low. It is also reported that there is an imbalance scale of ratio between female lecturers to male lecturers engaged in STEM disciplines. In addition, the comments suggest that there exist some bad perceptions about the competences of female lecturers engaged in STEM disciplines compared to male lecturers. It has also been reported that the lack of policies and advocacies towards STEM studies have invariably created room for the perceived lack of commitment of female lecturers engaged in STEM disciplines.

4.2.4.2 Main theme 2.0: female lecturers views about STEM disciplines in Ghanaian universities

The following issues were sought for 1) Enhanced Critical Thinking and Problem-Solving Skills. 2) Increased interest and Engagement 3) Exposure to Career Opportunities and 4) Addressing the Skills Gap. The excepts of the interviewees' responses are reported below under sub-themes:

Sub-theme 2.1: Enhanced Critical Thinking and Problem-Solving Skills

CK1 asserted that,

> *"The rationale of STEM education includes the acquisition of skills by learners that will enable them become creative and innovative in everyday dealings. It fosters these abilities by involving students in inquiry-based learning, hands-on learning, and problem- solving activities'.* CK3 shared her view that; *"the development of critical thinking and problem-solving abilities is the cornerstone of STEM education. These abilities are necessary for students to analyze complicated problems, develop hypotheses, plan experiments, and build novel solutions to difficulties encountered in the real world".*

UM3 posited out that,

> *"STEM education places a strong emphasis on practical learning opportunities that motivate students to participate actively in problem-solving situations. This method does not only improve their comprehension of academic ideas but also sharpens their capacity to recognize problems and come up with innovative solutions".* UM2 revealed; *'Making connections between many fields of study is frequently a part of critical thinking and problem-solving in the STEM fields. STEM education promotes interdisciplinary thinking, which is essential for addressing complex, diverse problems. It pushes students to think outside the box of traditional topic areas".* UG2 said that; *'By encouraging students to challenge presumptions, assess the evidence, and use logical reasoning to reach well-informed conclusions, STEM education fosters an analytical mindset. Students are prepared to tackle*

different facets of life with a critical eye due to this analytical approach, which goes beyond the classroom".

These following participants shared their view,

> *"Innovative thinking and creativity are essential for effective problem-solving in the STEM fields. STEM education creates a mindset that supports technical and scientific developments by encouraging students to investigate novel ideas and take prudent risks. Again, STEM education instils a lifetime learning philosophy in addition to problem-solving skills. Students are given the skills to keep learning, adapting, and solving problems in a quickly changing world through encouraging critical thinking". (*UG1).

> *"The dynamic nature of STEM subjects necessitates the development of flexible thinkers capable of overcoming new obstacles. Students who receive STEM education are given problem-solving abilities that go beyond narrow focus, enabling them to apply what they have learned to a variety of situations" (*KN4). *'As students evaluate the effects of their solutions in society, the environment, and diverse groups, enhanced critical thinking in STEM entails ethical considerations. This fosters a responsible problem-solving methodology that goes beyond technical considerations"* (AM3). *'Collaboration and teamwork are key components of efficient issue resolution. As in real-world situations where diverse teams solve complicated problems, STEM education places an emphasis on communication skills and the capacity to work with peers from various backgrounds"* (KN3).

Sub-theme 2.2: Exposure to Career Opportunities

Participants- UM1, UC2, CK2, and AM1 asserted that,

STEM disciplines exposes students to a variety of STEM-related career prospects since most of the specific disciplines of STEM education impact requisite knowledge and skills for the job market. Participants also suggested that institutions can assist students in making educated judgements about their future career pathways by combining real-world applications and contact with professionalism from STEM sectors. The interviewees' positions on the exposure of female lecturers to career opportunities are elucidated by the following excerpts:

> *Female lecturers highlight the wide array of STEM-related employment options. They showcase both established and new job routes while exposing students to a range of STEM careers. This makes a wide range of career options in STEM more understandable to students, especially*

women" (UMI). *'Successful women who have made noteworthy contributions to STEM fields are showcased by female lecturers, who act as role models for students. By showcasing these role models, they encourage female students and show that women can pursue successful professions in STEM fields"* (CK2).

"Women in STEM disciplines provide insights into their personal professional experiences. They talk about the difficulties they have encountered as well as the benefits and chances that STEM professions present. Students are encouraged to investigate STEM careers by this firsthand account, which provides them with insights into the realities of these fields" (UM1). *'Professionals from a range of STEM professions, including prominent women, share their work experiences and knowledge at guest speaker sessions organized by female lecturers. Students' awareness of the variety of opportunities accessible to them is expanded, and they are exposed to successful female role models, thanks to the guest speakers"* (UC2)

"Women in academia build relationships with industry stakeholders and assist students in accessing opportunities such as industrial visits, internships, and shadowing programmes. Students are exposed to a variety of STEM professions directly through these interactions, enabling them to make well-informed judgements about their own career goals" (AM2). *'Students interested in pursuing STEM disciplines can receive career counselling and help from female academics. They offer details on available resources, scholarships, and educational routes for particular vocations. With the help of this counsel, students—including female students—will be guaranteed to know what measures to take in order to pursue their desired career routes in STEM disciplines"* (UC3)

"Female lecturers push for professional development and networking among their students, especially among their female pupils. They stress how crucial it is to network professionally, go to conferences, and take part in STEM-related events in order to discover employment options and widen one's horizons" (KN2). *'Female lecturers encourage students to think about innovation and entrepreneurship as possible career options in STEM. By showcasing accomplished women in STEM professions as entrepreneurs, they inspire students to consider the potential of launching their own businesses and leaving a lasting legacy"* (UG1).

"Biases and gender differences in STEM fields are addressed by female professors. They strive to create welcoming and encouraging cultures where all students, regardless of gender, feel empowered to pursue STEM professions. They also push for gender equity and challenge misconceptions" (AM1). 'Female lecturers stay in touch with former students, particularly those who have chosen STEM professions. They provide a concrete example of the career outcomes that can be attained

> *in STEM subjects by sharing the experiences and success stories of previous students"* (UM1).

The comments suggest that females' engagement in STEM disciplines can improve their competencies, innovative and critical thinking skills to solve daily lives problems.

4.2.4.3 Main theme 3.0: Effect of STEM education activities on female lecturers lives

Participants' responses on the impact of STEM studies on their lives stemmed from a number of issues. The issues included 1) Career Opportunities. 2) Skills in Analytical Reasoning and Critical Thinking and 3) Global Competitiveness. These responses in this section from participants are reported below:

Sub-theme 3.1: Promotion of Females' Participation in STEM-related Subjects

Participants-UG2, UG1, UM3, CK2, CK3, KN4, KN2, AM3 revealed that Beneficiaries of STEM education through the various subjects' disciples are well equipped with the requisite information and abilities necessary to pursue professions in the disciplines of science, technology, engineering, and mathematics. Interviewees also added that the acquired skills paves way for a diverse array of professional prospects in a variety of fields, including medicine, engineering, computer science, teaching, research, and many more.

Participant-CK2 asserted that:

> *"The field of careers that lecturers can pursue has grown as a result of STEM education. Academic lecturers can pursue professions in academia and companies relevant to their STEM competence by gaining knowledge and skills in these domains. There are now more professional alternatives for professors as a result of this diversification of employment options". 'STEM education has made it possible for instructors to become specialists in their respective STEM domains by allowing them to focus on particular STEM subjects. This knowledge promotes leadership positions in academia and business, as well as career growth and research opportunities. By participating in cutting-edge research and innovation, lecturers can influence the direction of their fields in the future" (*UG2).

'By providing instructors with research skills, STEM education empowers them to conduct scientific studies and make contributions to the disciplines they teach. Research endeavours can often be supported through grants and funding opportunities relating to STEM fields. This enables lecturers to work with other researchers on projects that interest them, follow their own research interests, and significantly advance their particular STEM fields' (CK3). *'STEM education encourages interdisciplinary and collaborative work, giving instructors the chance to collaborate with students from various academic backgrounds. Through cooperative initiatives and alliances, instructors can apply their STEM knowledge in interdisciplinary contexts, addressing challenging issues that call for a range of knowledge and viewpoints'* (KN4).

"The information and abilities that STEM education imparts to instructors enable them to interact with industry and give consulting services. Instructors can use their knowledge in STEM to address problems in the sector, offer technical guidance, and help create novel solutions. This creates pathways for industrial partnerships, consultancy work, and career advancement beyond university settings" (AM3). 'STEM education promotes both creativity and entrepreneurial thinking. STEM disciplines lecturers may decide to use their experience to launch their own businesses or take part in entrepreneurial endeavours. Through STEM education, professors can develop the critical thinking and problem-solving abilities necessary to spot chances and realise creative ideas" (UG1)

"………..Because STEM education is relevant everywhere, lecturers can participate in international research exchanges, collaborations, and teaching opportunities. Around the world, lecturers can take part in conferences, workshops, and research initiatives to broaden their networks and experience a variety of viewpoints and cultures" (UM3).

"STEM education equips instructors to take on leadership roles in both academia and business. Lecturers are well-suited to administrative jobs, research leadership positions, or spearhead STEM-related initiatives within their institutions or organizations because of their strong problem-solving abilities and competence in STEM fields" (KN2).

Sub-theme 3.2: Skills in Analytical Reasoning and Critical Thinking

Participants- CK1, UC2, UC3, KN1 and UM1 asserted that; STEM studies helps students to enhance their critical thinking, analytical reasoning, and problem-solving abilities. They indicated that these skills are transferable talents that can be useful to other professions of life aside science, technology, engineering, and mathematics

(STEM). These relevant areas include decisions making, being innovative, and having the ability to overcome difficult obstacles of life.

> *"A solid foundation in analytical proficiency is provided to lecturers through STEM education. Through demanding coursework, interactive experiments, and problem-solving activities, lecturers gain the capacity to evaluate complex data, spot trends, and make sense of it all. These analytical abilities are essential for gathering information, analyzing data, and coming to conclusions that are supported by facts" (*AM3). *'As a core competency, critical thinking is emphasized in STEM education. Logic, evidence evaluation, and questioning of presumptions are all part of the training that lecturers get. They gain the ability to tackle issues from several angles, taking into account the advantages and disadvantages of various strategies. As a result, they develop a thorough comprehension of difficult ideas and improve their capacity for critical thought in a variety of academic and professional settings"* (UG1).

> *"STEM education refines instructors' aptitude for solving problems. They are taught to use methodical techniques, create original solutions, and dissect difficult issues into digestible parts. A variety of problem-solving techniques are learned by lecturers, enabling them to address difficulties quickly and skillfully" (*UM1). *'Lecturers who obtained STEM education are prepared with requisite skills. They gain knowledge of how to use computational tools and statistical techniques to gather, arrange, and analyze data. During their lectures, lecturers learn how to analyze and extrapolate meaning from data, which is a crucial skill for carrying out research, coming to wise decisions, and sharing conclusions"* (UM4).

> *"STEM education gives educators expertise in creating and assessing experiments. They get knowledge on how to create research topics, plan experiments, and choose suitable techniques. They gain the capacity to assess experimental results critically, pinpoint possible sources of inaccuracy, and improve their methods for subsequent research through this process"* (CK2). *'The scientific method is emphasized in STEM education as a methodical way to do research. Lecturers are taught how to create hypotheses, plan experiments, gather information, evaluate findings, and make conclusions. This thorough application of the scientific process develops their capacity for critical thought, evidence evaluation, and efficient communication of findings"* (KN4).

> *"…………Because STEM education emphasizes evidence-*based *approaches, instructors must critically assess the body of current research and literature. They gain the ability to distinguish between trustworthy and false sources of information. By learning how to evaluate the reliability and quality of evidence, lecturers become more equipped to contribute to evidence-based practices in their profession and make well-informed decisions"* (UC2).

"An attitude of constant learning and adaptation is ingrained in STEM education. STEM subjects are dynamic and changing quickly, and lecturers are aware of this. They acquire the capacity to keep abreast of developments, embrace novel approaches, and incorporate cutting-edge technologies into their research and instruction. Their capacity for adaptation and dedication to lifelong learning strengthen their critical thinking and analytical reasoning abilities" (UM3).

Sub-theme 3.3: Global Competitiveness

Participants- UG3, UC1, UM1, UM3, CK3, AM4, KN2 and KN3 admitted that individuals obtaining Education in the sciences, technology, engineering, and mathematics (STEM) is frequently viewed as a tool aimed at improving the global competitiveness of a nation. These interviewees added that people who have a strong background in STEM fields are in high demand in the job market such as industries, factories, medical fields and the likes., they again pointed out that beneficiaries of STEM education help to make contributions to the growth and advancement of societies and also have the potential to have a positive impact on issues that are both local and global.

Participant KN3 said that:

"STEM education equips instructors with a deep understanding of their subject matter and a high level of competence in it. Lecturers are able to contribute to cutting-edge research, innovations, and developments within their subjects because of their extensive grasp. As they become acknowledged authorities in their domains of competence, their knowledge increases their competitiveness on a worldwide scale".

"…………………because STEM education promotes teamwork, professors are encouraged to collaborate on research projects with peers worldwide. By means of international research alliances, educators can gain access to a multitude of viewpoints, resources, and knowledge, so broadening their research networks and enhancing their competitiveness on a worldwide scale. Collaborative research provides lecturers with avenues for funding and allows them to collaborate on projects that have a larger impact" (UG3)

"STEM education equips instructors with the knowledge and abilities needed to present at worldwide scientific conferences and write for esteemed international journals. By using these platforms, lecturers can network with professionals from around the world, share their research

findings, and discuss ideas. Their professional reputation is strengthened and their global competitiveness is increased by the visibility they receive from such international exposure" (UC1).

"Teaching, research, and technology improvements are areas of focus for lecturers in STEM education. Through participation in worldwide literature, conferences, and partnerships, they remain current with the most recent advancements in their domains. The ability of lecturers to adopt novel strategies and maintain their competitiveness in the quickly changing global environment is improved by this exposure to best practices from around the world" (UM1).

Participant UM3 stated to the fact that "STEM education gives lecturers the tools they need to mentor and educate a wide variety of students, including those from other countries. Proficiency in comprehending and fulfilling the requirements of a heterogeneous student body puts lecturers in a better position to draw and hold on bright international students. The capacity to interact and assist international students in an efficient manner boosts the global competitiveness of instructors and fosters intercultural understanding".

"Problem-solving and adaptability are traits that STEM education fosters and are crucial for instructors operating in global settings. Teachers are ready to negotiate linguistic obstacles, cultural gaps, and different educational systems. Their capacity to collaborate with colleagues from a variety of backgrounds and adjust to new work contexts increases their global competitiveness" (AM4).

"……….STEM education gives instructors the skills they need to help address issues including sustainability, energy, healthcare, and climate change. Academics who possess the ability to tackle these urgent global concerns as lecturers are in great demand and boost their countries' and institutions' competitiveness internationally (CK3). *'Collaborative international initiatives that tackle global concerns are encouraged among professors in STEM education. Participating in international and multidisciplinary research endeavours helps lecturers hone their problem-solving, collaboration and cross-cultural communication abilities. Their ability to compete on a worldwide scale is increased, and these experiences equip them to function well in international research teams"* (KN3).

4.2.4.4 Main theme 4.0: influence of stem disciplines on female lecturers' social and academic life

Participants' responses on this main theme have been reported into two sub-sections as social and academic life experiences below:

Sub-theme 4.1: Social Life

Participants- UG1, UG3, KN3, CK1, UM2, UM4, UC1, UC3, AM1, AM3 and CK2 mentioned that; their participation in STEM-related educational activities helped to create opportunities for contacts and collaborations with peers who have interests and goals that are comparable to one's own. They indicated again that collaborations with peers in STEM-related activities makes it possible for individuals to participate in STEM-focused clubs and organizations, or competitions where they can connect with other people who share their interests. They said that there is development of social networks, the cultivation of friendships, and the construction of a feeling of community through engagement in STEM fields. However, they also asserted that there have been instances whereby the public see females engaged in STEM-related studies as individuals who might not be good "materials" for marriage, will have child bearing difficulties, not respectful, compete with male colleagues for higher job positions and many others. Participants affirmed that these perceptions destruct and deter younger females interested in STEM studies.

> *"STEM education frequently necessitates a large time commitment, especially in higher education. It is possible for lecturers to have extensive work hours dedicated to administrative duties, research, grading, and class planning. This may reduce the amount of time spent at home engaging in social and family activities" (*UG3). *'Participant-*KN3 *said "for academics who are heavily active in STEM teaching, striking a work-life balance might be difficult. Relationships at home may suffer as a result of the pressures of teaching, research, and administrative responsibilities that occasionally invade personal and family time". 'Although STEM instructors frequently have set work hours in labs and classes, they may also have possibilities for scheduling flexibility, such as working on research projects during non-teaching hours. They may be able to schedule time for social activities at home or to attend family gatherings thanks to this flexibility"* (CK1).

> *"…………a lot of STEM instructors are enthusiastic and passionate about what they do. They could inspire curiosity and interest in science, technology, engineering, and mathematics among family members by sharing their passion for these fields"* (UM2). 'Participant-UM4 *revealed that "the demanding nature of STEM education, along with the*

expectation to publish research and teach at a high level, can occasionally result in stress and difficulties at work. The social interactions and home health of lecturers may be affected by these circumstances" (UC1).

*"STEM instructors frequently get the chance to go to conferences, work on research projects with colleagues, and attend conferences. By broadening their circle of contacts, these activities can improve their professional networks, which may have a positive knock-on effect on their social lives" (*UC3). *'Instructors working in STEM fields can help their own kids or relatives with STEM-related coursework by offering advice and support. This may encourage their families to have a curious and learning culture" (*AM1).

Participant AM3 asserted that *"Lecturers in STEM subjects, especially those who are breaking down boundaries in their disciplines, can act as role models for their families. Family members may be motivated to pursue their own educational objectives by their commitment to learning and knowledge acquisition" (*CK2). ParticipantCK3 argued that *"in order to further STEM disciplines, some STEM instructors may get involved in their local communities. Opportunities for family and community participation in STEM-related activities and projects may arise as a result of this involvement.*

Sub-theme 4.2: Academic Life

Participants- KN1, KN2, KN4, UG4,, CK1, CK3,UM1. AM2 and UC3 indicated that Participation in STEM-related educational activities have a great influence on the academic careers of them as lecturers. Engaging in STEM disciplines studies offers opportunities in the process of studying and obtaining knowledge in the domains of science, technology, engineering, and mathematics, which can improve an individual's understanding of these areas of study. In addition, STEM studies also leads to the development of skills such as analytical thinking, problem-solving thinking, and critical thinking, all of which are valuable in academic environments. Furthermore, participation in STEM education can open doors to job contracts, for hands-on learning, experimentation, and research, all of which contribute to a more profound comprehension of scientific principles. Also, engaging in STEM-related in academics create more room for attaining higher pedicels and invariably improves one's economic fortune at large.

> *"…………………………through ongoing education and research, STEM educators frequently become authorities in their domains. This in-depth subject knowledge strengthens their academic reputation and improves their capacity to give pupils top-notch education"* (KN2). *'………………………conducting field research and actively participating in STEM education frequently go hand in hand. In order to further knowledge in their field of specialization, lecturers may be able to work with colleagues on collaborative projects, research initiatives, and grant applications"* (KN1).

> *"……………………Teachers in the STEM fields are often committed to enhancing their instructional strategies and keeping up with the latest developments in education. Their dedication to teaching quality helps their pupils by offering creative and useful educational opportunities" (UG4*). Participant- KN4 said *"to represent the most recent developments in their domains, a large number of STEM professors are active in the construction and upgrading of curricula. By getting involved, we can make sure that our instructional programmes follow industry best practices and standards".*

> *"………………………STEM teachers frequently act as mentors to students, by offering advice on research projects, internships, and academic endeavours. In addition to promoting a positive learning atmosphere, this mentorship helps students advance both academically and professionally" (*CK1). *'Multidisciplinary cooperation is frequently promoted by STEM education. In order to tackle difficult real-world problems, lecturers may work with colleagues from a variety of STEM fields, enhancing their scholarly experience"* (UM1).

> *"…………………STEM disciplines instructors recognize the value of professional growth and lifelong learning. They are more likely to pursue opportunities for personal development during their academic careers, attend conferences, and participate in continuing education"* (CK3). '*Teachers who teach STEM subjects have the chance to establish wide ties both in the academic and business worlds. These relationships may result in joint ventures, partnerships, and the acquisition of priceless materials for scholarly pursuits"* (AM2).

> *"………………………………a lot of STEM instructors hold leadership positions in their educational settings. This can involve directing programmes, chairing departments, or sitting on committees to shape the policies and practices of higher education" (*UC3). *"STEM disciplines educators frequently adopt cutting-edge techniques and tools. Teachers can improve students' entire academic experience by incorporating internet resources, hands-on activities, and active learning practices into their classes*" (AM1).

> *"…………………………participating in STEM education frequently results in academic papers, conference presentations, and acknowledgment from other academics. The scholarly work that professors do enhances their academic portfolios"* (UG1). *'By supporting student progress, academic quality, and the prestige of their universities, lecturers can have a positive impact on their academic institutions through their dedication to STEM education" (*UM4).

4.2.4.5 Main Theme 5.0: Challenges female lecturers faced in STEM disciplines engagement

Participants' responses on the challenges they encounter both at home and work place through their engagement in STEM disciplines were categorized on the following issues:1) Workload and Time Management 2) Complexity of Concepts 3) Resource Limitations 4) Gender and Diversity Gap. These responses from the participants were transcribed and shown below

Sub-theme 5.1: Workload and Time Management

Participants- CK1, CK3, UC2, KN1, UM1, UM4, AM1, AM3, AM4, UG1, UG3 and UM2 revealed that; engaging and participating in STEM disciplines programmes or pursuing a career in a STEM field might include arduous coursework, research, and projects, as well as strict due dates. They indicated that managing all of these activities alongside attending to one's personal life and responsibilities can be difficult and calls for strong organizational and time management abilities for effective work output.

> *"……Because STEM subjects are so complicated and deep, working in them frequently entails a heavy workload. Professionals and researchers may have to manage several projects, deadlines, and obligations at once, which can result in high levels of stress and strain at work"* (UC2). *'Engaging in STEM subjects can take a lot of time, especially whether planning experiments, performing research, or analyzing data. It might be difficult to juggle several obligations, such as teaching, administrative work, and research, leaving little time for personal time and self-care"* (CK1).

> *Participant-*KN1 *revealed that "whether it's turning in research papers, hitting project milestones, or giving presentations, STEM work frequently has stringent deadlines and deliverables. It can be tough to*

> *keep track of deadlines and make sure that activities are completed on time, particularly when unforeseen problems or delays occur". 'In order to attain desired results, people in STEM disciplines may need to labour long hours. Extensive work durations may result from the intense focus and concentration required for problem-solving, data analysis, or experimental methods. Sustaining concentration and productivity for prolonged periods of time can be physically and mentally taxing"* (CK3).

> *"It might be difficult to have a healthy work-life balance when working in STEM disciplines. There is a risk that professional obligations, research obligations, and a rigorous workload will interfere with personal time and interests. Due to the responsibilities of work, it might be difficult to find time for personal relationships, leisure, and self-care, yet doing so becomes vital"* (UM1). *'People working in STEM disciplines frequently have to manage several things at once. Setting priorities for projects, effectively managing time, and balancing conflicting demands can be difficult. The ability to prioritize tasks and multitask well is essential for navigating the demanding nature of STEM involvement" (*UM4).

> *Participant-*AM1 *indicated that "working in the STEM fields frequently calls for cooperation with industry partners, research teams, and coworkers. It can be difficult to manage schedules, coordinate efforts, and maintain efficient communication within a team, especially when dealing with varied stakeholders or across time zones". 'People working in STEM professions need to keep up with the most recent findings, innovations, and techniques because these industries are changing quickly. While professional development and ongoing education are crucial, they can also increase workload and complicate time management. It can take some juggling to strike a balance between the requirement to keep current and ongoing obligations" (*AM3).

Sub-theme 5.2: Complexity of Concepts

Participants AM1, UC3, UM2, CK1 and KN3 admonished that; the fields of science, technology, engineering, and mathematics frequently entail difficult and abstract ideas, which might be difficult to be understood easily by learners. They suggested that for effective and complete grasping of the scientific concepts, skills and principles, it calls for commitment, research, devotion, persistence, and additional effort on the part of the facilitator and learners.

> *"It might be difficult to understand the complex and abstract ideas that are frequently included in STEM subjects. Theories, mathematical formulas, scientific principles, and technological details might be*

complex, making it challenging for some people to completely understand and implement these concepts" (AM4). *'……………………..STEM professions include a tremendous amount of constantly expanding knowledge. Sustaining current knowledge in a particular topic necessitates profound comprehension and ongoing learning about advances, interdisciplinary links, and emerging research findings. It can be difficult and time-consuming to acquire and maintain vast knowledge"* (UG1).

"Developing specialized technical skills is frequently required for STEM engagement. It takes commitment and practice to become proficient in sophisticated laboratory procedures, computer languages, data analysis software, or engineering concepts. Because of the intense training requirements and frequent technological advancements, gaining proficiency in these specialized fields can be difficult" (UG3).

"Because STEM subjects frequently touch on other academic areas, those working in these sectors must be able to combine their knowledge and methods from different fields. It may be mentally taxing to navigate the connections between various concepts and approaches across disciplines, necessitating a thorough grasp of numerous fields of specialization" (UM2).

*"Applying critical thinking abilities and addressing complicated problems are common components of STEM involvement. Developing theories, planning experiments, evaluating information, and coming up with answers all call for a high degree of analytical thinking and cognitive skills. The difficulties are in coming up with practical approaches to tackling problems and in coming up with innovative solutions to problems" (*UC3).

Participant-CK1*) pointed out that "it might be difficult to explain difficult STEM topics to coworkers, students, or the general public. Strong communication skills and the capacity to modify explanations for various audiences are necessary for effectively simplifying complicated topics without lost accuracy or oversimplification".*

"In STEM subjects, scientific research frequently entails addressing complex research questions and planning experiments that take into consideration a variety of variables and possible confounding factors. It might take a lot of effort and time to manage the intricacy of research design, data gathering, and analysis" (KN4).

"People who engage in STEM fields frequently have to deal with moral conundrums and issues pertaining to innovation, technology, and research. It can be difficult to strike a balance between scientific breakthroughs, moral obligations, privacy issues, and possible societal repercussions. This requires careful consideration and decision-making" (UM3).

Sub-theme 5.3: Resource Limitations

Participants- AM1, AM2, AM4, CK1, CK2, KN3, KN4, UC1, UC3, UG1, UG2 and UM1 pointed out that; access to tools and equipment for conducting hands-on experiments or research on STEM disciplines concepts can be difficult to come by, particularly for persons within educational institutions that have fewer resources available or those that live in neighbourhoods that are economically disadvantaged. They added that practical learning experiences could be more difficult due to the lack of access to technology or scientific tools.

> Participant-UM2 *specified that "research supplies, equipment, data collecting, and analysis are often expensive aspects of STEM undertakings. Insufficient funds may limit the breadth and depth of study, making it more difficult to carry out tests, buy essential equipment, or obtain pertinent datasets. It becomes difficult for researchers and institutions to manage the resources that are available and secure enough financing"/*
>
> *"Participating in STEM subjects may require access to specialized hardware, software, computer resources, or lab spaces. But having restricted access to cutting-edge tools or facilities can make it more difficult to carry out simulations, conduct tests, or evaluate intricate data. The absence of essential resources can make it difficult to carry out excellent research or put cutting-edge technical ideas into practice"* (UM4).
>
> *"………………………because access to particular research materials, including chemicals, biological specimens, or uncommon samples, is frequently necessary for STEM research. These materials can be expensive or scarce, which might make study and testing more difficult. In order to get over resource constraints, researchers might have to look for alternate sources or consider working together"* (UC1).
>
> *"Participating in STEM areas necessitates a substantial time commitment. Professionals and researchers have time constraints when carrying out experiments, gathering and evaluating data, and composing research articles. It can be difficult to juggle several projects, teaching obligations, and administrative responsibilities within constrained time periods, which can affect the caliber and depth of work"* (UC3).
>
> *"Working with large datasets or certain data sources might make data accessibility and availability difficult. One's capacity to carry out exhaustive studies or gather enough evidence to support research*

findings may be hampered by restricted access to extensive databases or restricted data sets" (UM3).

"Geographical limitations, institutional ties, or a lack of networks can all lead to a lack of opportunities for collaboration with subject matter experts. Limitations on collaboration partnerships can impede the pooling of resources and skills, multidisciplinary research, and knowledge exchange" (UM2).

*"Researchers may find it difficult to extensively disseminate their findings if they have limited access to open-access journals or publication resources. Limited accessibility to scientific materials can obstruct the dissemination of knowledge and reduce the prominence and influence of research findings" (*UG2).

"Participant-KN4 said *"to keep current with innovations and pick up new skills, people working in STEM disciplines need to engage in ongoing professional development and training. Strict access to pertinent conferences, workshops, or training courses might limit chances for skill development and impede career advancement".*

Sub-theme 5.4: Gender and Diversity Gap

21 participants asserted that; the underrepresentation of specific groups, such as women and minority populations (disabled persons) in STEM disciplines can generate additional obstacles, such as the perpetuation of preconceptions and biases, as well as a dearth of role models. Participants suggested that for fair participation in STEM fields, these barriers must be tackled and cultivating an environment that is welcoming to all are absolutely necessary for national development.

"Because STEM disciplines have traditionally been dominated by men, people may face difficulties as a result of biasness and gender preconceptions, particularly women and gender minorities. Biasness in recruiting, promotion, and advancement chances can be caused by preconceived ideas about gender roles and talents, which can have an impact on career advancement and representation in STEM fields" (KN1).

Participant-UG2 *confirmed that "one enduring issue in STEM professions is the underrepresentation of women, racial and ethnic minorities, and other marginalized groups. In the STEM field, innovation and problem-solving may be impeded by a lack of different viewpoints, experiences, and ideas resulting from limited representation".*

> Participant-AM1 *indicated that "people from marginalized groups may be afraid that bad preconceptions about them will come to pass. This phenomenon is known as stereotype threat. This worry can hinder confidence and put more strain on oneself, which can affect performance and job advancement. Furthermore, imposter syndrome can impair a person's confidence in their skills and impede their advancement in STEM disciplines. It is typified by self-doubt and a continuous sense of inadequacy".*

> *"People from different backgrounds may encounter difficulties in unwelcoming or exclusive work environments. Biased practices, discrimination, and harassment can demotivate people and make it more difficult for them to succeed in STEM disciplines. To address these issues, inclusive work cultures that promote diversity, equity, and inclusion are crucial"* (UM1).

> *"……………………"this type of bias can lead to the persistence diversity and gender disparities in STEM fields. Discriminatory standards, implicit prejudice in assessments, and restricted access to prospects for development and success can impede the progress of marginalized communities. Improving equity in STEM contexts requires addressing bias in hiring, evaluating, and promotion procedures"* (UC2).

> *"Because of their rigorous workloads, long hours, and deadlines for projects or research, females in STEM disciplines may find it especially difficult to balance their work and personal obligations. Because of social expectations around caregiving and family responsibilities, this issue may be more difficult for women. These issues can be addressed with the aid of support networks and policies that encourage flexible work schedules, inclusive family-friendly policies, and work-life balance"* (CK1).

4.2.4.6 Main Theme 6.0: Institutional collaborations with other sister universities in STEM disciplines

Participants- CK1 explained the term collaborative efforts:

> *'To be a number of different activities, including joint research initiatives, exchange programmes, shared resources, and the creation of curricula for a common goal. In addition, that interdisciplinary partnerships between educational institutions are rather typical in the STEM field and should be embraced by all stakeholders".*

Participant-AM2 argued that "*interinstitutional collaborations on STEM disciplines among Ghanaian universities has been inadequate stating an example of WiSTEM chapters that can be found in only five Ghanaian public universities"*

> "*The value of collaboration in improving the overall quality of science, technology, engineering, and mathematics (STEM) programmes and expanding the range of educational possibilities available to students should be recognized by all stakeholders concerned with STEM disciplines in tertiary institutions*."(AM3).

Participant-UC2 and UM4 revealed that *it is necessary for stakeholders to promote collaborative STEM activities for both lecturers and students. It was then suggested that various administrations of our institutions should develop interest in STEM disciplines and work together with other universities in the area on STEM programmes to address societal demands.*

Sub-theme 6.1: Collaboration and Communication

Participant-KN3 asserted that:

> *"Effective collaborative work, team projects, clear and concise communication are necessary in STEM areas. It is further said, for one to develop these abilities and able to work effectively in teams which will comprise varied members can be difficult, particularly for persons who are more oriented towards individual work or who have hurdles relating to language or culture".*

> *"In order to solve complicated challenges, STEM professions frequently need interdisciplinary collaboration. Working with people who have diverse backgrounds, specialties, and communication styles however, can be difficult at times. Effective coordination and communication are essential to bridging disciplinary boundaries in terminology, language, and methodology*" (UC1).

> *"Due to the use of specialized vocabulary and technical concepts, STEM areas can be difficult to explain to non-expert audiences. It can be challenging to clearly and concisely explain complicated concepts without oversimplifying them. To effectively communicate ideas to a variety of audiences, including coworkers, students, legislators, and the general public, effective science communication skills are required" (*UM1)

Participant-UG1 and UG3 indicated that working with foreign partners or teams with different cultural backgrounds can be difficult when it comes to communicating. UG3 further asserted that *"Effective collaboration may be impacted by cultural conventions, language obstacles disparate communication styles. Cross-cultural communication* *abilities and sensitivity are necessary for comprehending and managing these disparities".*

> *"In a society driven by technology and becoming more interconnected on a global scale, distant collaboration is becoming more typical. It can be difficult to collaborate across time zones, rely on online technologies for communication, and keep up productive dialogue when face-to-face encounters aren't happening" (*CK2).

AM1 and AM2- indicated that *adjusting to time variations, making sure that messages are understood, and developing a relationship when working remotely call for more work and flexibility.*

Participants-AM34and UM3 pointed out that;

> *"In STEM professions, poor or ineffective communication can impede teamwork. Misunderstandings, assumptions, and incomplete or imprecise instructions can result in mistakes, hold-ups, or conflicts" However*, AM3 suggested *"to reduce communication breakdowns, it is essential to engage in proactive, open communication as well as active listening and to clearly communicate expectations and criticism"*

> *"The development of strong interpersonal and communication skills can be difficult for STEM professionals, despite their propensity for technical excellence. Technical proficiency as well as strong cooperation skills, such as active listening, conflict resolution, and constructive criticism, are prerequisites for collaborative work in STEM professions"* (KN1).

CK1 argued that *"for collaboration to be successful, interpersonal and technical abilities must be balanced"*

> *"In STEM collaborative initiatives, team decision-making is frequently required. Keeping disparate viewpoints, concepts, and levels of experience in check can be difficult. Achieving agreement, settling disputes, and guaranteeing fair participation all involve strong communication, bargaining, and decision-making abilities" (*KN4)

> *"In STEM, large-scale collaborative projects may involve multiple departments, organizations, or team members"* (UG4) Participant-UG4 asserted that *"it might be challenging to plan ahead, synchronize objectives, and maintain efficient communication over the course of the project"* Participant-UC3 suggested that *"establishing well-defined roles, duties, and communication channels is crucial for promoting seamless teamwork in STEM disciplines"*

4.2.4.7 Main Theme 7.0: Links of role models and mentors in STEM disciplines within and outside Ghana

Participants- CK1 indicated that:

> *"There are programmes and organizations in Ghana that work towards the goal of establishing relationships between students and professionals working in STEM disciplines industries and serve as role models and mentors. These programmes frequently offer a variety of opportunities, such as those for networking, mentoring, and career assistance"*

CK1 further said "*one such organization is the Ghana STEM Network, which works to increase participation in STEM disciplines activities and education by running a variety of programmes, including mentorship programmes".* Participant-AM1 asserted that "*WiSTEM branches and activities are limited to only a few Ghanaian universities hence, they should be decentralized to get to the door steps of the less privilege and all institutions to benefit"*

Sub-theme 7.1: Increased Interest and Engagement

Some participants believe that involvement of STEM disciplines role models makes learning more interactive, participatory and applicable to students' daily lives, thus enhances reality.

UC1 further added that:

> *"STEM education frequently piques students' interest in STEM subjects and career choices. It was suggested that arousal of learners' interest is a call for Institutions to engage students more and inspire them to learn more about STEM areas by incorporating real-world experiments, projects, and technology".*

AM2 said:

> *"STEM education frequently includes practical applications and hands-on exercises, which can hold students' interest. Students become more engaged and excited about the subject matter when they recognize the practical applicability of what they are learning. Again, STEM subjects are directly related to routine activities. As students begin to understand how STEM principles impact the world around them, their interest is*

> *piqued, and their engagement is increased. STEM education enables students to apply what they learn in the classroom to real-world circumstances".*

UG3 was of the indicated that:

> *"STEM education promotes students' use of interactive, dynamic problem-solving techniques. This strategy not only tests their cognitive abilities but also promotes participation, which increases motivation and a sense of accomplishment. Again, STEM education frequently uses inquiry-based learning techniques, where students actively look for solutions and answers. This method of self-directed learning encourages independence and curiosity, which raises levels of engagement".*

These participants' contributions

> *"By incorporating projects and challenges into STEM instruction, students are given the opportunity to take charge of their education. These assignments give students a forum for invention, discovery, and creativity while also keeping them interested in what they are learning. Again, the digital-native generation is drawn to STEM education because it makes use of multimedia tools, simulations, and technological platforms. Using interactive tools keeps students interested and offers a multifaceted educational experience"* (UG1).

> *"Many STEM endeavours call for cooperation and teamwork. The learning process is made more interesting and enjoyable when peers are working together on challenging assignments because it develops a sense of teamwork and shared accomplishment. Again, it introduces students to prominent professionals and researchers in the STEM fields as role models and guest speakers to inspire them. Student interest can be increased by having guest speakers and role models share their experiences by highlighting the exciting possibilities of a future in STEM"* (CK2).

Sub-theme 7.2: Addressing the Skills Gap

Participants indicated that; there is the issue of STEM disciplines professions not able to get the required skilled female personals and this is of a great concern for national development. They pointed out that institutions may help close this gap by emphasizing on STEM disciplines studies and providing students with the knowledge and skills that they may need to succeed in the workforce.

UG2 asserted that:

> *"Female lecturers who double as role models provide a strong emphasis on the development of the critical thinking, problem-solving, analytical reasoning, and computational abilities that are necessary for success in STEM disciplines. To make sure students are prepared for the demands of STEM careers, they provide curricula and learning opportunities that center on fostering the development of these abilities".*

> *"Female lecturers place a strong emphasis on the real-world applications of STEM knowledge and abilities to show how STEM knowledge can be used to solve issues and meet real-life challenges, they offer case studies, practical projects, and real-world examples. This aids students in bridging the conceptual and practical knowledge gaps" (*CK3).

> *"Female STEM role models understand the value of teamwork and collaboration in STEM disciplines. To help students improve their collaboration skills, they organize group projects, promote cooperative learning, and create opportunities for teamwork. They equip students to function well in collaborative, interdisciplinary settings by encouraging teamwork"* (UG4).

> *"Female lecturers stress the value of traits for STEM professions. They help students develop a growth mindset by motivating them to tackle obstacles, keep going after failures, and never stop learning new things. They equip students to meet the needs of the changing technology landscape and the workforce by encouraging a mindset of continuous learning"* (UM3).

> *"Female lecturers make sure that their course materials and curriculum take into account the latest developments and trends in the fields. They keep up with the most recent advancements in the STEM domains in which they work and integrate pertinent material into their lessons. They provide students with the information and abilities that employers and looking for jobs by offering education that is relevant to the sector" (*UC2).

Participant-KN4 asserted that *"in order to close the skills gap in STEM disciplines, female role models in STEM disciplines must build relationships with relevant business partners to engage into activities towards the advancement of STEM disciplines studies".*

> *"To comprehend the demands and skill requirements in STEM professions today, they work in conjunction with professionals and industry experts. This partnership guarantees that students receive*

> *instruction that is applicable to the workplace and helps to inform their teaching methods"* (AM4).

> *"Female instructors in STEM stress on the significance of the factors that helps in closing the skills gap. They support inclusivity, ethnic diversity, and gender parity in STEM fields of study and employment. They close the gap by guaranteeing that underrepresented groups have equitable access to STEM opportunities through the creation of inclusive learning environments"* (KN2).

Participant-UC3 confirmed that *"female role models in STEM disciplines help students navigate professional options in STEM fields, thereby bridging the skills gap by offering career guidance and mentoring".* Participant-KN4 suggested that *"to assist students in obtaining relevant experience and expanding their professional networks, female role models offer guidance on skill development, internships, research opportunities, and networking".*

> *"Female instructors serve as role models for the value of ongoing professional development in the STEM fields. They attend conferences, actively participate in professional development events, and keep up with developments in their disciplines. Their dedication to lifelong learning serves as an inspiration for students to make professional development a top priority"* (AM3).

> *"It can be difficult for people, especially women and minorities, to see themselves thriving in STEM disciplines because there aren't enough prominent role models and mentors from underrepresented groups in these fields. Lack of relatable role models and mentors can exacerbate feelings of loneliness and restrict access to help and support"* (UM1).

Participant-KN4 pointed out that:

> *"It can be difficult for people, especially women and minorities, to see themselves thriving in STEM disciplines because there aren't enough prominent role models and mentors from underrepresented groups in these fields. Lack of relatable role models and mentors can exacerbate feelings of loneliness and restrict access to help and support"* (UM1).

Participant-UM2 said "*conscious efforts should be made by individuals and organizations in Ghana for opportunities to work together and make links with role models and mentors in STEM disciplines studies both within and outside Ghana".* KN1 suggested that *"the accomplishment of female STEM role models can be made possible* *through the formation of global collaborations, attending international conferences and other events, and active participation in international STEM communities". "Role models connections can provide possibilities for professional development, as well as useful insights, exposure to new ideas and perspectives, and experiences to build on".* (UM4)

Participant-KN3 revealed that;

> *"It would be appropriate to make contact with relevant STEM organizations, educational institutions, or professional networks that focus on promoting STEM discipline studies and mentorship in Ghana in order to obtain specific and up-to-date information regarding the links with role models and mentors in STEM-related fields both within and outside of Ghana".* This information can be obtained by getting into contact with the relevant STEM organizations.

4.2.4.8 Main Theme 8.0: Institutional collaborative programmes being designed to boost the capacities of females engaged in STEM disciplines

Sub-theme 8.1: Technological Literacy

Participants- UM4, UM2, KN1 and AM2 asserted that, in this era of society becoming increasingly driven by technology, individuals can develop their literacy in technology with the support of STEM disciplines they also pointed out that learners can develop an awareness of how technology operates and an appreciation for the influence it has on society. Finally, they said learners will also acquire the skills necessary to effectively navigate and make use of technological tools to solve daily life problems.

Participant-KN1 indicated that:

> *"STEM education has given instructors the ability to use a variety of software programmes and technology tools that are pertinent to their fields of study. They are now proficient in the use of sophisticated software programmes, data analysis instruments, modelling programmes, and programming languages. Because of their technological literacy, instructors are better equipped to use technology for professional, academic, and research purposes"*

> *"With the help of institutional collaborations, female lecturers are now more equipped to incorporate technology into their lessons with ease.*

They are skilled at boosting student engagement and facilitating interactive learning experiences through the use of multimedia resources, interactive simulations, virtual labs, and online platforms. The ability to use digital resources, create online tests, and support blended or online learning environments are all made possible by technological literacy among lecturers"(UM4).

Participant-AM4 pointed to the fact that:

"STEM education has given female professionals the ability to use technology to gather and analyze data through collaborative works. For the purpose of performing thorough data analysis and coming to insightful findings, they can make use of statistical software, data visualization tools, and computer languages". 'Professors that are technologically literate can carry out research more accurately and efficiently, which advances their areas" (CK2).

*"Female lecturers who received STEM education are more equipped to comprehend and utilize emerging technology. They keep up with the most recent developments in technology, including virtual reality, Internet of Things (IoT), machine learning, and artificial intelligence. This knowledge enables instructors to modify their pedagogical approaches, integrate nascent technologies into their investigations, and equip learners for the rigours of the swiftly changing technological terrain" (*UC3).

Participant UM3 said *"Proficiency in using digital media for effective communication is developed by lecturers through STEM education collaborations. They may use multimedia platforms to spread knowledge, provide interesting presentations, and make excellent instructional movies. Lecturers that possess technological literacy are able to explain difficult ideas and research findings through the use of interactive media, digital platforms, and visual aids".*

"…………………….STEM education improves instructors' capacity to encourage technologically based collaborative work. To facilitate productive student teamwork, they make use of online communication tools, project management software, and digital collaboration tools. With the help of technological literacy, instructors may facilitate online collaborations, allowing students to collaborate regardless of where they live" (CK3).

Participant UG4 asserted that *"STEM education gives female professors the flexibility they need to deal with the rapidly evolving technological environment. They possess the knowledge and attitude necessary to pick up new technologies as they become available. Incorporating new tools and approaches into their teaching, staying ahead of the curve, and contributing to creative practices in their disciplines are all made possible by lecturers' agile embrace of technology innovations"*

> *"…………………..STEM education places a strong emphasis on using technology in a responsible and ethical manner, instructors are knowledgeable in topics like cybersecurity, data privacy, and digital ethics. They teach students about digital citizenship, placing a strong emphasis on using technology ethically, encouraging online safety, and encouraging responsible online behavior"* (AM3).

Sub-theme 8.2: Mentorships

Participants- UG2 and UC2 indicated that, *organization of mentorship programmes help female lecturers and students who are into STEM subjects to get connected with experienced professionals who provide guidance, support, and career advice to the students. UC2 further stated that there is the need for all universities to form WiSTEM branches that will promote mentoring programmes to boost the capacities of females in STEM disciplines in Ghana.* Participants- UM1 and UC1 revealed that "*the establishment of clubs or networks that caters specifically is necessary to the needs of female students majoring in STEM disciplines".*

Participant-UM1further said:

> *"These organizations are not readily available in all institutions to work with hence suggest for the establishment of such organizations to serve as a community that is supportive, plans activities such as workshops, seminars, and networking gatherings, and seek to raise awareness and encourage empowerment of females"*
>
> "*Educational institutions provide scholarships and grants specifically for female students who are majoring in STEM (science, technology, engineering, and math) of which I am a beneficiary"* (AM1).

CK1 mentioned that:

> *"The lack of scholarships support packages retards the academic and professional growth of female lecturers and students alike in STEM disciplines. In addition, these monetary incentives if available will help at reducing the obstacles in females' underrepresentation in STEM disciplines".*

Participants-KN3 and UM2 asserted that, "*outreach programmes are organized for female students within elementary and secondary schools". "The goal of these programmes is to increase participants' interest in STEM fields".* Participant KN2 said

"*STEM outreach programmes provide females with opportunities to get practical experience and interaction with role models".* Participant UG3 stated that "*outreach programmes need to cover all relevant basic and second cycle institutions with the support of all stakeholders in STEM advance the call for more females' involvement in STEM disciplines studies Ghana"*

Participants- KN4 and UG1 asserted that "*the lack of collaborative research projects in STEM studies impedes their chances of developing requisite skills for the formation of professional networks, and the observation of real-world STEM applications"* Participant-AM2 argued that "*institutions must make frantic efforts to liaise with relevant organizations for effective STEM disciplines advocacy*"

4.2.4.9 Main Theme 9.0: Institutional support systems toward professional development and growth of female lecturers in STEM disciplines

Sub-theme 9.1: Development of Collaboration and Teamwork Abilities

These participants indicated that STEM disciplines encourages students to work in groups among their peers to solve challenges in the society. They added that teamwork will encourage collaboration, dialogue, and the growth of interpersonal skills. They suggested that all those activities are vital for success in STEM areas and the modern workplace to open them up for more job opportunities (AM4, UG4 and KN1).

CK3 narrated that:

> *"Female professors emphasize the value of teamwork and collaboration in STEM areas. They stress that it frequently takes a variety of viewpoints and specializations to effectively address complicated challenges. They inspire kids, whether male and female, to actively participate in cooperation and appreciate the power of group problem-solving by highlighting the importance of collaboration".*

UM3 added that:

> *"Female lecturers encourage collaborative learning settings in their classrooms, laboratories, and group projects. They design tasks and*

activities to promote teamwork, idea sharing, and project collaboration among students. This aids in the development of crucial teamwork abilities in the kids, including communication, coordination, and dispute resolution".

AM1 posits that:

> *"Women professors place a strong emphasis on the value of inclusive and diverse teams in the STEM fields. They advise students to build teams with people who have various backgrounds, viewpoints, and skill sets. They assist students in understanding the advantages of varied teams, which can result in more creative and successful problem-solving solutions, by promoting diversity".*

KN4 shared her view:

> *"Female lecturers place a strong emphasis on excellent communication as the basis for productive teamwork. They offer advice on how to actively listen, express ideas clearly, and interact with team members in a courteous manner. Students' communication skills are improved, which promotes efficient teamwork and collaboration".*

UG1 added that:

> *"Female professors provide students with structured possibilities for teamwork. This involves teamwork-intensive exercises including group projects, case studies, and practical work. They lead students through the process while providing encouragement and criticism to improve their collaborative skills".*

CK2 asserted:

> *"Female professors stress the need of reflection and feedback in productive teamwork. They encourage students to consider their experiences working in groups and to pinpoint their advantages and weaknesses. They allow students the chance to give and receive constructive criticism, which promotes ongoing improvement of collaborative abilities".*

These participants commented that:

> *"Female lecturers emphasise the distinctive abilities and viewpoints that women bring to leadership and teamwork roles. They place a strong emphasis on the importance of female cooperation traits like empathy, inclusion, and consensus-building. They encourage female students to take on leadership roles and contribute to collaborative situations by demonstrating women's skills in teamwork"* (AM3).

> *"Female professors create evaluations that take into account collaboration and teamwork. They encourage students to actively participate and contribute to the success of the team by recognizing and*

evaluating individual accomplishments within a team framework. This strategy emphasises the value of collaborative skills and gives students' chances to show off their capabilities" (KN2).

Sub-theme 9.2: Policies and Grants

Participants-KN4 revealed that:

> *"Underrepresented females in STEM disciplines may be disproportionately affected by the lack of networks and resources, including funding possibilities, research collaborations, and networking platforms. Inequitable access to these resources can impede prospects for collaboration, professional growth, and exposure in the area".*

Participant-UG2 confirmed that:

> "*The existence of laws and guidelines in their institutions helps in the promotion and advocacy of females' representations in STEM disciplines studies. It is further said that the implementation of these policies within the institutions help to advance the call for gender equity and equality in order to close the gap of gender inequality".*

Participants- CK1 indicated that:

> *"The absence of a national established policy documents for all tertiary institutions towards the advancement of gender equality and inclusivity. It is therefore suggested that all stakeholders in STEM education should endeavor support in the development of such policies for all tertiary institutions in Ghana to help bridge the gap of gender balance in the field of STEM disciplines studies"*

Participants- UM2 empathized that:

> *"Women empowerment is key in STEM disciplines studies however, the participant said that the insufficient planned of activities in universities towards female empowerment in STEM disciplines is challenging since empowered female lecturers invariably will motivate their students to challenge prevailing views about teaching in other subjects other than STEM as a last option"*

Participants- KN3 asserted that:

> *"Their institutions make provisions in the forms of scholarships and grants specifically for female lecturers and students engaged in STEM disciplines (science, technology, engineering, and math). It is further stated that those incentives have been designed with the goal of lowering obstacles of females' participation in STEM hence these gestures encouraged and motivated more female to pursue studies in STEM disciplines".*

Participants-AM2 revealed that:

> *"An all-inclusive learning environments are not in place and thus need to be created to encourage research or teaching collaborations between junior and senior faculty which will increase professional and personal interactions, and reduce professional isolation experienced by new faculty". Furthermore, creation of such conducive environments will help to cater for the needs all learners regardless of status".*

Participants-AM4 pointed out that:

> *"Institutions should deliberately present their technical work as part of department colloquia, brown-bags, and other special events, providing opportunities for these speakers to meet and mentor students" This they indicated will empower the female lecturer adequately to advance the active participation of girls in STEM disciplines in Ghana".*

Sub-theme 9.3: Innovation and Creativity

Majority of the participants revealed that the institutional activities of STEM studies encourages individuals to develop skills of innovation and imaginatively by providing them with the tools and opportunities that are necessary to do so. Participants again pointed out that STEM studies fosters in learners the ability to come up with fresh ideas, to approach issues from different angles, and to devise imaginative solutions. Learners are also able to have mindsets that are opened to new ideas and creativity which can be beneficial to individuals in all facets of their lives.

Participant AM3 asserted that:

> *"STEM education pushes instructors to take an original and creative approach to solving issues. They obtained knowledge on how to recognize and categorize issues, generate concepts, and consider several options. Through courses and practical experiences, instructors cultivate critical and creative thinking skills to tackle challenging problem".*

> *"By exposing instructors to state-of-the-art research, new trends in their domains, and technological breakthroughs, STEM education fosters innovative thinking in their lectures. Teachers are exposed to new concepts, cutting-edge technologies, and research approaches that encourage and motivate their own creativity"* (UG1).

> *"A major focus of STEM education is on practical projects and experiments that call for lecturers to apply their theoretical knowledge*

to actual situations. By designing experiments, creating prototypes, and investigating novel solutions, teachers are encouraged to be innovative and creative through this practical application. Through practical experiences, instructors can investigate novel strategies and evaluate their concepts in a real-world setting" (UM1).

Participant-UM4 revealed that:

"STEM education encourages multidisciplinary cooperation, which boosts originality and inventiveness. Lecturers have the chance to work together with professionals in many STEM domains, combining a variety of viewpoints, expertise, and abilities. The integration of several fields through interdisciplinary collaboration promotes creativity and idea sharing'

"Professors in STEM disciplines are exposed to cutting-edge research in their domains as well as new technologies. Educators become acquainted with cutting-edge equipment, programmes, and techniques that can improve their research and teaching. The opportunity to work with cutting-edge technologies stimulates lecturers' creativity and encourages them to consider novel approaches to innovation in their work" (CK2).

"………………A focus of STEM education is on research and experimentation, which gives instructors the chance to investigate novel concepts, test theories, and produce ground-breaking findings. By conducting research, instructors are inspired to think creatively, develop novel strategies, and further the body of knowledge in their domains" (KN4).

"Design thinking approaches are frequently used in STEM education, encouraging instructors to tackle issues in a creative and user-centered manner. Teachers acquire the ability to comprehend users' needs, pinpoint those needs, and create solutions that meet those needs. This design thinking methodology fosters innovation by emphasizing the development of workable and intuitive solutions to pressing problems" (UC2).

*"Lecturers in STEM fields are encouraged to embrace failure as a teaching tool, take calculated chances, and refine their concepts. Lecturers discover that failure is a natural element of the creative process and that invention frequently requires trial and error. A culture of innovation is fostered and professors are encouraged to think creatively when they adopt this attitude of accepting risk and learning from mistakes" (*UM3).

"STEM education equips instructors with the know-how and abilities to go after business ventures. Lecturers might use their skills to launch their own businesses, develop cutting-edge goods, or progress

technology. STEM education gives instructors the skills they need to think creatively and take entrepreneurial projects" (UC2)

"……………….by teaching STEM subjects, lecturers can motivate and develop the next wave of creative thinkers. Lecturers can help students develop their creativity, critical thinking, and problem-solving abilities by instructing and guiding them in STEM subjects. Lecturers help to foster an innovative culture in the next generation by providing direction and support" (AM2).

4.2.4.10 Main Theme 10.0: Female lectures self-efficacy belief towards effective teaching of STEM disciplines

Participants' responses on the effectiveness of their self-efficacy beliefs in the teaching of STEM disciplines were categorized on the following issues:1) Confidence in the Subject Matter 2) Capacity for Adaptation and Persistence 3) Positive Classroom Climate 4) Role Modelling. These responses from the participants were transcribed as shown below:

Sub-theme 10.1: Confidence in the Subject Matter

Participants- CK1, UM3, UM4, KN1, KN2 and UC1 revealed that

A person's self-efficacy in STEM fields have helped to build a solid comprehension of the subject matter and to have faith in the capacity to teach it in an efficient manner. They added that this self-assurance has given the potential to significantly improve the teaching processes and their engagement with students.

Participant-UCI confirmed that:

"A strong sense of mastery is fostered by self-belief in one's subject area competence. STEM teachers are better able to communicate difficult ideas to students in a clear and thorough manner when they have faith in their own comprehension of the subject matter. Again, lecturers who possess a strong subject-matter foundation are able to convey concepts with accuracy and clarity. They can ensure that students understand the material more readily by using suitable vocabulary, using examples from real-world situations, and confidently responding to queries".

"The ability to solve problems is crucial in STEM professions. Teachers who possess a strong sense of self-efficacy in their subject matter may

confidently address students' issues and enquiries, exemplifying critical thinking and effective problem-solving techniques" (CK1).

Participant-UM3 asserted that:

> *"Lecturers who possess a strong foundation in the subject matter are better able to modify their pedagogical approaches to meet the requirements and learning preferences of a wide range of pupils. They are more willing to try out various teaching methods and modify their strategy as needed. Moreover, lecturers with high levels of self-efficacy belief are frequently accompanied with a strong sense of enthusiasm and passion for the subject matter. Teachers who are enthusiastic about what they do can pique students' interests and foster an atmosphere in the classroom that invites inquiry and discovery"*

Participant-UM4 explained that:

> *'Lecturers desire to keep improving their instruction can be strengthened by their confidence in the subject matter. They are more likely to look for possibilities for professional growth, keep up with recent findings, and improve their instructional strategies. However, lecturers in STEM fields who possess strong beliefs in their own abilities set a positive example for their students. Students might be encouraged to pursue STEM disciplines with greater confidence by their self-assurance and belief in their own talents"*

Participant-KN1 indicated:

> *"Lecturers who are confident are more inclined to do so when giving instructions. They could present novel ideas or cutting-edge exercises that boost interest among students and encourage in-depth study. Again, lecturers who are knowledgeable about the subject area are able to create examinations that are meaningful and precise in guiding students' comprehension. Misconceptions can be recognized, and they can modify their instruction to successfully fill in the gaps"*

Participant-KN2 asserts that:

> *"Being resilient in the face of adversity is influenced by one's level of confidence in the subject matter. When teachers face challenges or losses, their conviction in their own abilities inspires them to keep going and figure things out. Again, lecturers who have high levels of self-efficacy may be more inclined to seek possibilities for professional growth, such as postgraduate coursework or research projects. The teacher and the pupils both gain from this ongoing learning"*

Sub-theme 10.2: Capacity for Adaptation and Persistence

Participants- UG3, UG4, UM1, KN4, CK3 and UC2 pointed out that

Their high level of self-efficacy belief in STEM disciplines has helped them to become more inclined to modify their instructional tactics in order to cater for the varied requirements of their students. They added that they are also able to persevere in the face of problems or losses, searching for alternative techniques to improve students' knowledge and achievement in STEM subjects.

Participant-UG3 pointed out that:

> *"Lecturers with high levels of self-efficacy belief are able to modify their lesson plans in order to meet the needs of students with different learning styles. They have faith in their abilities to modify their lessons to fit each student's particular requirements and preferences thus, creating a more welcoming learning atmosphere"*

Participant-KN4 said:

> *"Lecturers who have a high level of self-efficacy are more inclined to try out various teaching techniques and modify their plans in response to feedback from students and their performances. They are confident in their abilities to modify the course materials and instructional strategies to maximize comprehension and involvement on the part of the students"*

UG4 revealed that:

> *"Lecturers that have high levels of self-efficacy when it comes to integrating technology are more likely to adopt digital tools and platforms and use them to improve students' engagement, enrich learning experiences, and present content in novel ways".*

'Participant-UM1 mentioned:

> *'Lecturers who possess self-efficacy demonstrate perseverance when confronted with obstacles or failures. Whether it's related to difficult material, disruptive students, or unforeseen circumstances, they have faith in their capacity to handle challenges, which enables them to keep a positive and targeted teaching style"*

Participant-CK3 stated:

> *"Lecturers who possess a high level of self-efficacy have faith in their ability to assist students in reaching learning objectives, even in*

challenging STEM courses. This conviction motivates them to keep working to help pupils, whether it's through providing more context, materials, or chances for practice"

Participant-UC2 argued:

"Lecturers who possess self-efficacy view their work as a problem-solving exercise. They have faith in their abilities to spot obstacles to learning and use practical solutions to get through them, giving students the help they need to thrive in STEM fields. Lecturers that have high self-efficacy have confidence in their ability to adjust to changes in pedagogy, technology, or curricula. This flexibility guarantees that they remain up to date and give students applicable information and abilities"

"Lecturers with high self-efficacy create an example of growth mindset and perseverance for their pupils. They show that success in STEM disciplines requires a strong work ethic, perseverance, and a readiness to learn from failures" (CK2). Participant-UM2 said;

"Lecturers who have a high sense of their own abilities are receptive to criticism from peers and pupils. They see criticism as a chance to do better, and they take the confidence to adjust their methods of instruction in response to helpful criticism".

Participant-KN3 revealed that:

"Lecturers who are self-assured aggressively look for chances to advance their careers. They have faith in their ability to learn new things and develop new abilities that will help them and their students. Again, in inclusive classrooms, lecturers who are self-efficacious have faith in their capacity to modify lessons to suit the unique requirements of students from varied backgrounds or with impairments, guaranteeing fair educational opportunities for all".

Sub-theme 10.3: Positive Classroom Climate

Participants- UG2, CK2, UC3, AM1, AM2 and UG1 revealed that their high levels of self-efficacy in STEM subjects have helped to establish a positive classroom atmosphere that encourages student involvement, curiosity, and beliefs of increased self-efficacy. Students can be inspired by their passion and the belief that they have in their own abilities, which helps to build an environment that is supportive of learning. They however indicated that the classroom climate need to be considered seriously by stakeholders by improving them to make the learning environment more conducive for effective teaching-learning of STEM disciplines studies.

Participant-AM1 stated that: *"a lecturer with high self-efficacy in classroom management is able to set clear rules, procedures, and expectations for behaviour. This self-assurance fosters a polite, orderly classroom atmosphere that supports efficient teaching and learning".*

Participant-UG1 explained:

> *"Sincere and compassionate interactions result from a self-efficacious belief in fostering positive relationships with students. Open communication, trust, and a feeling of community are all fostered in the classroom when educators have faith in their abilities to engage with their students".*

Participant-AM2 pointed out that:

> *"Lecturers who possess a high level of self-efficacy provide students with constructive criticism that enables them to identify areas in which they can grow. They have the ability to offer direction and support in a way that inspires rather than deters students".*

Participant-UG2 admitted that:

> *"Lecturers who have a high level of self-efficacy in differentiation are able to adapt their lessons to fit the wide range of demands of their students. As a result, an inclusive classroom is created where all students are encouraged to pursue their academic goals and feel respected"*

> *"Lecturers who have faith in their capacity to resolve disputes and conflicts amicably may deal with problems in the classroom quickly and constructively" (AM3). "It was further stated that as lecturers carry out these activities, any disagreements can be settled amicably without interfering with the educational process".*

Participant-UC3 suggested that:

> *"Lecturers who have a self-efficacy believe in emotional regulation are better able to control their own emotions and react to the emotional demands of their students in an empathic manner. This fosters an environment of empathy, tolerance, and understanding in the classroom".*

Self-efficacy beliefs are very crucial towards the academic and professional development of females in STEM disciplines which can be confirmed that *'lecturers who possess a high degree of self-efficacy are typically resilient and optimistic. They are able to remain optimistic in the face of difficulties, which fosters tenacity and a growth attitude among students"* (AM4).

Participant-KN4 revealed that:

> *"Female lecturers who possess self-efficacy beliefs motivate their students to handle challenges and take intellectual risks. They foster an environment of inquiry and discovery because they have faith in their students' capacity to overcome challenges".*
>
> *"Lecturers who believe in their own abilities act as positive role models for their students. Students can be motivated to develop faith in their own learning capacities by their own self-assurance in their ability to teach" (*CK2).

Participant-UM3 indicated:

> *"Lecturers who have a high level of self-efficacy are more likely to actively involve their students in the educational process. Their creation of possibilities for students' participation, discussions, and practical exercises helps to foster a lively and dynamic learning environment in the classroom".*

Participant-CK2 argued:

> *"The development of a growth mindset is facilitated by self-efficacious educators who highlight the notion that skills may be acquired via hard work and education. This kind of thinking encourages perseverance and optimism about future progress"* Participant-KN1 added*; 'an inclusive and accepting classroom is one where all students, regardless of their backgrounds or skill levels, feel appreciated and respected because of the teacher's self-efficacy in promoting these qualities".*

Sub-theme 10.4: Role Modelling

Participants indicated that:

The high level of confidence in their own abilities in STEM fields can serve as positive role models for their students. They said students might be motivated to develop their own self-efficacy beliefs in STEM studies by teachers who exude confidence and competence in the subject matter they are teaching. They believe these competences will in turn encourage students to pursue professions and occupations linked to STEM disciplines. They however indicated that stakeholders urgently need to put in place more policies aimed at improving the representation of females in STEM disciplines studies in tertiary institutions in order to galvanize high level role models in STEM disciplines studies.

Participant-UC2 noted that:

> *"Self-efficacy in one's competence as a STEM lecturer is a good indicator of one's level of confidence in their skills. In the classroom, this self-assurance is contagious, encouraging students to see their own ability to succeed in difficult STEM courses. Lecturers who have a high level of self-efficacy in their ability to solve problems serve as role models for their pupils in this regard. They take a confident approach to solving challenging STEM problems and model successful problem-solving techniques for students, inspiring them to follow suit".*

Participant-CK3 confirmed;

> *"Lecturers who possess self-efficacy do not back down from difficult problems in STEM fields. Rather, they see obstacles as chances for improvement. Through transparent and self-assured approaches to challenging ideas or experiments, they inspire students to embrace a growth mindset and persevere through obstacles in their academic journey".*

> *"It is a known fact that lecturers who have faith in their capacity to pique students' interests help them develop awe in the world. They inspire kids to investigate, pose questions, and look for solutions on their own by showcasing their own enthusiasm for STEM subjects" (UM4).*

Participant-KN1 pointed out:

> *'There are ambiguity and uncertainty that frequently occur in STEM fields. Teachers who possess self-efficacy demonstrate how to handle ambiguity with assurance and methodological approach. Students discover that problem-solving is a process and that it's acceptable to not have all the answers right away".* Participant-UG3 affirmed that *Strong ethical standards are frequently associated with high levels of self-efficacy beliefs. Integrity is crucial in STEM subjects, and teachers who model ethical behaviour in research, data analysis, and experimentation provide a good example for their pupils".*

UG4 Asserted:

> *"Lecturers who possess self-efficacy exhibit resilience when confronted with obstacles or unsuccessful experiments. For students, their capacity to recover and keep on after scientific knowledge is an important lesson in resilience. Again, lecturers who possess confidence in their communication abilities may enthusiastically and clearly explain difficult STEM subjects to their students. Their self-assured delivery and skill at involving students serve as role models for successful science communication".*

In addition, Participant-KN1 said:

> *"Working together is essential in many STEM professions. High self-efficacy teachers model good communication, teamwork, and problem-solving techniques that students can use in group projects and other contexts, creating collaborative learning environments in the classroom".* Participant-CK3 further admitted that

> *"Lecturers who possess self-efficacy are dedicated to ongoing professional development and education. They actively look for ways to learn more, go to conferences, and do research, demonstrating a lifetime dedication to growth and learning".* Participant-AM1 asserted;

> *"Female lecturers who have faith in their capacity to promote diversity and cultural competency serve as role models for learners in STEM disciplines who come from a variety of backgrounds and viewpoints. They design learning environments where each student feels important and included".*

4.2.5 Comparative analysis of quantitative and qualitative data (Findings)

This section presents the comparative analysis of quantitative and qualitative data. As previously discussed in Chapter 3, the choice of the design I used was the concurrent triangulation mixed-method. This design ensured that both quantitative and qualitative data were collected and analyzed simultaneously and then merged to compare and construct how the weaknesses of one phase strengthened the other phase (Creswell & Creswell, 2018). The comparative analysis was done by using the data obtained from questionnaire and the interview guide. The researcher presented the analysis under six areas in connection with the research questions. These are:

- Representations of female lecturers in the study of STEM disciplines.
- Challenges hindering professional and academic growth of female lecturers in STEM disciplines.
- Cross-institutional collaborations to enhance the career aspirations of the female Lecturers in STEM disciplines
- Influence of networks of local and international role models on female lecturers in STEM disciplines.
- Institutional commitment and support systems to boost the confidence and capabilities of female lecturers in STEM disciplines.
- Influence of female lecturers' Self-efficacy beliefs on their academic and professional growth in STEM.

4.2.5.1 Sociodemographic profile of respondents

The sociodemographic profile for respondents and participants were grouped into seven (7) areas for both the quantitative and qualitative phases. The results of both the quantitative and qualitative phases on female lecturers' socio-demographic profile (age and marital status) reflects their status With regards to the name of institutions of respondents, six (6) were used for both quantitative and qualitative phases that is, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AM), C. K. Tedam University of Technology and Applied Sciences (CK), Kwame Nkrumah University of Science and Technology (KN), University of Cape Coast (UC), University of Ghana (UG) and University of Mines and Technology (UM). However for the assessment, 62 respondents were selected for the quantitative phase with the purposive sampling technique whilst 22 participants were selected for the qualitative phase the convenient sampling technique. Both respondents and participants were female lecturers in Ghanaian universities.

With regard to the age category which reflects female lecturers status, data showed that the dominant age group was within the range of 31-40 years with a percentage of 40.3%, (25) of the sample while those above the age of 60 years are the least. In the qualitative data, the dominant age groups were within the ranges of 31-40 and 41-50 years with (7) and (7) respectively. The marital status category also reflects the status of female lecturers engaged in STEM disciplines. The data for the quantitative showed that majority of the respondents were married with a high percentage of 67.7 % (42) and 29.9% (18) were single whilst the least of percentage of 3.2%, (3) represented those divorced. In the qualitative phase, it was revealed that the majority of the interviewees were married with (14) with (7) single and (1) divorcee as the least.

The quantitative data on educational level which reflects female lecturers' stature revealed that majority of respondents were PhD holders recorded a high percentage of 75.8% (47) whilst those at the master's level had a percentage 24.2% (15). For the qualitative phase, nineteen (19) participants held Doctorial certificates whilst three (3) interviewee were masters' degree certificate holders. In addition, the professional ranks of respondents had data which showed that senior lecturers constituted a high percentage of 40.3% (25) and the least percentage were full professors at a percentage of 3.2% (2) for the quantitative phase whilst the qualitative phase had majority of senior lecturers constituting (10) participants whereas (1) Assistant lecturer represented the least.

In the case of STEM specific subjects taught by female lecturers, this also represents their stature. The quantitative phase revealed that science had the highest of respondents with percentage of 40.1% (25) followed by mathematics with a percentage of 25.8% (16), technology had the next percentage of 17.7% (11) and the least was engineering lecturers that constituted 16.1 % (10). Percent. However, the qualitative phase showed that science, technology and mathematics as STEM-related subjects had higher number of teachers at (6), (6) and (6) respectively and the least was engineering which constituted (4) of the sample.

The years of teaching experience in STEM disciplines reflects the quality of female lectures' academic engagement. Those who have taught in the universities for the period of 11-15 years constituted a percentage of 43.5% (27) thus the highest of respondents and the least was those who worked in the universities above 25 years with a percentage of 3.2% (2) in the quantitative phase. The analysis showed differences between female lecturers' work experiences in the qualitative phase as those who have taught in the universities for the period of 11-15 years constituted (7) of the sample made up the highest whilst the least was those within the range of 16-20 and above 25 years (1) and (1) respectively. The next section was on the comparative analysis of the representation of female lecturers in the study of STEM disciplines.

4.2.5.2 Representation of female lecturers in the study of STEM disciplines

Analysis of the quantitative and qualitative phases under the representation of female lecturers in the study of STEM disciplines reflects their stature and the results showed that respondents were uncertain with an overall mean score 3.06 (SD=1.06) in the quantitative phase. "Involvement of female lecturers as role models in STEM education in the past years enhancing effective teaching of STEM-related subjects" recorded a mean of 3.96 (SD=0.1.00) and 54.80% represented agreed response rate. "The proportion of female lecturers in STEM disciplines are encouraging," recorded an agreed mean of 3.21 (SD=1.30) and 38.70% indicating no opinion by respondents. "Career path of most successful female lecturers having encouraged or motivated more females to advance into STEM subjects in academics" recorded a mean score of 2.81 (SD=0.99) and 33.90% represented moderate response or no opinion. "Perceived lack of commitment among women as compared to men" recorded a disagreed mean of 2.61 (SD=1.12) and 37.10% represented no opinion. "Females in STEM disciplines are of higher educational ranks." had a mean of 2.45 (SD=1.14) and 38.70% represented disagreed. "Gender representations in STEM disciplines is currently in a balanced scale with the men" recorded a mean of 2.42 (SD=0.95) and 52.20% which indicated disagreed to the statement suggesting that female lecturers and their male counterparts engaged in STEM disciplines do not have equal representation.

The respondents interviewed at the qualitative phase highlighted similar issues on female lecturers' representation as against the quantitative phase. The analysis of the interview data showed that all the responses revealed that the representation of females in STEM-related subjects in terms of numerical strength is low in the Ghanaian universities. For instance, a participant KN2 suggested that;

> *"It is expected that the few females engaged in STEM disciplines studies in tertiary institutions would have achieved higher professorial ranks through their engagement in STEM disciplines studies in order to motivate the younger generations to emulate such moves but data within tertiary institutions showed that the highest professional ranks in these institutions rather have fewer numbers as against the non-professorial ranks"*

Some participants were of the view that the rationale of STEM education since its inception in Ghana in the 1990's aimed at increasing females' participation as well as motivating many of them to venture into STEM-related careers but that is not fully realized since statistics currently in institutions show low representation in the four specific subjects of STEM.

In the same direction, with the statement "proportion of female lecturers in STEM subjects are encouraging." recorded a mean of 3.21 (SD=1.30) and 38.70% indicated moderate or uncertain sentiment. The quantitative phase also revealed that employment ratio of females and males in STEM students is not in a balanced ratio in Ghanaian universities and this does not meet the concerns of equality by stakeholders in STEM education in Ghana. “Career path of most successful female lecturers has encouraged or motivated more females to advance into STEM–related careers in academics” recorded a mean score of 2.81 (SD=0.99) and 38.70% represented uncertain response rate by respondents. In the qualitative phase, Participants-CK3 and UG4 asserted that *STEM education through its rationale and aims has offered job skills and knowledge to individuals for the socio-economic development of the society and the nation at large.* However, participant CK3 further commented that “*STEM education programmes targeted more participation of girls to invariably increase the enrolment of girls in order to bridge the gap of the dominance of males in STEM disciplines in tertiary institutions”. Participant UC1 indicated that “STEM education has given them equal chances of securing higher job positions as their male counterparts in the Ghanaian tertiary institutions. However, there is the need for more females in the field of STEM*

In addition, Participants- AM2 advanced that “*Females' involvement and engagement in STEM disciplines over the years has been perceived by the general public of not giving out adequate work output as compared to their male counterparts in tertiary institutions”* AM4 revealed that *“the perception about female lecturers not being well committed towards STEM education as compared to the males stifles their efforts in the advocacy for the involvement of more females in STEM disciplines studies and careers”*

4.2.5.3 Challenges hindering professional and academic growth of female lecturers in STEM disciplines

The analysis from both quantitative and qualitative phases assessed challenges that female lecturers faced through their engagement in STEM disciplines. The challenges ranged from social to cultural issues. The quantitative data revealed uncertain response rates for all the three sub-scales of the challenges with overall means of means scores as; Institutional/technical challenges (2.91, SD=1.20), Cultural challenges (2.99 SD=1.14) and Social challenges (3.31, SD=1.19). The moderate response rates suggest that respondents did not show clear positions about the challenges. In the qualitative phase, participants commented on how gender and diversity gap, limited resources and workload and time management were affecting their academic and professional development in STEM disciplines. A response from participant- AM2 indicated that:

> *Access to particular research materials, including chemicals, biological specimens, or uncommon samples, is frequently necessary for STEM research. These materials can be expensive or scarce, which might make study and testing more difficult. In order to get over resource constraints, researchers might have to look for alternative sources or consider working together.*

However, both quantitative and qualitative data showed that due to the perception in the society about STEM subjects as reserves for males, female lecturers were having challenges in convincing younger females especially those from rural communities to participate and study STEM disciplines at the tertiary level. In affirmation, the comments made by participants on challenges they experience in STEM engagement, Participant CK1 suggested:

> *To keep current with innovations and pick up new skills, people working in STEM disciplines need to be engaged in ongoing professional development and training. Strict access to pertinent conferences, workshops, or training courses might limit chances for skill development and impede career advancement.*
>
> Furthermore, *participant*-AM1 *indicated that "working in the STEM fields frequently calls for cooperation with industry partners, research teams, and coworkers. It can be difficult to manage schedules, coordinate efforts, and maintain efficient communication within a team, especially when dealing with varied stakeholders or across time zones". 'People working in STEM professions need to keep up with the most recent findings, innovations, and techniques because these industries are changing quickly. While professional development and ongoing education are crucial, they can also increase workload and complicate time management. It can take some juggling to strike a balance between the requirement to keep current and ongoing obligations" (*AM3).

It has also been revealed from participants that the inadequacies of teaching resources in universities was a huge challenge. For example

> Participant-UM2 *specified that "research supplies, equipment, data collecting, and analysis are often expensive aspects of STEM undertakings. Insufficient funds may limit the breadth and depth of study, making it more difficult to carry out tests, buy essential equipment, or obtain pertinent datasets. It becomes difficult for researchers and institutions to manage the resources that are available and secure enough financing"/*

4.2.5.4 Institutional collaboration with other sister universities on STEM activities

The analysis of the quantitative and qualitative phases on cross-institutional collaboration were revealed as the quantitative phase indicated an overall mean of means 3.05 (SD=1.02) which represented uncertain response rate from respondents on whether there are cross-institutional collaborations available to boost their careers in STEM disciplines studies in universities. Furthermore, individual responses asserted that their institutions support towards their academic and professional growth through science conferences and research. For instance, "my institution provides opportunity for inter-institution collaborations to enhance our professional growth" recorded a percentage of (61.30%) and a mean 3.69 (SD=1.05) that represented agreement. In a similar manner participants in the qualitative phase commented on interdisciplinary partnerships between educational institutions and that they were typical in the STEM field and should be embraced by all stakeholders. The participants argued that interinstitutional collaborations on STEM education among Ghanaian universities has been inadequate, stating an example of WiSTEM chapters that can be found in only five Ghanaian public universities. For example, a participant commented;

> *The value of collaboration in improving the overall quality of science, technology, engineering, and mathematics (STEM) programmes and expanding the range of educational possibilities available to students should be recognized by all stakeholders concerned with STEM disciplines in tertiary institutions."(AM3).*

Again, participant-KN3 asserted that:

> *"Effective collaborative work, team projects, clear and concise communication are necessary in STEM areas but these are lacking in my institution. It is further said, for one to develop these abilities and able to work effectively in teams which will comprise varied members can be difficult, particularly for persons who are more oriented towards individual work or who have hurdles relating to language or culture".*

In sum, participants AM2, CK3, UM1, UM2, KN2, UG1 and UM2 asserted that "There were outreach programmes organized by universities and geared towards female students' participation in STEM fields in basic and secondary schools. The goal of these programmes is to increase participants' interest in STEM fields while also providing them with opportunities to get practical experience and role models. They however, said such programmes often do not cover all relevant basic and second cycle schools hence suggested that all stakeholders in STEM should support through sponsorships to achieve the aims of STEM education in Ghana" Both quantitative and qualitative findings showed that institutional collaborations are relevant in their academic and professional growth and thus suggested that stakeholders should collaborate in the organization of STEM activities towards females academic In the same vein, it was emerged that With the help of institutional collaborations, female lecturers are now more equipped to incorporate technology into their lessons with ease.

4.2.5.5 Influence of network of role models and mentors in STEM-related areas within and outside Ghana

On issues of whether there were role models and mentors within universities and internally to support and motivate female lecturers as well female students engaged in STEM disciplines, both quantitative and qualitative findings confirmed that the availability of role models was necessary in STEM disciplines studies. For the quantitative phase, analysis revealed an overall mean of means score of 2.59 (SD=1.03) which represented moderate response rate. In this same phase however, there were 6 questions whose response rates represented disagreements to issues pertaining the influence of role models on female lecturers in STEM disciplines. For instance, "female mentors in STEM disciplines support younger colleagues' professional growth" recorded a mean of 2.34 (SD=1.02) and 38.7 0% represented a disagreement. "Majority of female lecturers in STEM disciplines are academic professors in Ghanaian universities." had a mean of 2.27 (SD=0.99) and 59.70% represented a disagreement by the respondents. "There are regular exchange progrommes for females in STEM studies in all universities' recorded a mean of 2.19 (SD=1.05) and 41.90% which suggested that the issue of networks of STEM role models in universities was of a great concern.

With regard to the qualitative phase, participants commented; 'there are programmes and organisations in Ghana that work towards the goal of establishing relationships between students and professionals working in STEM-related industries and role models and mentors. These programmes frequently offer a variety of opportunities, such as those for networking, mentoring, and career assistance. One such organisation is the Ghana STEM Network, which works to increase participation in STEM-related activities and education by running a variety of programmes, including mentorship programmes'

UM2 asserted however that these programmes and activities are limited and not also decentralized to get to the door steps of the less privilege in our institutions to benefit". For instance,

> *"Many STEM endeavours call for cooperation and teamwork. The learning process is made more interesting and enjoyable when peers are working together on challenging assignments because it develops a sense of teamwork and shared accomplishment. Again, it introduces students to prominent professionals and researchers in the STEM fields*

> *as role models and guest speakers to inspire them. Student interest can be increased by having guest speakers and role models share their experiences by highlighting the exciting possibilities of a future in STEM"* (CK2).

> *"Female lecturers place a strong emphasis on the real-world applications of STEM knowledge and abilities to show how STEM knowledge can be used to solve issues and meet real-life challenges, they offer case studies, practical projects, and real-world examples. This aids students in bridging the conceptual and practical knowledge gaps"* (CK3).

> *"Female lecturers stress the value of traits for STEM professions. They help students develop a growth mindset by motivating them to tackle obstacles, keep going after failures, and never stop learning new things. They equip students to meet the needs of the changing technology landscape and the workforce by encouraging a mindset of continuous learning"* (UM3).

Participant-KN4 asserted that *"in order to close the skills gap in STEM disciplines, female role models in STEM disciplines must build relationships with relevant business partners to engage into activities towards the advancement of STEM disciplines studies"*.

The findings showed that both respondents and participants were able to indicate the relevance and need for STEM role models in universities towards their academic and professional growth.

4.2.5.6 Institutional commitment and support systems being envisaged to boost the confidence and capabilities of female lecturers in STEM disciplines

The analysis on both quantitative and qualitative phases showed that support systems do exist in universities towards the study of STEM disciplines, however, there were exceptions in both phases with the findings. In the quantitative phase, the analysis revealed an overall mean of means score of 3.43 (SD=0.96) which represented uncertain response rate. However, the analysis showed two responses on agreements that were made by respondents. For instance, "professional societies and universities could provide structured professional development opportunities, so women can anticipate some of these barriers, plan how to navigate them, and predict important decision points for example, reduced fees for society membership and conference registration." recorded a mean of 3.69 (SD=0.92) and 62.90% represented agreement. "Academic departments should recruit senior women in STEM fields to present their technical work as part of department colloquia, brown-bags, and other special events, providing opportunities for these speakers to meet and mentor students" also recorded a mean of 3.66, SD=0.87) and 53.20% that represented agreement to the statement.

In the qualitative phase, these participants- UG1, UG3, UG4, KN1, and KN4 revealed that 'There exist laws and guidelines in their institutions to help promote and support the advocacy of females' representations in STEM-related studies'. They also indicated that there were policy documents which were implemented within the institutions to advance the call for gender equity and equality in order to close the gap of gender inequality. On the contrary, these participants-CK1, AM4 and CK3 asserted that;

'There are no established laws and policy documents in place for the advancement of gender equality and equity in STEM disciplines. They suggested that all stakeholders in STEM education should endeavor to develop a national policy document for all tertiary institutions. This, they said would go a long way to bridge the gap of gender balance in the field of STEM studies"

In the same vein, Participants- UG2, UG4, KN1, UC3 and UM1 asserted that

'Their institutions provide scholarships and grants specifically for female students who study STEM (science, technology, engineering, and mathematics) disciplines majors. They said these monetary incentives have been put in place with the goal of lowering obstacles and encouraging more female students to pursue studies in STEM-related disciplines'. In confirmation,

> *"With the help of institutional collaborations, female lecturers are now more equipped to incorporate technology into their lessons with ease. They are skilled at boosting student engagement and facilitating interactive learning experiences through the use of multimedia resources, interactive simulations, virtual labs, and online platforms. The ability to use digital resources, create online tests, and support blended or online learning environments are all made possible by technological literacy among lecturers*"(UM4).

> *"Female lecturers who received STEM education are more equipped to comprehend and utilize emerging technology. They keep up with the most recent developments in technology, including virtual reality, Internet of Things (IoT), machine learning, and artificial intelligence. This knowledge enables instructors to modify their pedagogical approaches, integrate nascent technologies into their investigations, and equip learners for the rigours of the swiftly changing technological terrain" (*UC3).

Participant-UM1further said:

> *"Mentoring organizations are not readily available in all institutions to work with hence I suggest for the establishment of such organizations to serve as a community that is supportive, plans activities such as workshops, seminars, and networking gatherings, and seek to raise awareness and encourage empowerment of females"*

> "*Educational institutions should provide scholarships and grants specifically for female students who are majoring in STEM (science, technology, engineering, and math) of which I am a beneficiary"* (AM1).

Participants-KN4 revealed that;

> *"Underrepresented females in STEM disciplines may be disproportionately affected by the lack of networks and resources, including funding possibilities, research collaborations, and networking platforms. Inequitable access to these resources can impede prospects for collaboration, professional growth, and exposure in the area".*

CK1 mentioned that:

> *"The lack of scholarships support packages retards the academic and professional growth of female lecturers and students alike in STEM disciplines. In addition, these monetary incentives if available will help*

at reducing the obstacles in females' underrepresentation in STEM disciplines"

4.2.5.7 Female lectures self-efficacy belief towards effective teaching of STEM disciplines

On the issues of how female lecturers' self-efficacy belief helps them to prepare and present STEM-related subjects effectively in universities, both quantitative and qualitative findings confirmed that female lecturers who had high or good self-efficacy belief were able to formulate strategies and concepts that assisted in lessons delivery and research in STEM fields. In the quantitative phase, the analysis revealed an overall mean of means score of 3.89 (SD=0.83) represented agreement by respondents. With specific statements, "my self-efficacy belief helped me to remain calm when facing difficulties because I can rely on my coping abilities" indicated a mean of 4.21 (SD=0.68) and 50.0% that represented agreement. Again, "my self-efficacy belief has influenced me to do activities in the classroom with confident." recorded a mean of.4.19 (SD=0.57) and 64.50% that represented an agreement to the question. In addition, "my self-efficacy beliefs have helped me to develop the competence and skill to achieve academic success' and this resulted into an agreement response rate with a mean score of 4.18 (SD=0.50) and 72.60%. Also, "my professional development growth has helped me understand the dignity and worth of every student" recorded a mean of 4.11 (SD=0.63) and 59.70% for agreed. Moreover, "my self-efficacy belief has influenced my quality of instructions delivery for student academic and professional growth" recorded a mean of 4.10 (SD=0.59) and 64.50% On the other hand, the statement; "my self-efficacy belief helped me to handle whatever comes my way as a female scientist." recorded a mean of 3.48 (SD=1.28) and 59.70 % which represented uncertain response rate. Again, "my self-efficacy belief has helped me to solve most problems for my academic and professional growth." recorded a mean of 3.44 (SD=1.15) and 59.70 %

that represented uncertain or moderate response rate. "My self-efficacy belief helped me to deal with unexpected events' recorded a mean score of 3.37 (SD=1.23) and 40.30% that revealed uncertain rate of responses by respondents.

With respect to the qualitative phase, participants-CK1, UM3, UM4, KN1, KN2 and UC1 revealed that a person's self-efficacy in STEM fields helped to build a solid comprehension of the subject matter and to have faith in the capacity to teach it in an efficient manner. They added that this self-assurance has given the potential to significantly improve the teaching processes and their engagement with students. Furthermore, participant-UCI confirmed that:

> *"A strong sense of mastery is fostered by self-belief in one's subject area competence. STEM teachers are better able to communicate difficult ideas to students in a clear and thorough manner when they have faith in their own comprehension of the subject matter. Again, lecturers who possess a strong subject-matter foundation are able to convey concepts with accuracy and clarity. They can ensure that students understand the material more readily by using suitable vocabulary, using examples from real-world situations, and confidently responding to queries".*

The analysis also showed that participant-UC2 noted that:

> *"Self-efficacy in one's competence as a STEM lecturer is a good indicator of one's level of confidence in their skills. In the classroom, this self-assurance is contagious, encouraging students to see their own ability to succeed in difficult STEM courses. Lecturers who have a high level of self-efficacy in their ability to solve problems serve as role models for their pupils in this regard. They take a confident approach to solving challenging STEM problems and model successful problem-solving techniques for students, inspiring them to follow suit".*

Participant-UM3 asserted that:

> *"Lecturers who possess a strong foundation in the subject matter are better able to modify their pedagogical approaches to meet the requirements and learning preferences of a wide range of pupils. They are more willing to try out various teaching methods and modify their strategy as needed. Moreover, lecturers with high levels of self-efficacy belief are frequently accompanied with a strong sense of enthusiasm and passion for the subject matter. Teachers who are enthusiastic about what they do can pique students' interests and foster an atmosphere in the classroom that invites inquiry and discovery"*

> *"Lecturers with high self-efficacy create an example of growth mindset and perseverance for their pupils. They show that success in STEM disciplines requires a strong work ethic, perseverance, and a readiness to learn from failures"* (CK2). Participant-UM2 said;

> *"Lecturers who have a high sense of their own abilities are receptive to criticism from peers and pupils. They see criticism as a chance to do better, and they take the confidence to adjust their methods of instruction in response to helpful criticism".*

Participant-UG1 explained:

> *"Sincere and compassionate interactions result from a self-efficacious belief in fostering positive relationships with students. Open communication, trust, and a feeling of community are all fostered in the classroom when educators have faith in their abilities to engage with their students".*

Participant-UC2 noted that:

> *"Self-efficacy in one's competence as a STEM lecturer is a good indicator of one's level of confidence in their skills. In the classroom, this self-assurance is contagious, encouraging students to see their own ability to succeed in difficult STEM courses. Lecturers who have a high level of self-efficacy in their ability to solve problems serve as role models for their students in this regard. They take a confident approach to solving challenging STEM problems and model successful problem-solving techniques for students, inspiring them to follow suit".*

Participant-CK3 confirmed;

The findings showed that respondents could relate their self-efficacy beliefs to an effective delivery of STEM concepts. However, there were other uncertain issues in the quantitative phase where respondents did not assert to a positive influence of their self-efficacies towards effective delivering of STEM concepts.

4.3 Summary of Chapter Four

In this chapter, the analysis of research findings was done in two (2) phases which involved quantitative and qualitative data analysis. Research questions were used for the quantitative phase and were analyzed using descriptive statistics whilst the qualitative phase analysis was done using thematic analysis for the interview data. A comparative analysis was done to merge quantitative and qualitative data since the study is a concurrent triangulation mixed method design.

A comparative analysis as presented in this chapter, provided the empirical context of status that were embedded in the socio-demographic characteristics of the respondents. The stature which has been embedded in Research question 1 whilst the challenges of female lecturers engaged in STEM disciplines in Ghanaian universities were also indicated. These variables therefore sets the background for discussion of the findings to be presented in chapter five.

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.0 Overview

This chapter discusses the findings from the quantitative and qualitative phases of the study. The findings of the study were discussed under themes in order to aid readers' understanding of the findings. In this chapter, there has been a combination of the quantitative and qualitative results making it one entity and the discussion was done in relation with the literature reviewed in chapter two of the study.

The discussion was based on the following themes:

- Representations of Ghanaian Female Lecturers in STEM disciplines in public universities
- Social, Institutional/Technical and Cultural Challenges that hinder Female Lecturers' Professional and Academic growth in STEM disciplines in Ghanaian public universities
- Cross-institutional Collaborations for career aspirations of the Ghanaian Female Lecturers in STEM Disciplines studies
- Influence of networks of Local and International Role Models for the Female Lecturers in STEM Disciplines in Public Universities in Ghana
- Institutional Commitment and Support Systems to boost the Confidence and Capabilities of Female Lecturers in STEM Disciplines.
- Influence of female lecturers' Self-efficacy beliefs on their Academic and Professional growth in STEM disciplines.

5.1 Respondents' Sociodemographic Profile

The sociodemographic profile of participants of the study was examined based on respondents' university's name, age, marital status, educational level, educational rank, STEM subjects taught by female lecturer and number of years of teaching experience. The descriptions of the sociodemographic profile of respondents aimed at helping me and readers alike to understand how the sample was distributed among respondents in their social context. In addition, Nardi (2018) and Plonsky (2017), concluded that interpreting the sociodemographic profile of respondents explains the variables used in the study.

With regard to respondents' university distribution, the quantitative findings revealed that the majority of the respondents who participated in the study came from KNUST and the UG respectively whilst the least number of respondents were from CKT-UTAS. This is evident with the quantitative finding in Table 8 which showed majority with twenty-two percent 22.6%, (14) for KNUST and UG respectively and followed by the AAMUSTED respondents recorded seventeen percent 17.7%, (11), UMaT with a percentage of 14.5%, (9). UCC followed with 12.9 %, (8) whilst CKT-UTAS recorded a percentage of 9.7 %, (6) of the sample size of 62. According to uniRank (2005-2023), the oldest and largest university in Ghana is the UG established in 1948 whilst the second oldest is KNUST which was established in 1952. The findings of UniRank also stated that theses leading universities were as well established with the inclusion of various engineering courses. It also revealed that the UCC was also established in 1962. The findings suggest that the AAMUSTED and UMaT appears not as old as the first three universities but their mandate since establishment aimed at running STEM disciplines hence their numbers of respondents. Finally, the results of the study resonates with the fact that the CKT-UTAS was established recently by an Act of

Parliament (ACT 1000) which came into effect on 23rd August, 2019 making it one of the newest autonomous universities in Ghana with STEM disciplines studies hence the least number of respondents in the study.

The profile of participants' age is a reflection of their status. The study showed that the dominant age groups in both quantitative and qualitative phases from Tables 6 and 21 of respondents was within the range of 31-40 years with a percentage of 40.3% which represented 25 and 8 of the samples followed by the age range of 41-50 and 51-60 with 22.6% which represented 14, 7 and 5. The range of 20-30 had 9.7%, which represented 6 and 1. Finally, the range of participants above the age of 60 had the least percentage of 4.8% represented 3 and 1. This findings showed that the dominant age of respondents is within the middle age group. However, respondents within the age group of 41-50 and 51-60 implies that a significant number of participants are individuals near retirement. The findings also indicated that the very younger age group between the ages of 20-30 who are very productive are rather inadequate in STEM disciplines studies in universities. The findings as well revealed that participants above the age of 60 years are the least and this might discourage the younger generations to venture into STEM studies due to the fact that the eldering usually are endowed with knowledge and vast experiences. The findings conform to a study that states that the processes of recruiting and retaining women within S&T disciplines continues to challenge many higher-education institutions worldwide. In Canada, for example, in 2011 women aged 25 to 34 accounted for 39% of university graduates with an S&T degree (CNHS, 2011), compared with 66% of university graduates in non-S&T programs (Hango, 2013). In 2009 in the USA, women represented 24% of those pursuing S&T careers (Beede et al., 2011).

The marital status of participants from the findings of both the quantitative and qualitative findings showed that majority of the respondents are married with 67.7%, which represented 42 and 15 whilst 29.9% represented 18 and 6 of the respondents are single The remaining 3.2%, represented 3 and 1 for those divorced. It implies that marriage might not negatively affect female lecturers' engagement in STEM disciplines studies. The findings, however, indicated that a few number of the respondents were single as well as those divorced. In support of the findings of respondents' marital status, the trajectory of the faculty career from graduate school to full professor rank seems not encompass the career expected of an academic woman (Wolf-Wendel & Ward, 2006). To gain legitimacy, however, many female scientists have focused on scientific identity based on research and career achievement and not focusing on marriage and child-caring responsibilities alone (Etzkowitz et al., 1994).

The findings from Table 8 implied that majority of respondents with a higher educational level with PhD was at 75.8% represented 47 which is very significant whilst those at the master's level were 24.2% represented 15. In the qualitative phase, participants with PhD were 19 as against 3 with Master's certificate degrees and this significant high educational levels of female lecturers invariably have a positive influence on students' performance in STEM disciplines studies. This is in agreement with Akoto-Baako (2018) study which shows a significant difference between teacher educational level and students' academic performance.

The findings of both the quantitative (Table 9) and qualitative (Table 21) phases showed that the majority of the respondents were of senior lecturers ranks which constituted a percentage of 40.3% represented 25 and 10 whilst lecturers made up of 37.1% which represented 23 and 6. Assistant lecturers constituted 12.9% represented 8 and 1. Associate professors constituted 6.5%, which represented 4 and 3. Finally, full professors were made up of 3.2% represented 2 and 2. These findings indicated that majority of female lecturers in STEM disciplines studies are without the highest professional ranks and that could impede their professional growth and their social engagements since their lower ranks might not offer them opportunities to occupy higher positions in their institutions. To confirm this shortcoming of female with higher professional ranks is in the study of (Leifer et al., 2015) which states that Women in STEM encounter diverse challenges in the STEM fields. Sadly, as we understand, for many women in science, technology, engineering and mathematics (STEM), the route to academia ends long before they attain a faculty position and are the "lucky" beneficiary of biased student beneficiary/evaluations.

The findings on STEM-related subjects taught by female lecturers in Table 10 revealed that science had the highest of respondents with a percentage of 40.1%, represented 25 which was followed by mathematics making up 25.8%, represented 16. Technology had 17.7% that represented 11 of the sample. Finally, engineering constituted 16.1% which represented 10 respondents. Similarly, the qualitative findings also revealed 6 respondents for science, 6 for mathematics and 6 for technology. 4 respondents represented engineering. The findings implies that STEM-related subjects taught at the university level by females have more science lecturers and the least being engineering. This could be due to the fact that most tertiary institutions do not run engineering courses. In support of this findings, a study by (UNESCO, 2013) shows that young women only make up 7 to 12 % of engineering students in Africa. It also revealed that the overall percentage of young women seeking higher education in science, technology, engineering and mathematics (STEM) disciplines is moderately low, although the situation varies greatly.

The findings for both the quantitative (Table 11) and qualitative (Table 21) phases revealed the years of work experience of the female lecturers in STEM studies. It showed that differences existed. For instance, those who have taught in the universities for the period between 11-15 years constituted 43.5% which represented 27 of the sample that was the majority of the respondents. The second percentage was 29.0%, which represented 18 of the sample that is within the range of 6-10. Respondents whose work experience was less than 5 years were 9.7%, represented 6 of the sample where as those within the ranges of 21-25 had 8.1%, represented 5 of the sample and those within the range of 16-20 were 6.5%, 4 of the respondents. Finally, those whose work experience above 25 years were 3.2%, represented 2 of the sample. With the qualitative findings, participants who have taught in the universities within the range of 11-15 years constituted 7 of the sample and was followed by the ranges of 6-10 which recorded 5 participants. Those with less than 5 were 5 whereas those with work experience in the ranges of 21-25 were 3 interviewees. Finally, those within the range of 16-20 and above 25 years were 1 and 1 participants respectively. The findings are indicative that females who had work experiences in the universities for less than 25 years were significantly higher than those whose experiences ranges from 25 and above in the institutions. The findings is in conformity with a study that states that the tenure clock of academic work is structured on male normative paths that insulate them from family responsibilities, disadvantaging women with families (Grant et al., 2000; UNESCO, 2017). In the larger context in Ghana, some public universities example CKT-UTAS do not have gender policy and the policy frameworks are in dissonance with gender concerns. The next section is the discussion on the findings on the representation of female lecturers in STEM-related studies.

5.2 Representations of Ghanaian Female Lecturers in the Study of STEM Disciplines in Public Universities

The first theme sought to assess the stature of female lecturers in STEM disciplines studies in Ghanaian universities. In the discussing of this research question, related literature reviewed on female lecturers' representation in STEM disciplines has been critically used to support the findings under the sub-sections below

5.2.1 Numbers of female lecturers in STEM disciplines studies in tertiary institutions

The quantitative data in Table 12 showed that female representations in STEM disciplines was lower than that of the male lecturers., The reported percentage was 52.20% and a mean of 2.42 (SD=0.95) suggested that there were low number of females compared to male lecturers in academia in the study of STEM disciplines. With regard to female lecturers' numerical strength in STEM-related subjects in the universities, 38.70% and a mean of 3.21 (SD=1.30), indicated that they were uncertain about their numerical strength in STEM-related subjects in Ghanaian public universities. This uncertainty could be as a result of respondents' inability to ascertain the exact data in the institutions. The findings also revealed that female lectures engaged in STEM-related subjects are not of higher educational ranks with a mean of 2.45, SD=1.14). This suggests that most women engaged in academic work in STEM disciplines compared to the men were within the lower professional ranks. In the qualitative phase, the findings showed that majority of participants commented on the fact that their institutions currently had low representations of female lecturers in the four specific subjects of STEM. They also indicated that it is "expected that the few females' lecturers engaged in STEM-related subjects in tertiary institutions would have achieved higher professional ranks through their engagement in STEM studies in order to motivate the younger generations to emulate such moves. But data within tertiary institutions shows that the highest professional ranks among female lecturers in these institutions rather had fewer numbers as compared to the lower ranks. There remain areas of the academy where women are grossly underrepresented, and despite notable progress, the number of women in fields like the hard sciences continue to trail behind the number of men in terms of academic rank and tenure (Sturm, 2006). The reasons for this discrepancy are debated with an assertion that women are just not as interested in fields like the hard sciences (i.e. physics, math, engineering, and computer science) compared to men. In connection with this findings, (UNESCO, 2013) indicated that in Africa, the overall percentage of young women seeking higher education in science, technology, engineering and mathematics (STEM) disciplines is moderately low, although the situation varies greatly according to country. These reasons can be tackled through engaging male faculty in gender equity work. Gender equity work is premised on understandings of what constitutes gender equity. Latimer et al. (2014) define gender equity in academia as representation of women across all fields of inquiry, at all levels of rank and administrative appointments that is proportional to the availability of women candidates in those fields. In affirmation, it has been established that the interest of females in STTM, especially in Africa, has been low. One reason is because African women have been urged to seek out arts and humanities and have been discouraged from seeking out science subjects, as science is seen as a manly field (Adusah-Karikari, 2008). Again, David (2015) says that despite the global expansion of tertiary education systems, participation rates among women in S&T higher education and in the academic workforce have substantially lagged behind those of their male counterparts. Four participants however commented that “the engagement of female lecturers in STEM disciplines in their institutions has over the years seen a gradual increase in the numerical strength and this could be due to some interventions implemented by various stakeholders in STEM disciplines. However, much is needed to be done for improvement and achieve the aims of increasing the numbers of female lecturer in STEM disciplines in Ghanaian universities" This affirms to (Mama, 2011) assertion that there have been some cumulative gains in the representation of women among faculty and student populations, even though this is unevenly distributed, remaining concentrated at the lower levels of the hierarchy and in less prestigious regions, even within specific fields of scholarships.

5.2.2 Scale of ratio between females and males engaged in STEM-related studies in Ghanaian universities

The data from Table 12 suggest that there is high view about female lecturers in STEM disciplines having difficulty in securing positions as against their males' counterparts in the same geographical locations as there was a response rate mean at 3.63 (SD=0.49) This suggested that, female lecturers in STEM disciplines might be disadvantaged and challenged or not in securing job positions the same way as their male counterparts. Qualitative data suggest that stakeholders in STEM-related studies particularly employers most of the time do not make deliberate attempts in the search of female employees in STEM fields in tertiary institutions which would have otherwise served as a motivation for more qualified females to be engaged in STEM disciplines studies. (Participant UM2). For instance, there remain areas of the academy where women are grossly underrepresented, and despite notable progress, the number of women in fields like the hard sciences continue to trail behind the number of men in terms of academic rank and tenure (Stake, 2006).

Again, in the qualitative phase, some participants admitted that employment ratio of females and males in STEM disciplines in Ghanaian universities is imbalanced and this does not meet the concerns of equality by stakeholders in STEM education in Ghana. In this connection, Savigny (2014) and UNESCO (2007, 2017) listed factors that breed gender inequalities and inequities in STEM career settings. Women’s and men’s career paths diverge as the former are promoted more quickly and the latter slow which make women leave STEM careers into other fields. Suitable girls are not privy to information on STEM courses and careers and may turn to other fields. Again, it has been argued by Prah (2002) that if women should excel in any profession, then it should be teaching at the universities because teaching is supposedly women’s forte and universities are assumed to be meritocratic institutions. Prah further asserts that Ghanaian universities are male-dominated institutions and the women within them-academics, administrators, support staff and, students face major obstacles because of lack of attention to their specific needs and problems. According to Leney (2003), in the first year of the University College in Ghana in 1946, women accounted for just 2% of the student population, while in the year 1957, of independence, they still amounted to less than 5%. At the first phase of development of the University of Ghana with a population of 58, there were four residence halls for men and one for women (Leney, 2003). Additionally, Schulze and Heerden, (2015) pointed out that there is little doubt that more and more professional jobs will be in the S&T fields. This raises concerns about current disparities in S&T disciplines where almost everywhere in the world male enrolments outweigh that of females (Zander et al., 2015). Research has also revealed that institutional obstacles, psychological/cognitive and personal attitudes are believed to have contributed to women’s underrepresentation in the S&T fields. Institutional obstacles have negatively affected women's pursuit of S&T programmes (Stout et al., 2011).

However, three participants however said that, STEM education has offered job skills and knowledge to individuals for the socio-economic development of society and the nation at large. They also indicated that STEM education programmes have invariably increased the enrolment of girls as compared to their males' counterparts. Again, they indicated that STEM education has given them equal chances of securing higher job positions as their male counterparts in the Ghanaian tertiary institutions". They however added called for more advocates and support towards increasing females' engagement in STEM disciplines. In confirmation, Britwum, et al. (2014) reported that in Ghana there has been some efforts geared toward ensuring the parity between men and women in tertiary education or in the Ghanaian society at large. In addition, Watt et al. (2012) contended that an effective effort to recruit and support future S&T teachers, in general and female teachers in particular, is pivotal to student learning and engagement.

5.2.3 Perceived lack of commitment among women compared to men in STEM disciplines

From Table 12, the perceived lack of commitment among women as compared to men indicates that the female lecturers neither strongly disagree nor strongly agree to that assertion since it had a mean of 2.61 (SD=1.12) and 37.10% It suggests that the female lecturers'' commitment to academic work in STEM subjects is comparable to that of their male counterparts. However, the qualitative data acknowledge the perceptions. Majority, 17 of the interviewees agreed to the existence of perceptions in society and even some tertiary institutions suggesting that female lecturers engaged in STEM disciplines have no strong commitment in the execution of STEM. The limited presence of women in S&T fields is not only a breach of their rights but also a restriction on women's contribution to teaching and research (Kwaramba & Mukanjari, 2013). Also, Cheryan et al. (2009) demonstrated how stereotypes impact the retention of women in S&T fields. S&T environments are unwelcoming to women (LaCosse et al., 2016). Consequently, women internalize these negative gender stereotypes and are convinced that they have lower capabilities in S&T disciplines than men. Three participants revealed that the perception about female lecturers not being well committed towards STEM education as compared to the males stifles their efforts in the advocacy of the involvement of more females in STEM-related studies and careers. In confirmation, (UNESCO, 2013) said in situations where women are present, the huge challenge is to retain them. In addition, the few women who set out on training in scientific disciplines are prevented by discrimination and suppressed motivation bringing about very few women scientists on the continent. In addition, it is indicated that females are a long way from being urged to study science and are constantly told that science is not an appropriate field of study for them (Rathgaber, 2003). Furthermore, common perceptions of CS culture by teenagers and undergraduates who characterize computer science as boring, antisocial, and irrelevant to their lives (Hartness, 2011; Yardi & Bruckman, 2007).

Two participants commented that some females perceived STEM disciplines to be of no much value to them, hence, they will prefer to study the arts and other courses aside STEM. In connection, researchers have found common perceptions of computer science culture by teenagers and undergraduates who characterize computer science as boring, antisocial, and irrelevant to their lives (Hartness, 2011; Yardi & Bruckman, 2007). In addition, Yardi and Bruckman (2007) found that many of them expressed enjoying the effectiveness of technology including games and social networks.

However, they perceive that computer science careers are filled with lonely, endlessly detailed work, and the exclusion of underrepresented groups.

On the contrary, two participants indicated that there are no perceptions about the lack of commitment among female lecturers engaged in STEM disciplines at higher educational institutions since such female employees in STEM disciplines work assiduously as their male colleagues to achieve the stipulated goals of STEM education. Research has shown that Women in STEM who take interest in higher education, similar to male STEM students, go to college with their STEM backgrounds and have scholarly relationships with their colleagues, professors, etc. inside or outside the classrooms (Boateng 2015). Analyzing their experiences to the academic relationships, they either encounter continuity of their relationships or a change (Boateng 2015).

5.2.4 Female lecturers' views about STEM disciplines studies in Ghanaian universities

The findings below present participants' views about STEM disciplines in Ghanaian universities.

5.2.4.1 Enhanced critical thinking and problem-solving skills

Findings from Table 17 from the quantitative phase revealed participants responses pointing out that the activities and programmes of STEM education such as conferences and workshops in Ghanaian universities and other educational institutions helped them to become inspired, do in-depth research, employ problem solving skills and enhanced young female students' ability to solve daily life problems through the application of scientific knowledge and skills. This is evident with a mean scored of 3.92 (D=1.00) and a percentage of 54.80% thus agreement to the assertion which implies that female lecturers' academic and professional growth could be enhanced through such platforms for them to develop more requisite skills in their careers.

Again, the findings showed that respondents get empowered as teachers through the knowledge and skills obtained from STEM education, critical thinking skills and problem solving so that they in turn empower their students to challenge and solve prevailing problems. In connection with this, the important contribution of STEM as an enabler for sustainable and national economic growth was affirmed at the World Summit on Sustainable Development (WSSD) in 2002. According to David et al. (2018), it is in this regard that in the framework of the New Partnership for Africa's Development (NEPAD), African leaders recognized that Science and Technology will play a major role in the economic transformation and sustainable development of any nation. STEM education is used in research, policy issues, teaching for innovation, problem-solving and prospects. From the qualitative phase, 8 participants commented that one rationale of STEM education is the acquisition of skills by learners that will enable them become creative and innovative in everyday dealings. These activities will foster learners the abilities to learn through inquiry-based learning, hands-on learning and problem-solving activities hence STEM disciplines studies helps to instil technological skills in individuals. The participants also pointed out that these methods and approaches pushes students to examine actual issues, manipulate and use scientific principles through critical thinking to create original answers. In support of this assertion, the words of Abakpa and Agbo-Egwu (2014) indicates that mathematics education has the potential of developing life-long skills in an individual that will enable him to add significantly to the development of the society in which he lives. In the same vein, Momoh and Yusuf (2012) and Charles-Ogan et al. (2017) stated that mathematics has been recognized as a tool for solving every day's challenges faced by individuals and ensures national stability.

Branches of mathematics such as college algebra, trigonometry and statistics underscore the importance of truth and honesty and analytical thinking that can tackle the problem of bribery and corruption. Again, Chado and Bala (2014) affirms that mathematics education ensures that the knowledge of the subject gained is applied to all areas of life, such as business, economics, finance, engineering, farming, sports, sciences, and arts and ensures that everybody excels in his/her area of specialization.. As viewed by Fitz (2013) and Idoezu (2018), STEM in its nature is interdisciplinary since it involves other disciplines. Shaughnessy (2013) approached STEM through a complementary view that draw from the individual discipline and described STEM Education as referring to problem solving techniques that harness from the models and procedures in mathematics and science while amalgamating the collaboration and design approaches of engineering using relevant technology.

5.2.4.2 Increased interest and engagement of females in STEM disciplines

Table 12 revealed a mean of 2.81 (SD=0.99) and 38.70%. This suggests that female lecturers had moderate representation in STEM disciplines as a result of the recorded response rate to the "career path of most successful female lecturers have encouraged or motivated more females to advance into STEM disciplines careers in academics". The qualitative phase had comments from five participants indicating that STEM disciplines studies makes learning more interactive, participatory and applicable to students' daily lives, that is, it enhances reality. They added that STEM education frequently piques students' interest in STEM subjects and career choices. These suggested that arousal of learners' interest is a call for institutions to engage students more and inspire them to learn more about STEM areas by incorporating real-world experiments, projects, and technology. This is evident in Brooks and Vernon (1956) study where they reported that the growth of some personality variables such as interest, attitude, and self-concept are spurred by a lot of activities. Also in support is a study in Egypt where the researcher uncovered that middle-class and upper-class women were more likely to pursue scientific and professional subjects, while lower middle class women pursue agricultural science, humanities, education, nursing, and social sciences (Cochran, 1992). Furthermore, it has been established that the interest of females in STM, especially in Africa, has been low. In the colleges, they experienced lack of support and/or gender biases (Boateng 2015).

5.2.4.3 Development of collaboration and teamwork abilities

Table 17 revealed a mean of 3.69 (SD=1.05) and 61.30%, which suggested that there has been instances where respondents have had the opportunity to attend WiSTEM workshops that are organized by sister institutions for all Ghanaian females constituting both lecturers and students to inspire female students towards STEM disciplines studies. It is indicated that these conferences and workshops were avenues that provided them knowledge and skills required in building their capacities in STEM disciplines. Three participants in the qualitative phase indicated that

STEM education is a meta-discipline that encourages students to work in groups thus cooperative learning among their peers to solve challenging challenges in the society. They added that team work encourages collaboration, dialogue, and the growth of interpersonal skills. They suggested that all of those activities are vital for success in STEM areas and the modern workplace to open them up more for job opportunities. Tapping into young people's passion for saving the planet creates a great opportunity to make STEM and related subjects very real and personal. And it infuses STEM with a sense of purpose that helps students stay engaged. In support, Jassawalla and Sashittal, (2006), indicates that Knowledge sharing through research Collaborators skills and the issue of competitiveness, it is clear that the integration of STEM fields will play an important role given that "groups of people from diverse functional areas become high-collaboration teams" (Jassawalla & Sashittal, 2006).

The findings also revealed that collaborations among female lecturers in STEM disciplines can help to instil in students' leadership and managerial skills. In conformity, Stowell (2005) says that leadership skill development posited that "one of the most important things a leader needs to be able to do is to collaborate with his/her team members and create a culture where members value and listen to alternative views and seek out win-win objectives. This can be accomplished by clearly identifying common needs and objectives; and certainly should occur on multiple occasions over time. However, findings from Table 17 revealed moderate response rate with mean of 3.10 (SD=1.14) indicating that WiSTEM chapters/branches are not adequate in all public universities in Ghana and this retards the activities and goals of STEM studies. In addition, two participants pointed out that their institutions in specific have no WiSTEM branches and thus are not privy to the rationale and activities towards the promotion of STEM disciplines studies. This is confirmed by Erinosho (1994) that suitable girls are not privy to information on STEM courses and careers and may turn to other fields, concepts about their abilities in science and mathematics.

5.2.4.4 Exposure to career opportunities

Table 17 revealed a mean score of 2.73 (SD=0.99) and 41.90% which implies that respondents had moderate views that STEM education exposes students to a variety of STEM career prospects. Participants also suggested that institutions can assist students in making educated judgements about their future career pathways by combining real-world applications and contact with professionalism from STEM sectors. To Sulai et al. (2018) Science is defined as an intellectual activity carried out by human, designed to discover the ways in which this information can be organized to benefit human race.

A scientifically literate person should possess a body of scientific knowledge, Science, Technology, Engineering and Mathematics (STEM) Education According to Charles-Ogan et al. (2017), every nation needs technology to develop its economic, human, material and natural resources. They posited that, if mathematics education is faulty, the basis for both scientific and technological development becomes faulty. Again, Mathematics education ensures that the knowledge of the subject gained is applied to all areas of life, such as business, economics, finance, engineering, farming, sports, sciences, and arts and ensures that everybody excels in his/her area of specialization. Chado and Bala (2014).

Wang et al. (2015) found that career perceptions were the second most potent factor influencing a high school girl's pursuit of computer science. Stoilescu and Egodawatte (2010) described the mixed views about programming among female and male undergraduate students. Female students, they found, were more interested in the use of computers than in programming them. Male students, on the other hand, saw programming as a principal activity in computer science.

5.2.4.5 Addressing the skills gap

Table 14 had a mean score of 3.66 (SD=1.16) and 56.50% that indicated a high response and suggest that there exists gender discrimination at workplace, transfers to other places, promotions based on gender, men get paid more than females, profiling female by marriage status and number of children. Also, complex work schedule with long working hours makes it hard to manage family, establish work-family balance and unsupportive employers as shown a mean of 3.39 (SD=1.26) and 51.60% which suggested a moderate response rate by respondents. There was moderate response on the "lack of quality assessment tools, and knowledge of STEM disciplines are barriers to females' representation in academia" as seen with a mean of 3.27 (SD=1.15) and 50.0%.

The lack of female mentors (women engaged in STEM disciplines) in tertiary institutions as revealed in Table 14 showed a mean of 2.46 (SD=1.18) and 53.20%, which implied that female lecturers and upcoming females in STEM disciplines in the universities are not able to gain pre-requisite skills and knowledge in STEM disciplines. Table 14 also revealed the lack of pedagogical models in teaching STEM disciplines effectively with a mean of 2.31 (SD=1.16) and 56.50% which suggested that female lecturers had low response rates to the fact that they are not being faced with challenges compared to the male lecturers which might impede female lecturers' instructional activities thus creating gender gap. Some of these occurrences in institutions discourage and deter the younger females from engaging in STEM disciplines careers.

Six (6) participants also revealed that STEM-related professions do not get the right skilled personals and this is huge challenge great for national development. To confirm the findings, research revealed that, in higher education institution, women encounter sexual harassment, violence, omission from professional development opportunities, prejudices concerning their scholastic abilities and intellectual authority, and prejudices against them as mothers (Adusah-Kakari, 2008; Heller et al., 1985). The "ideal" worker is glued to their work interminably to satiate tenure demands, a role that leaves little time for childbearing or raising and/or even marriage (Williams, 2000). The conflict between work and home demands may make female faculty, who may be a wife and/or a mother, not an "ideal" academic worker (Ward & Bensimon, 2002). The tenure clock of academic work is structured on male normative paths that insulate them from family responsibilities, disadvantaging women with families (Grant et al., 2000; UNESCO, 2017). In addition, there is little doubt that more and more professional jobs will be in the S&T fields (Schulze & Heerden, 2015). This raises concerns about current disparities in S&T disciplines where almost everywhere in the world male enrolments outweigh that of females (Zander et al., 2015). In addition, the few women who set out on training in scientific disciplines are prevented by discrimination and suppressed motivation bringing about very few women scientists on the continent (UNESCO, 2013). It is suggested that, all stakeholders and institutions should help to advance STEM education through the provision of more skilled professionals to succeed in the workforce as against the research findings that school curriculum and materials are illustrative of socially held female passivity (Erinosho, 1994). These facts are consonant with the findings of Murray et al. (1999) that the STEM classroom environment, should be manifested in the course and curriculum structure, faculty, and male students' beliefs and behavior hamper persistence and success of females at the post-secondary level of education. Furthermore, in the larger context in Ghana, public universities do not have a gender policy and the policy frameworks are in dissonance with gender concerns. A seeming exception is the University of Cape Coast's Strategic Plan which, like the National Council Tertiary Education's (NCTE) goal of increasing female enrollments, mentions gender but does not include modalities for addressing gender inequities (Manuh et al., 2007).

5.2.4.5.1 Skills in analytical reasoning and critical thinking

Table 19 showed a mean of 3.53 (SD=0.97) and 53.20%, suggests that STEM education has moderately helped to empower female teachers and invariably empowers their students to challenge prevailing views about STEM disciplines teaching and the benefits it offers to them. The approaches employed in the teaching of STEM subjects such as projects and problem-solving engages students actively, allows them to discover ideas and skills with which they are able to apply such knowledge in real life situations. To affirm this, technology is viewed as application of knowledge for development and improvement of human life. It is science of mechanical and industrial arts which involves application of science in solving human problems (Suleiman, et al, 2018). It is also revealed by participants that STEM-related studies help students to enhance their critical thinking, analytical reasoning, and problem-solving abilities. It is also asserted that the skills acquired are transferable talents that can be applicable to other professions of life aside science, technology, engineering, and mathematics (STEM). These relevant areas help to engage them in decisions making, being innovative, creative, and having the ability to overcome and solve difficult life challenges.

5.2.4.5.2 Innovation and creativity

From Table 19, a mean of 3.58 (SD=0.90) and 51.60% suggests that STEM education helped moderately in fostering an inclusive environment for learning which can encourage research or teaching collaborations between junior and senior faculty members hence increases professional and personal interactions, and reduce professional isolation that might be experienced by new faculty members. The findings in the qualitative phase also showed that most STEM education activities encourage individuals to develop innovative skills and imaginative creativity by providing them with the tools and opportunities that are necessary to enable them do so. Participants again pointed out that STEM disciplines foster in learners the ability to come up with fresh ideas, being able to approach issues from different angles by solving them, and to devise imaginative solutions. Learners are also able to have mind-sets that will open them up to new ideas and creativity. According to McComas (2014), Sanders (2009), and White (2014), SMET a precursor of STEM was coined and initiated by the NSF in the early 1990s. The initiative was intended to help American students develop critical thinking and creative problem-solving skills to ultimately become more marketable in the U.S. labour force. By 2008, the STEM acronym became part of the educational lexicon and continues to be recognized internationally (Loewus, 2015). These opportunities will be beneficial to individuals in solving problems in all facets of their lives.

5.2.4.5.3 Technological literacy

The data in Table 14 revealed the relevance of technology in the effective teaching and learning of STEM disciplines since there was a mean of 2.31 (SD=1.16) and 56.50% which suggested a disagreement to the idea that pedagogical models do not facilitate the teaching and learning of STEM disciplines in an attractive way to attain the goals for STEM education. Technological models help to present scientific concepts using visuals, pictures, videos and films to make the concepts more real. Technology is the practical application of knowledge especially in a particular area to achieve some results This is supported by Alabede (2017), opines that technology is a systematic approach of applying scientific or other organized knowledge to a particular task. It is about product and process. The process is the application, while the product is the outcome of application, which includes hardware and software materials.in addition, Zakariyya and Bello (2018) and Adeniran and Odebode (2018), view technology as application of knowledge obtained from scientific discovery for development and improvement of human life. It is the mechanical and industrial arts which involves application of science and mathematics in solving human problems. They also promote interest in learners to participate actively in the acquisitions of the concepts in this era of technological world. It implies that most universities are technologically insufficient in the transmission of knowledge and skills towards individual and nation development. The findings also showed that most universities experience administrative constraints in accessing adequate content materials and specifically female expects for teaching STEM disciplines. Findings of participants' views on technology literacy showed that learners can navigate and develop an awareness of how technology operates and have an appreciation for the influence it has on society. However, the unavailability of these facilities poses treats to the effective teaching and learning of STEM disciplines. This is in support with Salinger and Zuga (2009), the U.S. federal government passed laws such as the Vocational Education Act of 1917 in support of career and technology education. Ghana science, technology and innovation policy (2017) focuses on creating an enabling environment for the development and application of science, technology, and innovation to solve national problems and enhance competitiveness. It emphasizes collaboration between the government, industry, and academia. These findings suggest that technology plays a vital role in the study of STEM subjects but much need to be done in the acquisition of adequate technological tools to help achieve the goals of STEM education in Ghanaian universities.

5.3 Social, Institutional/Technical and Cultural Challenges that Hinder Female Lecturers' Professional and Academic Growth in Stem Disciplines in Ghanaian Public Universities

The second theme of the study assess the Social, institutional/technical and cultural challenges that hinder female lecturers' professional and academic growth in STEM disciplines in Ghanaian public universities. In the discussions of this theme, related literature reviewed on challenges faced by female lecturers in STEM disciplines has been critically used to support the findings under the sub-sections below

5.3.1 Social challenges

This section discusses the hindrances that the female lecturers faced both at work place and society at large.

5.3.1.1 Relationships with other colleagues in STEM disciplines studies

Data in Table 13 showed that about 44% of the respondents indicated that there existed unfriendly attitudes among most faculty members as well as unsupportive attitude of female colleagues in STEM disciplines. In consonants, at some STEM academic institutions, female faculty additionally deal with actual discrimination in their surroundings before and during their tenure decision process (Rollor, 2014). There is immediate proof that some men in STEM higher education environments are inert to the convergence of female faculty members (Rollor, 2014). It has also been revealed that they sometimes get less praises from colleagues and other persons in the society even when they exhibit much efforts in their career fields. It is implied that these occurrences demoralizes the younger generations to venture into STEM disciplines and also hinders the professional and academic growth of female lecturers.

About 36% of the respondents from Table 13 indicated that the perception of female lecturers in STEM disciplines as not being fashionable was not factual and unfounded and cannot derail their professional and academic growth in the field (Item 8, M=2,82, SD=1.39). Participants, however, suggested that having cordial relationships with colleagues in STEM activities will make it possible for individuals to participate in STEM-focused clubs and organizations, or competitions where they can connect with other people who share their interests. They said that there is development of social networks, the cultivation of friendships, and the construction of a feeling of community through engagement in STEM fields.

5.3.1.2 Gender and diversity gap

From Table 13, 50.0% of the respondents assert that there are perceptions in the society about STEM disciplines leading to the domination of males in careers path and discourages most female from pursuing it which turns to affect the female lecturers' professional and academic growth. Table 13, Item 2: M=3.71. SD= 1.12. This is in connection with a study by Bella and Crisp (2016) which revealed that women are regularly exposed to stereotypes and discrimination. Cheryan et al. (2009) showed how stereotypes impact the retention of women in science and technology fields. Gender discrimination begins early in a young girl's life and continues throughout development stages to the point where women develop less sense of belonging in science and technology fields. Findings from participants also indicate gender discrimination at workplaces and some promotions made based on gender. Men are given preferences to the disadvantage of females in STEM disciplines studies. In support, women who experience stronger gender-science stereotypes tend to have weaker science identification and thus weaker science career aspirations (Cundiff et al., 2013). In addition, sexism and stereotyping of women's roles and discrimination against women in accessing decision making positions is viewed by the respondents as challenges. From Table 16, Item 7, with a mean of 2.44, (SD= 1.18), it showed that there are challenges that negatively affect female lecturers' quest and commitment to the advancement of STEM education in Ghana. At various levels of education in STEM, women encounter conscious and unconscious teacher/faculty bias on the basis of gender (Moss-Racusin et al., 2012) as males are given the upper hand in the education process because they are engaged more by faculty/teachers (Johnson, 2007). The findings of the qualitative phase asserts that the underrepresentation of specific groups that is women and minority populations (disabled persons) in STEM disciplines also create obstacles, such as the perpetuation of preconceptions and biases. In support of these findings, Lundgren & Prah, (2009); Britwum et al., (2014) asserts that the disregard for the reproductive rights of women in academia is denotative of academic freedom being gendered. Opportunities necessarily for both men and women to undertake their academic functions are unequal. For example, women who return from maternity leave are negatively assessed by their students and senior colleagues, and thereon, frosty relationships develop between them and their senior colleagues. The findings suggest that fair participation in STEM fields can be enhanced when, these barriers are curbed as well as creating environment that welcomes all for national development.

5.3.2 Institutional/technical challenges

This section of the discussion focuses on institutional/technical issues that impede the professional progress of the female lecturers in STEM disciplines within the universities of the respondents are engaged in.

5.3.2.3 Professional development and growth

The quantitative data in Table 14 revealed that there is inadequacy of pedagogical models for effective teaching and learning of STEM disciplines (Item 8: M=2.31, SD=1.16). It also indicates that lack of quality assessment tools, and planning time impedes the study of STEM subjects in tertiary institutions (Item 7: M=2.47, SD=1.17) with mean of 2.47 (SD=1.17). It affirms that these challenges and barriers lead to females' underrepresentation representation in academia. In consonants, the few women who set out on training in scientific disciplines are prevented by discrimination and suppressed motivation bringing about very few women scientists on the continent (UNESCO, 2013). The findings also showed that the lack of frequently professional development collaborations learning opportunities for STEM retards their professional and academic growth. However, the findings indicated that when institutions seek collaborative information or research materials in STEM subjects can help to promote effective career aspirations among female lecturers. Findings of the qualitative phase indicated that female lectures engaged in STEM disciplines studies when offered opportunities to obtain knowledge in the domains of science, technology, engineering, and mathematics, can help improve their academic growth in those fields. In addition, it will lead to the development of analytical thinking and problem-solving skills all of which are valuable in academic environments. Furthermore, the findings showed that STEM education can help to open doors for job contracts and female empowerment. The findings suggested that when female lecturers acquire continuous professional development trainings in STEM disciplines, it can create more room for them to easily attain higher pedicels and invariably improves one's economic fortune at large.

5.3.2.4 Workload and time management

From Table 14, (Item 7: M=2.47, SD=1.17), showed that there is the lack of quality assessment tools. Planning time of STEM disciplines are challenges and barriers to females' representation in academia. On the contrary, Table 20 (Item 2: M=4.19, SD=0.57) indicated that female lecturers' self-efficacy beliefs have influenced and helped them navigate the huge workload of academic activities in the classroom with much confidence. Comments of participants revealed that their engagement in careers in relation with STEM fields usually includes arduous coursework, research, and projects, as well as strict due dates. In conformity, the utilisation of scientific talents of women remain an elusive undertaking (Sulaiman & AlMuftah, 2010). The findings also show that managing all of those activities alongside attending to other personal life situations and responsibilities can be difficult and calls for strong organizational and time management abilities by employers and other stakeholders to enhance effective work output. Table 14 reported that the lack of female mentors (women engaged in STEM disciplines) in tertiary institutions was a challenge (Item 1: M=2.48, SD=1.18) suggesting for awareness advocacies towards STEM-related subjects studies.

5.3.2.5 Resource limitations

Table 14 (Item 3: M=3.27, SD=1.15) suggested that there is lack of quality assessment tools, and personnel towards STEM education in tertiary institutions and this impede academic growth as well as lowering the interest of the younger generations towards STEM-related subjects in universities. Also, there existed administrative constraints in accessing adequate content materials for effective teaching of STEM disciplines (Item 5: M=2.81, SD=1.28) which makes it difficult in acquiring the relevant teaching and research materials for effective teaching and learning of complex scientific concepts. The findings suggest that these limitations impede their academic duties and engagement. This is evident by (Watt et al., 2012) who states that an effective effort to recruit and support future S&T teachers, in general and female teachers in particular, is pivotal to student learning and engagement. Comments of participants showed that performing practical work and active students' engagement coupled with inclusivity during instructional periods has been challenging especially within educational institutions with fewer resources or those within neighbourhoods that are economically disadvantaged. This suggest that the availability of appropriate resources is key in the effective teaching and learning of STEM disciplines.

5.3.2 Cultural challenges

These discussions below are centred on the cultural issues female lecturers encounter through their engagement in STEM disciplines in Ghanaian universities.

5.3.2.1 Family, childbearing and motherhood

Table 15 (Item 1: M=3.69, SD=0.98) suggests that the perceptions that a woman's place is not the hard sciences indicating that stereotyping still exist in society and these perceptions retard their professional, academic growth These perceptions may lead to underrepresentation of females in STEM-related subjects. In confirmation, Williams

(2000) says the "ideal" worker is glued to their work interminably to satiate tenure demands, a role that leaves little time for childbearing and/or even marriage. In addition, the conflict between work and home demands may make female faculty, who may be a wife and/or a mother, not an "ideal" academic worker (Ward & Bensimon, 2002). The tenure clock of academic work is structured on male normative paths that insulate them from family responsibilities but disadvantage women with families (Grant et al., 2000; UNESCO, 2017). The comments of participants however oppose to family and parents' perceptions about the prolong period of their wards not marrying early as a result of their involvement in STEM education. It suggests that females' engagement in STEM disciplines does not have a negative effect on females' marriage and childbirth since a significant number of female lecturers are married and have biological children but that their engagement in STEM disciplines should rather motivate the younger generations to take up STEM- related studies the betterment of their lives. Also, findings of the qualitative phase pointed out to the fact that individuals in the society sometimes perceive them as not being "holy" as a result of their engagement in STEM disciplines studies. This situation isolates families and friends from them in order not to become influenced and less committed with their spiritual living. Participants however pointed out that those perceptions about their religious life are unfounded and do not negatively affect STEM studies since they do plan out activities for religious programmes. In addition, they said one's spiritual life cannot be judged by fellow human beings and outward appearances (Angeline, 2011). These perceptions or mentality informs why some educators teach and attend to the girls in classes, particularly in mathematics and science, and this ends up influencing the performance of the girls (Akinsowon & Osisanwo, 2014).

5.4 Cross-institutional Collaborations Being Designed to Enhance the Career Aspirations of the Ghanaian Female Lecturers in STEM Disciplines

This theme below discussions cross-institutional linkages that enhances the career aspirations of the Ghanaian female lecturers engaged in STEM disciplines

5.4.1 Collaboration and communication

Table 17 revealed that platforms for collaborative research work among female lecturers in Ghanaian universities are inadequate since there are no links among institutions to design and carry out STEM collaborative activities to boost their professional growth and motivate STEM discipline students (Item 2: M=3.45, SD=0.99). Comments of participants also indicated that effective collaborative work, team projects, clear and concise communication are key and necessary in STEM fields. They said this was necessary particularly for individuals who are more oriented towards individual work or who have hurdles relating to language or culture. Table 18 (Item 4: M=2.42, SD=1.15) suggested that WiSTEM chapters do not exist in all public universities in Ghana whose core mandate is to inspire and encourage young girls to be involved in STEM disciplines. The findings suggest and points out that some respondents did not benefit from WiSTEM and its activities. The data further indicated that WiSTEM programmes and activities are only moderately organized annually for female lecturers, university students and SHS students (Item 5: M=3.08, SD=0.36). The findings suggestted that annual activities of WiSTEM might not include all Ghanaian universities. The findings further suggest that WiSTEM plays an important role in the advancement of STEM education in the country. However, it is also revealed in Table 17 that not all universities in Ghana have branches of WiSTEM (Item 6: M=2.92, SD=1.15) and as such, STEM conferences organized are limited to only few institutions that study STEM-related subjects. In addition, Table 17 (Item1: M=3.69, SD=1.05) indicated that some institutions do make provisions and opportunities for inter-institution collaboration to enhance our growth. Comments of the qualitative phase showed that the availability of interdisciplinary partnerships between educational institutions are typical in the STEM field and should be addressed by all stakeholders. It also indicated that interinstitutional collaborations on STEM disciplines among Ghanaian universities were inadequate since majority of the universities do not have STEM disciplines clubs and societies to build the capacities lecturers and students in STEM fields. Tapping into young people's passion for saving the planet creates a great opportunity to make STEM and related subjects very real and personal and it influnces STEM with a sense of purpose that helps students stay engaged. In support, Jassawalla and Sashittal (2006), indicates that Knowledge sharing through research Collaborators skills and the issue of competitiveness, it is clear that the integration of STEM fields will play an important role given that "groups of people from diverse functional areas become high-collaboration teams.

The aforementioned findings suggested that there is the need for frequently organized professional development learning and international conference opportunities with other institutions in STEM initiatives for both lecturers and students. It showed that appropriate collaborations can improve the overall quality of science, technology, engineering, and mathematics (STEM) activities and also make room for all stakeholders concerned with STEM-related studies in tertiary institutions to identify and address the challenges of STEM education.

5.4.2 Mentorship programmes

Table 19 revealed that STEM conferences moderately enables female lecturers to foster a sense of belonging among women in STEM and also encourages female students to develop much interest in STEM fields (Overall mean: M=3.34, SD=0.94). The findings suggest that much need to be done to encourage and motivate younger females in STEM-related studies. Participants' comments pointed out that institutional programmes helps to empower teachers who in turn will empower students to challenge prevailing views about STEM teaching. It adds that collaborations fosters the creation of an inclusive environment which encourages research work between junior and senior faculty, thereby increasing professional and personal interactions. The qualitative data also showed that university institutions are capable of constructing mentorship programmes for female students in STEM disciples to become connected with experienced professionals who will provide guidance, support, and career advice to them. The findings, however, pointed out that mentorship programmes are inadequate. Recent studies have demonstrated that male and female students have the same levels of situational anxiety, but stressful situations tend to have more negative impacts on the motivation of female students than on that of male students (Moeller et al., 2014). Female students also experience less intrinsic motivation and more withdrawal motivation, which leads to disengagement when faced with traumatic situations daily. This suggest that universities need to have frequent STEM programmes to reach out to more females in STEM studies.

5.5 Network of Local and International Role Models for the Female Lecturers in STEM Disciplines Studies in Public Universities of Ghana

This theme discussions the availability of network of role models for the Ghanaian female lecturers in STEM disciplines.

Table 18 data showed that award schemes are in place for outstanding females in STEM disciplines (Item 1: M=3.74, SD=0.65). This suggests that more female lecturers will get motivated and strive to work harder to develop their academic growth. The issue of insufficient female role models in STEM disciplines in Ghanaian universities and their ability to interact and tap knowledge and experiences from such individuals towards their professional development indicated a moderate response by the respondents Table 18 (Item 2: M=3.19, SD=1.41). It suggests that the network of role models is still of importance for the advancement of STEM disciplines in Ghanaian universities. Table 18 Item 8: M= 2.11, SD=0.93 pointed out that female lecturers in STEM disciplines who double as role models to colleagues and students do not occupy top responsibility positions in the universities. This suggests that the absence of role female models with top leadership positions might deter the younger generations involved in STEM-related subjects. The data also pointed out the relevance of role models in STEM disciplines since students and lecturers alike will benefit from their vast experiences. Furthermore, Table 18 (Item 5: M= 2.34, SD=1.02) suggested that female mentors in STEM disciplines do not support their younger colleagues towards their professional growth.

Findings from the qualitative phase indicated that there are WiSTEM activities in Ghana that work towards the goal of establishing relationships between students,' role models and mentors in STEM-related industries. Furthermore, it is revealed that the WiSTEM programmes offer opportunities, such as networking, mentoring, and career assistance however, the findings indicated that there are limitations as most of those training programmes are not decentralized to the less privilege to benefit. In support of this findings, the limited presence of women in S&T fields is not only a breach of their rights but also a restriction on women's contribution to teaching and research (Kwaramba & Mukanjari, 2013). It will also have a considerable impact on the next generation because there are too few women in S&T to serve as role models for girls and young women (Zander et al., 2014). Also, Barley's (2000) study in Ghana provides the evidence that numerous girls lack role models and auxiliary teachers to guide them to higher accomplishments. The findings therefore suggest that stakeholders in STEM fields in Ghana should make deliberate and conscious efforts to create opportunities that will link young females with role models and mentors in STEM disciplines studies both within and outside Ghana. Finally, making links with experienced females in STEM studies though WiSTEM activities can improve the professional development for women in STEM disciplines.

5.5.1 Women in STEM clubs and networks

Comments of the qualitative phase showed that educational institutions have the ability to establish clubs or networks to solely cater for the needs of female students in STEM disciplines but these are currently absent in the universities. At some STEM academic institutions, female faculty additionally deal with actual discrimination in their surroundings before and during their tenure decision process (Rollor, 2014). There is immediate proof that some men in STEM higher education environments are inert to the convergence of female faculty members (Rollor, 2014). It also indicates that the establishment of STEM clubs will serve as a community to support and plan activities such as workshops, seminars, and networking gatherings, that seeks to raise awareness and encourage empowerment of females"

5.6 Institutional Commitment and Support Systems in Place or being Envisaged to Boost the Confidence and Capabilities of Female Lecturers in STEM Disciplines

This section focuses on discussions of institutional commitment and support systems available in Ghanaian universities to boost the confidence of female lecturers engaged in STEM disciplines.

5.6.1 Fostering an inclusive environment

From Table 19 it was revealed that 51.6% of the respondents, (Item 3: M= 3.58, SD=0.90) agreed that to the establishment of all-inclusive learning environments to promote interactive teaching-learning processes among female lecturers and students. It added that such aids are not adequately in place and need to be created to encourage research or teaching collaborations between junior and senior faculty which will increase professional and personal interactions, and reduce professional isolation experienced by new faculty. Commentary by participants on the contrary, indicated that some teachers engaged in STEM discipline studies exhibit some biasness in their instructions which invariably contributes to the underrepresentation of females in STEM disciplines. In support of these findings, research shows that at various levels of education in STEM, women encounter conscious and unconscious teacher/faculty bias on the basis of gender (Moss-Racusin et al., 2012) as males are given the upper hand in the education process because they are engaged more by faculty/teachers (Johnson, 2007). This suggest that much efforts need to be taken by relevant stakeholders to help boost and encourage more females to venture into STEM-related subjects.

5.6.2 Scholarships, duty leaves and grants

Table 19 (Item 1: M=.3.69, SD=0.92) pointed out that professional societies and universities could provide structured professional development opportunities to enable women to anticipate some of the barriers in STEM fields, plan how to navigate them, and predict important decisions to solving such challenges. However, the findings from Table 19 (Item 8: M=2.77, SD=1.22) suggest that financial support in the form of scholarships for females engaged in STEM-related studies in Ghanaian public universities needs to be given much attention by all stakeholders in STEM studies. In confirmation, opportunities necessarily for both men and women to undertake their academic functions are unequal. For example, women who return from maternity leave are negatively assessed by their students and senior colleagues, and thereon, frosty relationships develop between them and their senior colleagues (Lundgren & Prah, 2009; Britwum et al., 2014). Participants' comments revealed that some educational institutions do provide support specifically for female students who are majoring in STEM (science, technology, engineering, and math) but indicated that those packages are inadequate since most universities and students do not get such benefits. For instance, the C. K Tedam University Technology and applied sciences has through the Mr. Eazy's scholarships supported needy students with priority to the female students in 2022. These findings suggest the need for national policies on grants and scholarships to enhance the advancement of STEM disciplines for national development.

5.6.3 Programmes of outreach and awareness

Table 19 (item 3: M=3.58, SD=0.90) pointed out that there are outreach programmes organized by the universities. Additionally, the universities fosters inclusive learning environments which can encourage research or teaching collaborations between female junior and senior faculty, increases professional and personal interactions, and reduces professional isolation that is usually experienced by new faculty. The findings however suggests the need for more strategies to be employed to enhance awareness creation programmes for females engaged in STEM disciplines. The qualitative findings also affirms that the main goal of these STEM awareness programmes is to promote students' interest in STEM fields while also providing them with opportunities to get practical experience and role models. However, findings indicated that the inadequate or absence of such outreach and awareness programmes and even the available ones often do not cover all relevant basic and second cycle institutions. It is then suggested for all stakeholders in STEM education to support through sponsorships in other to achieve the aims of STEM education in Ghana.

Table 19 (item 4: M=3.53, SD=0.97) showed that there is the need for university institutions to empower teachers to enable them in turn empower their students to challenge prevailing views about teaching as a last option for females. It however suggested that there should be plan of activities or guidelines in place to help empower females engaged in STEM-related subjects. Sadly, as we understand, for many women in science, technology, engineering and mathematics (STEM), the route to academia ends long before they attain a faculty position and are the "lucky" beneficiary of biased student beneficiary/evaluations (Leifer et al., 2015).

5.6.4 Policies to ensure gender equality and equity

Table 19 (item 6: M=3.39, SD=0.88) suggested that policies and laws in universities that are aimed at ensuring gender equality and support for female representations in various universities need to be given all the necessary implementation attention. These laws and policy guidelines aim at promoting the advocacy of females' representations in STEM disciplines and bridging the gap of gender inequality. Furthermore, the findings showed that some of Ghanaian universities do not have established laws and policy documents in place to address the gender equality and equity. To support, Britwum et al. (2014) says in Ghana, there have been few efforts geared toward ensuring the parity between men and women in tertiary education or in the Ghanaian society at large. The findings then suggest that all relevant stakeholders in STEM education endeavor to develop national policies documents towards STEM-related studies for the implementation of all tertiary institutions in the country.

5.6.5 Recruitment of senior academic women in STEM fields

Table 19 (Item 2: M=3.66, (SD=0.87) suggest that there are insufficient senior women in STEM fields who can present their technical work as part of department colloquia, brown-bags, and other special events, providing opportunities for these speakers to meet and mentor female students. Participants suggested that employers, institutions and other relevant stakeholders should make deliberate and conscious efforts to provide opportunities in mentoring students in STEM-related studies. In connection, to findings from Carrell et al. (2010) female students perform considerably better in their mathematics and science courses when their professor or teacher is a woman. Carrell et al. (2010) assertion is supported by findings from Young et al. (2013) which state that female STEM professors presented several advantages to women without disadvantaging men, and all students assessed female STEM professors as more supportive role models than male professors.

5.7 Influence of Female Lecturers' Self-efficacy Beliefs on their Academic and Professional Growth

The findings of this item are discussed below:

5.7.1 Confidence in the subject matter

Findings from Table 20 (Item 5: M=4.10, SD=0.59) indicated that female lecturers' self-efficacy beliefs have influenced the quality of instructional delivery for their students' academic and professional growth. Blaney and Stout (2017) report that both self-efficacy and a sense of belonging are key predictors of retention, persistence, and success in the computing field. This suggests that female lecturers engaged in STEM disciplines impacts positive attitudes into younger females through their academic engagement. In addition, comments in the qualitative phase showed how their self-efficacy beliefs have also influenced and helped to do activities effectively in the classroom with confidence. This is possible by building a solid comprehension of the STEM subjects matter and having faith in their capacity to teach it in an efficient manner. It implies that this self-assurance has given the potential to significantly improve the teaching delivery and their engagement with students to become motivated towards STEM disciplines.

Findings in Table 20 (item 3) 4.18 (SD=0.50) shows that the self-efficacy beliefs of female lecturers helped them to develop the competence and skill to achieve academic success. This is revealed in them not to become more inclined to their instructional tactics in order to cater for the varied requirements of their students. Again, the findings asserts that female lecturers are able to persevere in the face of problems or losses, searching for alternative techniques to ensure students' knowledge and achievements in STEM-related subjects are good. However, it is indicated that external support from all stakeholders are required in order to work and overcome the numerous challenges female lecturers are faced with in STEM disciplines.

5.7.2 Female lecturers serving as role models to younger females

From Table 20, (Item 6: M=3.48, SD=1.28) points out that female lecturers' self-efficacy belief cannot play much significant influence on their handlings in life as female scientists. It implies that the high level of confidence in their own abilities in the STEM fields to serve as role models for their students is uncertain. It is asserted that students might be motivated to develop their own self-efficacy beliefs in STEM disciplines by teachers who exude confidence and competence in the subject matter they teach as well as motivation from parents. In connection with this findings Shin et al., (2015) points out that in many countries, women experience a similar internal dilemma over the choice of a career related to a male-dominated fields. For instance, in South Korea this situation can activate an "internal 'tug-of-war' that can result in Korean females' low motivation, low self-beliefs, and the underrepresentation of females in male-dominant fields" Many other studies demonstrate that parents are outstanding role models and influence the career choices of their children through advice, encouragement, and financial and emotional support, among other factors. For instance, Archer et al. (2013) reported that mothers, in particular, play an essential role in the career choice of their daughters. Findings therefore suggests that all stakeholders should urgently propose, establish and enact policies that will aim at improving the representation of females in STEM disciplines in tertiary institutions to help galvanize high level role models in STEM studies.

5.8 Summary of Chapter Five

The chapter was done by merging both quantitative and qualitative findings alongside the related literature review found in chapter two (2) to support the discussions. The discussions were organised according to the research questions of the study as seen below:

The sociodemographic profile of participants revealed that majority of participants were from KNUST and UG whilst the least were from CKT-UTAS. Also, the highest professional rank was senior lecturers with few full professors. The findings showed that female lecturers' representations in STEM disciplines was lower than that of the male lecturers. There were perceptions about females in the society about STEM disciplines leading to the domination of males in careers path. It has also been revealed that collaborative research works among female lecturers in Ghanaian universities were inadequate. Networks of role models is still of importance for the advancement of STEM disciplines in Ghanaian universities. Findings suggests that policies and laws are absent in universities for ensuring gender equality and support for female representations in STEM disciplines and finally, female lecturers self-efficacy beliefs have positive influence on the quality of instructional delivery and academic and professional growth.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Overview

This chapter highlights the summary of findings, the conclusions and recommendations as well as suggestions for further research studies. In the first stage, the summary of findings was presented whereby the focus was based on chapters, the quantitative and qualitative questions sections of the study. The second part focuses on the conclusions of the study with highlights drawn from the research questions. The implication of findings was on theory and policy. Recommendations and suggestions for future research study have also been discussed.

6.1 Summary of the Study

The study was to explore the status, stature and challenges of female lecturers in STEM disciplines in Ghanaian universities. The study was underpinned by the pragmatism paradigm where concurrent triangulation mixed method design was adopted. For the quantitative phase, a descriptive survey was used, due to the researcher's quest to obtain current information about female lecturers in STEM disciplines in science education in Ghana.

The multi-stage sampling procedure was employed in the study. The first stage involved the classification of all public universities in Ghana. These included the University of Cape Coast, University of Ghana, Kwame Nkrumah University of Science and Technology, University of Mines and Energy, C. K. Tedam University of Technology and Applied Sciences and Akenten Appiah-Menka University of Skills training and Entrepreneurial Development, Ghana Communication Technology University, Ghana Institute of Journalism, Ghana Institute of Languages, Ghana Institute of Management and Public Administration, S. D. Dombo University of Business and Integrated

Development Studies, University for Development Studies, University of Education, Winneba, University of Energy and Natural Resources, University of Health and Allied Sciences and the University of Professional Studies.

The second phase employed the purposive sampling technique to select six public universities in Ghana that run STEM disciplines that is, Akenten Appiah-Menka University of Skills training and Entrepreneurial Development, C. K. Tedam University of Technology and Applied Sciences, Kwame Nkrumah University of Science and Technology, University of Cape Coast, University of Ghana and the University of Mines and Energy, In the interview phase, the convenience sampling technique was employed to select twelve (22) female lecturers engaged in STEM disciplines. Thus, four (4) female lecturers from KNUST, four from UG, four from UMAT, four from AAMUSTED, three from UCC and three from CKT-UTAS were chosen.

A five-point Likert scale self-constructed questionnaire and a semi-structured interview guide were the instruments used to gather data for the study. Sixty-two (62) female lecturers answered the questionnaire while semi-structured interviews were conducted for the twenty two (22) female lecturers in STEM disciplines. Quantitative data analysis was done using the SPSS version 25.0. Regarding the quantitative data, descriptive statistics (Percentages, Means and Standard Deviation) were used to analyse the data. The qualitative data was analysed through thematic analysis for the interviews.

The key findings from the study were:

1. The summary from Table 12 on research question 1 indicates that "involvement of female lecturers as role models in STEM disciplines enhanced effective teaching of STEM subjects" was the first agreed response exhibited by the female lecturers. However, "females in STEM disciplines are of higher ranks"

and "Gender representation in STEM subjects being in a balanced scale as men" revealed disagreement by the respondents. Finally, it was showed that the respondents were moderate in their responses about the representation of female lecturers in STEM disciplines in Ghanaian universities.

2. Research question 2 examined the social, institutional, technical and cultural challenges hindering female lecturers' professional and academic growth in Ghanaian public universities.

   The quantitative findings from Tables 13, 14 and 15 of this research question revealed that all the three sub-scales of challenges had moderate responses. These suggest that the factors affect female lecturers' professional and academic growth moderately in STEM disciplines in public universities in Ghana. The challenges may affect the respondents' academic growth which is evident in these statements with high response rates; "society perceive STEM disciplines as male dominated careers path, discourages females from pursuing it" and "female lecturers feel less marginalized and less professional opportunities are given them". The comments from participants in the qualitative phase points out that social, institutional and cultural challenges all affect female lecturers' engagement in STEM disciplines.

3. The third research question was to find out the cross-institutional collaborations that have been designed to enhance the career aspirations of the Ghanaian female lecturers in STEM disciplines.

   The findings showed that there were opportunities for inter-institutional collaboration for female lecturers in STEM disciplines. It was also indicated that there were only moderate WiSTEM conferences for females engaged in STEM disciplines in Ghanaian universities.

4. The fourth research question examined the extent to which network of local and international role models had influence the female lecturers in STEM disciplines in public universities of Ghana. Findings revealed that award schemes are in place in some few universities for outstanding females in STEM disciplines. The comments by participants also revealed some commendations to stakeholders in STEM disciplines for interactive STEM sessions with female lecturers in STEM disciplines in universities. However, respondents disagreed on the existence and influence of network of role models in STEM disciplines in Ghanaian public universities. The findings indicated the need for a general policy document on females in STEM networking for all universities in Ghana.
5. The fifth research question sought to find out what institutional commitment and support systems are in place or being envisaged to boost the confidence and capabilities of female lecturers in STEM disciplines. The findings agreed to the existence of institutional support systems for female lecturers' professional growth but however suggested that institutional supports in the form of scholarships were not readily available to boost the career aspirations of the female lectures. Commentary by participants indicated that the insufficient outreach and awareness programmes the few available ones often do not cover all relevant basic and second cycle institutions
6. Research question six (6) in Table 20 examined how the female lecturers' self-efficacy beliefs about STEM disciplines could influence their academic and professional growth. The findings revealed that there were positive impact of respondents' self-efficacy beliefs on their engagement in STEM disciplines. Comments by participants revealed how their self-efficacy beliefs have influenced and helped to teach effectively in the classroom with confidence. This

is possible by building a solid comprehension of the STEM subjects matter and having faith in their capacity to teach it in an efficient manner.

6.2 Conclusions

A number of conclusions were drawn from the findings as follows:

It is concluded from findings of research question one that the engagement of female lecturers in STEM disciplines helped to enhance effective teaching of STEM disciplines. It is also concluded that female lecturers in STEM disciplines do not possess higher professional ranks. Again, it is concluded that female lecturers' representation in STEM disciplines is not in a balanced scale compared to male lecturers in the universities. Finally, it concluded that there is the need to improve the representation in terms of numbers and responsibility roles in the universities

The findings of research question two concluded that all the three sub-scale challenges were challenges that affected females moderately in their engagement in STEM disciplines in Ghanaian universities. Again, it is concluded that female lecturers are often marginalized and less professional opportunities given them. Participants' comments revealed worries about the social, institutional and cultural challenges affecting their engagement in STEM disciplines.

The third research question conclusion is that there were opportunities available within universities for inter-institutional collaborations among female lecturers in STEM disciplines. It is then concluded that seeking institutional collaborative or research materials will help promote effective career aspirations among female lecturers engaged in STEM disciplines in Ghanaian universities. The findings also concluded that the lack of regular local and international conferences for instance, WiSTEM for the female lecturers in STEM disciplines retards their academic engagements in the universities.

It is concluded in research question four that there were award schemes in various universities for outstanding females in STEM disciplines which helps to boost the academic credentials of the female lecturers and invariably make them role models for the girls aspiring to study and acquire STEM-related careers. It is also concluded that females' lecturers engaged in STEM disciplines do not support and mentor younger colleagues' professional growth. Majority of female lecturers in STEM disciplines are not of higher academic rankings (professors) in Ghanaian universities. In addition, majority of female lecturers in STEM disciplines do not occupy top managerial positions in Ghanaian public universities.

Conclusions in research question five are that there were few institutional support systems towards the female lecturers' academic and professional growth in STEM disciplines in Ghanaian public universities. Universities empowering teachers is a requisite for females to in turn empower their students to challenge prevailing views about STEM disciplines, findings showed the need for financial support and scholarships for female lecturers in STEM disciplines and Policies to ensure gender balance. It is also concluded that laws on gender equity are necessary to support policy of representation of females in STEM disciplines. Comments also concluded that there were insufficient outreach and awareness creation programmes for all relevant basic and second cycle institutions in Ghana. It is concluded that the availability and implementation of all relevant support systems in Ghanaian universities were not determined in the study.

Conclusions from the findings of research question six are that, the self-efficacy beliefs of the female lecturers in STEM disciplines had positive impact on their academic engagements particularly in the exhibition of competencies and skills to achieve academic success in STEM disciplines in Ghanaian universities. It is also concluded that female lecturers' self-efficacy beliefs may or not influence how they handle other societal problems as female scientist. Conclusion on participants' comments is that female lecturers' self-efficacy beliefs has influenced and helped in effective classroom practices with confidence through the building of solid comprehension of the STEM disciplines subject matter and having faith in their capacity to teach efficiently.

6.3 Implications for Policy and Practices

Policies addressing the status, stature, and challenges of female lecturers in STEM disciplines in Ghanaian universities should consider the following implications:

6.3.1 Gender equality policies

- Implement and enforce gender equality policies within universities to ensure fair representation of both genders in STEM disciplines.
- Establish clear guidelines for hiring, promotion, and tenure processes that concern gender diversity.

6.3.2 Mentorship and support programmes

- Develop mentorship programs to support female lecturers in STEM disciplines, providing guidance on career advancement and work-life balance.
- Create support networks and communities that foster collaboration, information exchange, and mutual encouragement among female STEM faculty.

6.3.3 Professional development opportunities

- Offer targeted professional development opportunities for female lecturers, including training, workshops, and conferences that address specific challenges faced by women in STEM disciplines.
- Encourage participation in national and international conferences to enhance visibility, networking, and collaboration.

6.3.4 Family-friendly policies

- Implement family-friendly policies such as flexible work hours, parental leave, and on-site childcare facilities to support female lecturers in managing their professional and personal responsibilities.

6.3.5 Workplace culture and bias mitigation

- Establish a zero-tolerance policy for gender-based discrimination and harassment, with clear reporting mechanisms and consequences for offenders.
- Conduct awareness programmes to address unconscious biases that may affect the evaluation and treatment of female lecturers in STEM disciplines.

6.3.6 Research funding and opportunities

- Ensure equitable distribution of research funding and opportunities, eliminating gender-based disparities in resource allocation.
- Promote and recognize research conducted by female lecturers in STEM through awards and grants.

6.3.7 Data collection and monitoring

- Implement systematic data collection on the representation and experiences of female lecturers in STEM disciplines.
- Regularly monitor and evaluate the effectiveness of implemented policies to make data-driven adjustments and improvements.

6.3.8 Partnerships with industry

- Encourage partnerships with industry to create opportunities for female lecturers in STEM disciplines to engage in real-world applications of their research and enhance their professional networks.

6.3.9 Educational initiatives

- Support initiatives that encourage young girls to pursue STEM disciplines from an early age, fostering a pipeline of female talent for future academia.

6.3.10 Visibility and recognition

- Promote the visibility of female lecturers in STEM disciplines through seminars, conferences and public events showcasing their achievements and contributions to the academic community.

6.4 Contribution to Knowledge

This study was to explore female lecturers engaged in STEM disciplines in Ghanaian universities; their status, stature and challenges. The research was underpinned using the social and cognitive developmental theories with the concurrent triangulation mixed method design to contribute knowledge in research domains. As indicated by Creswell et al, (2003), the concurrent triangulation method design in this study involved the collection of both quantitative and qualitative simultaneously and analyzed in concert to answer the study's research questions

The pattern of methodology of the study was blended with different approaches in which different views were sought from the respondents in STEM disciplines in the university setting. The contribution made by the respondents helped to address the various challenges faced by female lecturers in STEM disciplines in Ghanaian universities.

The social dimension factors accounting for the low presence of women and girls in STEM careers and fields which is based on the influential roles the home, school, and society play in aligning females to feminine ideals (Erinosho, 1994; Witt & Wood, 2010) has helped to provide scientific knowledge and insight on the status, stature and challenges of female lecturers engaged in STEM disciplines in Ghanaian public universities.

It is expected that female lecturers engaged in STEM disciplines will play critical roles as experts in the advancement of STEM-related studies in Ghanaian universities and the nation at large. The study would also improve female lecturers' body of knowledge in research by sharing their views to other researchers in the field of STEM disciplines and education in general. This implies that Ghanaian female lecturers in STEM disciplines and their counterparts in other developing countries would transfer knowledge and appropriate strategies to improve the underrepresentation of female lecturers in STEM discipline in the universities.

6.5 Recommendations

Following the findings obtained, a number of recommendations are proposed so as to improve the representations of female lecturers in STEM disciplines in Ghanaian universities.

1. The researcher recommends that female lecturers in STEM disciplines should be encouraged, inspired and supported in diverse forms by all relevant stakeholders to work harder in academia in order to attain higher professional ranks in the universities. Also, it is recommended that special incentives should be set aside in Ghanaian universities for outstanding female lecturers engaged in STEM disciplines to motivate students in STEM disciplines to take keen interest in academia in Ghanaian universities which will invariably increase the numbers of female lecturers in STEM disciplines. In addition, it is recommended that guidelines on equity should be established in universities to give female lecturers the opportunity to take up higher responsibility roles in the universities

2. Universities should provide more advocacies and awareness services about females' engagement in STEM-related subjects in order to address bad perceptions about women in the hard sciences, sexism and stereotyping of women's roles as well as the negative traditional beliefs making women inferior to men. Universities management should tackle institutional and technical challenges with all the seriousness they deserve through the proivision of technological tools to facilitate effective instructional processes of STEM disciplines in universities.
3. Universities should collaborate and formulate by-laws on conferences at both local and international levels to promote the academic growth of the female lecturers. The by-laws will also help boost the career aspirations of female students at the pre-tertiary and universities levels. An example is WiSTEM, which is currently operational in only six (6) Ghanaian public universities. WiSTEM's core mandate is to inspire the young generations to venture into STEM-related careers for sustainable living.
4. The researcher recommend that the ministry of education should establish a general policy document on females in STEM disciplines for all universities in Ghana to enhance the networking of females. It is also recommended that universities provide guidelines for mentorships programmes among female lecturers in STEM disciplines to support younger colleagues/students' academic and professional growth.
5. Universities should support female lectures with scholarships and fellowships programmes for female lecturers in STEM disciplines. Government of Ghana through GTEC should establish policies on enhancing gender balance and representation of females in STEM disciplines. Universities management should

commit time and resources on outreach and awareness programmeas for pre-tertiary institutions in Ghana. These activities will enable stakeholders catch the young girls earlier to motivate them to pursue STEM disciplines at the university level.

6. The researcher recommends that outstanding female lecturers engaged in STEM disciplines should be duly recognized and awarded for their professional performances in universities. This at large, will encourage positive competitions among the females themselves and between their male colleagues in the process of impacting knowledge of STEM concepts to students in universities.

6.6 Suggestions for Further Research

The researcher suggests that this study can also be conducted in other tertiary institutions, specifically technical universities and colleges of education to find out how females in STEM-related subjects are represented.

1. A qualitative study can be employed to investigate the stature of female lectures engaged in STEM disciplines in Ghanaian universities.
2. A study can also be conducted to investigate the lingering efforts of certain cultural beliefs and practices on females' participation in science at the pre-university levels. This is meant to ensure that appropriate interventions are implemented to attract more females into science at the pre-university level.

REFERENCES

Abafemi, M. A. (2013). Effect of design thinking approach on students' achievement in some selected physics concepts in the context of STEM learning. *International Journal of Technology and Design Education, 1-28.*

Acker, J. (2000). Revisiting class: Thinking from gender, race, and organizations. *Social Politics: International Studies in Gender, State & Society*, *7*(2), 192-214.

Adeyebv 2008, R. (2008). Enhancing learning and engagement through embodied interaction within a mixed reality simulation. *Computers & Education*, *95*, 174–187. https://doi.org/10.1016/j.compedu.2016.01.001

Adiniran and ode, J. L. (2018). Gender Gap in Science, Technology, Engineering, and Mathematics (STEM): Current Knowledge, Implications for Practice, Policy, and Future Directions. *Educational Psychology Review*, *29*(1), 119–140. https://doi.org/10.1007/s10648-015-9355-x

Adusah-Karikari, A. (2008). Experiences of women in higher education: A Study of women faculty and Administrators in selected public universities in Ghana. Retrieved from: https://etd.ohiolink.edu/!etd.send_file?accession= ohiou1210704502&disposition=inline

Ajayi, J. A., Goma, L. H., & Johnson, A. G. (1996). *The African experience with higher education*. Ohio University Press.

Akinsowon, O. A, Osisanwo, F. Y (2014). *Enhancing interest in sciences, technology and mathematics (STEM) for the Nigerian female folk.* Retrieved from: http://article.sapub.org/10.5923.j.ijis.20140401.02.html#Sec2

Akoto-Baako, H. (2018). *Perceived Influence of Large Class Size and Psychological Classroom Environment on Students Academic Performance.* Unpublished Thesis submitted to the Department of Education and Psychology of the Faculty of Educational Foundations, College of Education Studies, University of Cape Coast. https://erl.ucc.edu.gh/jspui/bitstream/123456789/3421/ 1/HANSEN%202018.pdf Retrieval 19/07/019.www.ckt-utas.edu.gh

Alabrde, J. G. (2017). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 21-29.

Alon, S. & Di Prete, T.A. (2015), "Gender differences in the formation of a field of study choice set". *Sociological Science*, *2*, p. 50.

American Association for the Advancement of Science (1990). *The liberal art of science: Agenda for action.* American Association for the Advancement of Science.

American Association for the Advancement of Science. (1989). *Science for all Americans: Project 2061*. Oxford University Press.

Amponsah, K. D., & Mensah, F. (2014). Differences among female students in science and technology-based university programmes in their motivation to learning Science in Ghana, *British Journal of Education, Society & Behavioural Science, 4*(1), 120-138.

Amponsah, K. D., Mensah, F. and Mensah, A. (2014). *Constraints experienced by female students pursuing science and technology-based* university programmes in their learning of science in Ghana. *International Journal of Research Studies in Education, 3*(4), 1-12.

Andam, A. B., Amponsah, P., Nsiah-Akoto, I., Anderson, C. O., Ababio, B. A., Asenso, Y. A., & Nyarko, S. (2015, December). Women in science in Ghana: The Ghana science clinics for girls. In *AIP Conference Proceedings (Vol. 1697, No. 1). AIP Publishing.*

Angeline, N. (2011), "Girls, schools and statistics education in South Africa", first Africa young statisticians conference. Retrieved from: http://www.statssa.gov.za/ycs

Appleton, S., Hoddinott, J., & Mackinnon, J. (1996). Education and health in subSaharan Africa. *Journal of International Development, 8*(3), 307–339.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2013). 'Not girly, not sexy, not glamorous': Primary school girls' and parents' constructions of science aspirations. *Pedagogy, Culture & Society, 21*(1), 171-194.

Asare, O. A. (2011). *Ghanaian female STEM lecturers and professors transcending barriers: The Kitchen is no longer our place.*

Atuahene, F., & Owusu-Ansah, A. (2013). A descriptive assessment of higher education access, participation, equity, and disparity in Ghana. *SAGE Open*. doi: 10.1177/2158244013497725.

Aumeerally, N. L. (2005), "The ambivalence of postcolonial Mauritius: policy versus practice in education: a reading of official and popular multiculturalism", *International Journal of Cultural Policy, 11*(3), pp. 307-323.

Ausik, G. C. (2013). STEM education centers: catalyzing the improvement of undergraduate STEM education. *International Journal of STEM Education*, *5*(1). https://doi.org/10.1186/s40594-018-0143-2

Avotri, R., Owusu-Darko, L., Eghan, H., & Ocansey, S. (2000). *Gender and primary schooling in Ghana.* Institute of Development Studies.

Babbie, K. D. (2007). Selecting research techniques for a method and strategy. In *The Palgrave handbook of research design in business and management* (pp. 63-79). Palgrave Macmillan US.

Bailey, T. (2014). *The role and functions of higher education councils and commissions in Africa: A case study of the Ghana National Council of Tertiary Education* (p.1-32). Centre for Higher Education Transformation (CHET), South Africa

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes*, *50*(2), 248-287. http://dx.doi.org/10.1016/0749- 5978(91)90022-L

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

Bandura, A. (1999), "Social cognitive theory of personality". *Handbook of Personality, 2*, pp. 154-196.

Bandura, A., & Locke, E. A. (2003). Negative self-efficacy and goal effects revisited. *Journal of Applied Psychology, 88*, 87–99.

Bardley, M. N. (2000). Barriers to Girls' Education in Ghana. Retrieved from: on25/05/2013fromhttp://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1102&context=uhp_theses

Barnett, R. C., & Marshall, N. L. (1992). Worker and mother roles, spillover effects, and psychological distress. *Women & Health*, *18*, 9–40.

Barnett, R. C., & Marshall, N. L. (1993). Men, family-role quality, job-role quality and physical health. *Health Psychology*, *12*(1), 48–55.

Bartels, F. L. (1965). *The roots of Ghana Methodism*. Cambridge University Press.

Basoc, S. A., & Howe, K. G. (1979). Model influence on career choices of college students. *The Vocational Guidance Quarterly*, *27*, 239–245.

Beede, D., Julian, T., Langdon, D., McKittrick, G., Khan, B., & Doms, M. (2011). Women in STEM: A gender gap to innovation (State News, ESA Issue Brief# 04-11). Department of Commerce, Economics and Statistics Administration.

Benschop, Y., & Brouns, M. (2003). Crumbling ivory towers: Academic organizing and its gender effects. *Gender, Work and Organization, 10*(2), 194-212.

Betz, N. E. (1994). Career counseling for women in sciences and engineering. In W. B. Walsh & S. H. Osipow (Eds.), *Career counseling for women* (pp. 237–261). Erlbaum

Betz, N. E., & Schifano, R. S. (2000). Evaluation of an intervention to increase Realistic self-efficacy and interests in college women. *Journal of Vocational Behavior, 56*, 35–52.

Beyer, S. (2014). Why are women underrepresented in Computer Science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS coursetaking and grades. *Computer Science Education*, *24*(2–3), 153–192.http://doi.org/10.1080/08993408.2014.963363

Biesta, G. (2010). Pragmatism and the philosophical foundations of mixed methods research. *Sage Handbook of Mixed Methods in Social and Behavioral Research*, *2*, 95-118.

Birke, L. (1986). *Women, feminism, and biology: The feminist challenge*. Methuen.

Blaney, J. M., & Stout, J. G. (2017). Examining the relationship between introductory computing course experiences, self-efficacy, and belonging among first-generation college women. *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education*, 69–74. http://dx.doi.org/10.1145/3017680.3017751

Blickenstaff, J. C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education, 17*(4), 369-386. https://doi.org/10.1080/09540 250500145072

Boateng, F. K. (2015). *Dealing with the ball and chain: A grounded theory study of the experiences of women in STEM domains in Ghana* (Order No. 10102465). Available from ProQuest Dissertations & Theses Global. (1786686317). Retrieved from http://libproxy.txstate.edu/login?url=http://search. proquest. com/docview/1786686317?accountid=5683

Boateng, F. K. (2019). From Studentship to Academia: The Academic Female STEM Trajectory in Ghana. *Journal of Underrepresented and Minority Progress* http://ojed.org/jump doi: 10.32674/jump.v3i1.1077

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychological Review, 15*, 1–40.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43*, 485–499.

Britwum, A. O., Oduro, G. Y., & Prah, M. (2014). Institutionalising gender and women's studies at theUniversity of Cape Coast. *Rwanda Journal of Education, 2*(1), 4–19.

Brooks, J. A. M., & Vernon, P. E. (1956). A study of children's interests and comprehension at a science museum. *British Journal of Psychology*, *47*(3), 175–182

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? *Qualitative Research*, *6*(1), 97-113.

Bryman, A. (2012). *Social research methods*. (4th ed.). Oxford University Press.

Bryman, A., (2012). *Understanding research for social policy and social work: themes, methods and approaches*. Policy Press.

Campion, P., & Shrum, W. (2004). Gender and science in development: Women scientists in Ghana, Kenya, and India. *Science, Technology, & Human Values*, *29*(4), 459-485.

Carlone, H. B. (2004). The cultural production of science in reform-based physics: Girls' access, participation and resistance. *Journal of Research in Science Teaching*, *41*(4), 392-414.

Carrell, S. E., Page, M. E., & West, J. E. (2010). Sex and science: How professors gender perpetuates the gender gap. *Quarterly Journal of Economic, 125*(3), 1101-1144.

Caruso, H. M., & Woolley, A. W. (2008). Harnessing the power of emergent interdependence to promote diverse team collaboration.

Castillo-Montoya, M. (2016). Preparing for interview research: The interview protocol refinement framework. *The Qualitative Report, 21*(5), 811-831.

Ceci, S. J., & Papierno, P. B. (2005). The rhetoric and reality of gap closing: When the "have-nots" gain but the "haves" gain even more. *American Psychologist, 60*, 149 –160. http://dx.doi.org/10.1037/0003- 066X.60.2.149

Ceci, S. J., & Williams, W. M. (2010). Sex differences in math-intensive fields. *Current Directions in Psychological Science, 19*, 275–279. http:// dx.doi.org/10.117

Ceci, S. J., Ginther, D. K., Kahn, S., & Williams, W. M. (2014). Women in academic science: A changing landscape. *Psychological Science in the Public Interest, 15*, 75–141. http://dx.doi.org/10.1177/15291 00614541236

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin, 135*, 218 –261. http://dx.doi.org/10.1037/ a0014412

Charles-Ogan, G. I, Ekwueme, C. O. & Agomuo, R. (2017). Mathematics Educations: A Tool for Achieving Sustainable Development and Self-Reliance. in Ogunkunle, S. J., (Ed.), *Achieving Sustainable Development and Self Reliance Through Science Technology and Mathematics Education. Book of Readings in Honour of Dr. Sunday Adewole Adeniran*, School of Secondary Education (Science Programme) Federal College of Education (Special), Oyo.

Cheryan, S., Master, A. & Meltzoff, A. N. (2015). "Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes", *Frontiers in Psychology, 6*, p. 49.

Cheryan, S., Plaut, V. C., Davies P. G., & Steele, C. M. (2009). Ambient belonging: How Stereotypicalcues impact gender participation in computer science. *Journal of Personality and Social Psychology*, *97*(6), 1045-1060

Chiang, W. W., & Liu, C. J. (2014). Scale of academic emotion in science education: Development and validation. *International Journal of Science Education, 36*(6),908–928.

Chi-Ying Cheng, C., Sanchez-Burks, J., & Lee, F. (2008). Taking advantage of differences Increasing team innovation through identity integration. In E. Mannix & M. Neale (Eds.), Diversity and Groups (Research on Managing Groups and Teams, Volume 11), (pp. 55-73). Emerald Group Publishing Limited.

Cochran, M. (1992). Communities for teacher research: Fringe or forefront? *American Journal of Education*, *100*(3), 298-324.

Cohen, C. C., & Deterding, N. (2009). Widening the net: National estimates of gender disparities in engineering. *Journal of Engineering Education*, *98*(3), 211-226.

Cohen, W.M., Nelson, R.R., Walsh, I.P. (2002). Links and impacts: the influence of public research on industrial R&D. *Management Science, 48*, 1-23

Cohoon, J. M. (2006). Just get over it or just get on with it: Retaining women in undergraduate computing. In J. M. Cohoon & W. Aspray (Eds.), *Women and information technology: Research on underrepresentation*.

Connell, R. (2009). *Gender*. Cambridge and Malden, Mass: Polity.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE Publications.

Creswell, J. W., & Clark, V. P. (2011). *Mixed methods research*. SAGE Publications.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.

Creswell, J. W., Clark, V. L. P., Gutmann, M. L., & Hanson, W. E. (2003). ADVANCED MIXED. *Handbook of mixed methods in social & behavioral research*, *209*.

Cundiff, J. L., Vescio, T. K., Loken, E., & Lo, L. (2013). Do gender–science stereotypes predict scienceidentification and science career aspirations among undergraduate science majors? *Social Psychology Education*, *16*, 541-554.

Cvencek, D., Meltzoff, A.N. & Greenwald, A.G. (2011), “Math-gender stereotypes in elementary school children”, *Child Development, 82*(3), 766-779.

Dallal, A. (2010). *Islam, science, and the challenge of history*. Yale University Press

Dasgupta, N. & Stout, J. G. (2014), “Girls and women in science, technology, engineering, and mathematics: stemming the tide and broadening participation in STEM careers”, *Policy Insights from the Behavioral and Brain Sciences, 1*(1), 21-29.

David, E. S., Shapiro, C., Toma, S., Sayson, H. W., Levis-Fitzgerald, M., Johnson, T., & Sork, V. L. (2018). Creating inclusive classrooms by engaging STEM faculty in culturally responsive teaching workshops. *International Journal of STEM Education*, *7*, 1-15.

David, M. E. (2011). Overview of researching global higher education: Challenge, change or crisis? *Contemporary Social Science, 6*(2), 147-163.

Dawson, C. (2019). *Introduction to research methods 5th edition: A practical guide for anyone undertaking a research project*. Robinson.

DeBoer, G. (1991). *A history of ideas in science education: Implications for practice*. Teachers College Press.

Deemer, E. D., Thoman, D. B., Chase, J. P., & Smith, J. L. (2014). Feeling the threat: Stereotype threat as a contextual barrier to women's science career choice intentions. *Journal of Career Development, 41*, 141–158. http://dx.doi.org/10.1177/0894845313483003

Di Bella, L. & Richard, J. Crisp, R. J. (2016). Women's adaptation to STEM domains promotes resilience and a lesser reliance on heuristic thinking. *Group Processes & Intergroup Relations, 19*(2), 184–201.

Diekman, A.B., Brown, E.R., Johnston, A.M. & Clark, E.K. (2010), "Seeking congruity between goals and roles: a new look at why women opt out of science, technology, engineering, and mathematics careers". *Psychological Science, 21*(8), 1051-1057.

Dillon, J., Wals, A. E., Neo, L. S., & Freilich, J. D. (2000). On the dangers of blurring methods, methodologies and ideologies in environmental education research. In *Towards a Convergence between Science and Environmental Education* (pp. 113-124). Routledge.

Eagleman, D. (2015). *The brain: The story of you*. Random House.

Eccles, J. S. (1994). Understanding women's educational and occupational choices. *Psychology of Women Quarterly, 18,* 585– 609. http://dx.doi.org/10.1111 /j.14716402.1994.tb01049.x

Eccles, J. S., Barber, B., & Jozefowicz, D. (1999). Linking gender to educational, occupational, and recreational choices: Applying the Eccles et al. model of achievement-related choices. In W. B. Swann, Jr., J. H. Langlois, & L. A. Gilbert (Eds.), *Sexism and stereotypes in modern society: The gender science of Janet Taylor Spence* (pp. 153–192). American Psychological Association. https://doi.org/10.1037/10277-007

Ehrlinger, J., & Dunning, D. (2003). How chronic self-views influence (and potentially mislead) estimates of performance. *Journal of Personality and Social Psychology*, *84*(1), 5.

El-Bizri, N. (2005). A philosophical perspective on Alhazen's optics. *Arabic Sciences and Philosophy*, *15*, 189–218.

Eminah, J. K. (2006). A survey of perceived hindrances to junior secondary school science teaching. *African Journal of Educational Studies in Mathematics and Sciences.*

Enlightenment (2018, October 1). In Encyclopædia Britannica online. Retrieved from https://www.britannica.com/event/Enlightenment-European-history

Erinosho, S. (Ed.). (1994). *Perspectives on women in science and technology in Nigeria*. Bookman

Etzkowitz, H., Kemelgor, C., & Uzzi, B. (2000). *Athena unbound: The advancement of women in science and technology, chap. 8*. Cambridge University Press.

Etzkowitz, H., Kemelgor, C., Neuschatz, M., Uzzi, B., & Alonzo, J. (1994). The paradox of critical mass for women in science. *Science*, *266*, 51–54. https://doi.org/10.1126/science.7939644

European Commission (2012). Meta-analysis of gender and science research: A synthesis report. Publications Office of the European Union.

Faulkner, W. (2000). Dualism, hierarchies and gender in engineering. *Social Studies of Science*, *30*(5), 759-792.

Fide, S. (2013). Cumulative negativity: Reasons for women faculty departure from one research institution. *Journal of Higher Education Management*, *28*(1), 148-165.

Fiske, S. T. (2010). *Social beings: Core motives in social psychology*. Wiley.

Fiske, S. T., & Markus, H. R. (2012). *Facing social class: How societal rank influences interaction*. Russell Sage Foundation.

Fowlkes, M. R. (1987). Role combinations and role conflict: Introductory perspective. In F. J. Crosby (Ed.), *Spouse, parent, worker: On gender and multiple roles*. Yale University.

Friedman, T. L. (2007). *The world is flat, 3.0: A brief history of the twenty-first century*. Picador / Farrar, Straus, and Geroux.

Fuegi, J. & Francis, J, (2003). Lovelace & Babbage and the creation of the 1843 'notes.' *IEEE Annals of the History of Computing*, *25*(4), 16-26

Gable, R.K. & Wolf, M.B. (1993): *Instrument Development in the Affective Domain*. Kluwer Academic Publishers.

Gal, I. & Ginsburg, L. (1994). The role of beliefs and attitudes in learning statistics: Towards an assessment framework. *Journal of Statistics Education*, *2*(2).

Retrieved August 23, 2007, from http://www.amstat.org/publications/jse/v2n2/gal.html

Gelernter, D. (1999). *Women and science at Yale*. The Weekly Standard. Retrieved from http://www.weeklystandard.com/women-andscience-at-yale/article/11423

Gilbert, A. F. (2009). Disciplinary cultures in mechanical engineering and materials science: Gendered/gendering practices. *Equal Opportunities International, 28*(1), 24-35.

Gist, M. E., & Mitchell, T. R. (1992). Self-efficacy: A theoretical analysis of its determinants and malleability. *Academy of Management Review, 17*, 183–211.

Gonzalez, H. B. & Kuenzi, J. J. (2012). *Science, technology, engineering, and mathematics: A primer* (CRS Report No. R42642). Retrieved from Congressional Research Service website: https://fas.org/sgp/crs/misc/R42642.pdf

Gottlieb, B. H. (1979). The primary group as supportive milieu: Applications to community psychology. *American Journal of Community Psychology, 7*(5), 469-480. https://doi.org/10.1007/bf00894044

Grant, L., Kennelly, I., Kathryn, B., & Ward, K.W. (2000). Revisiting the marriage, motherhood and productivity puzzle in scientific research careers. *Women's Studies Quarterly, 38*(1– 2), 62–85.

Gray, J. A. (1981). A critique of Eysenck's theory of personality. In *H. J. Eysenck (Ed.), A model for personality*. 246–276. Springer. https://doi.org/10.1007/978-3-642-67783-0.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis, 11*(3), 255-274.

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Educational Reviews, 29*(6), 911-922.

Hall, R. M., & Sandler, B. R. (1982). The classroom climate: A chilly one for women? Association of American Colleges. http://eric.ed.gov/?id= ED215628

Hango, D. (2013). Gender differences in science, technology, engineering, mathematics and computer science (STEM) programs at university, 1-11. Catalogue no. 75-006-X ISSN 2291-0840. Retrieved from http://www.statcan.gc.ca/pub/75-006- x/2013001/article/11874-eng.htm

Hartness, K. (2011). Working to change perceptions. *Journal of Computing Sciences in Colleges, 26*(5), 259–267. Retrieved from https://dl.acm.org/citation.cfm?id=1961629

Hayes, A. R., & Bigler, R. S. (2013). Gender-related values, perceptions of discrimination, and mentoring in STEM graduate training. *International Journal of Gender, Science, and Technology 5*(3), 254.

Heller, R. S., Beil, C., Dam, K., & Haerum, B. (2010). Student and faculty perceptions of engagement in engineering. *Journal of Engineering Education, 99*(3), 253-261.

Herrera, F. A., Hurtado, S., Garcia, G. A., & Gasiewski, J. (2012). A model for redefining STEM identity for talented STEM graduate students. In *American Educational Research Association Annual Conference*. University of California.

Herrera, R., Duncan, P.A., Green, M.T. & Skaggs, S.L. (2012), "The effect of gender on leadership and culture", *Global Business and Organizational Excellence, 31*(2), 37-48.

Herz, B., Subbrarao, K., Habi, M., & Raney, L. (1991). *Letting girls learn: Promoting approaches in primary and secondary education*. Discussion Paper 133. World Bank.

Hill, Catherine. (2010). *Why so few? Women in Science, Technology, Engineering, and Mathematics*. AAUW

Hills, P., & Shallis, M. (1975). Scientists and their images. *New Scientist, 67*, 471– 475

Holth, L. & Mellström, U. (2014). Revisiting engineering, masculinity and technology studies: Oldstructures with new openings. *International Journal of Gender, Science and Technology, 3*(2), 313-329.

Hornblower, S. (1983). *The Greek world 479–323 BC*. Methuen

Idovz, C. A. (2018). Implicit gender bias, engagement, and protective factors in STEM faculty. *ADVANCE Journal, 1*(1).

Igho, M. (2017). Engaging biomedical engineering in health disparities challenges. *Journal of Community Medicine & Health Education, 8*(2).

Ikart, E. M. (2019). Survey questionnaire survey pretesting method: An evaluation of survey questionnaire via expert reviews technique. *Asian Journal of Social Science Studies, 4*(2), 1.

Inweregbuh, O. C. (2015). Assessment of students' creative thinking ability in mathematical tasks at senior secondary school level. *International Journal of Curriculum and Instruction, 12*(2), 494-506.

Isaacson, W. (2017). *Leonardo da Vinci*. Simon and Schuster.

ITEEA. (2019). International Technology and Engineering Educators Association standards. Retrieved from https://www.iteea.org/39197.aspx

Jassawalla, A. R., & Sashittal, H. C. (2006). Collaboration in cross-functional product innovation teams. In M. Beyerle (Ed.), *Innovation through Collaboration*

Johnson, A. C. (2007). Unintended consequences: How science professors discourage women of color. *Science Education, 91*(5), 805–821. http://doi.org/10.1002/sce.2020

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14-26.

Jones, M. G., Brader-Araje, L., Carboni, L. W., Carter, G., Rua, M. J., Banilower, E., & Hatch, H. (2000). Tool time: Gender and students' use of tools, control and authority. *Journal of Research in Science Teaching, 37*, 760-783.

Kennedy, P. (1987). T*he rise and fall of the great powers: Economic change and military conflict from 1500 to 2000*. Vintage Books.

Kessels, U. (2015). "Bridging the gap by enhancing the fit: how stereotypes about STEM clash with stereotypes about girls", *International Journal of Gender, Science and Technology*, *7*(2), 280-296.

Koenig, A. M. & Eagly, A. H. (2014). "Evidence for the social role theory of stereotype content: observations of groups' roles shape stereotypes", *Journal of Personality and Social Psychology*, *107*(3). 371.

Konrad, A.M., Ritchie, J.E. Jr, Lieb, P. & Corrigall, E. (2000), "Sex differences and similarities in job attribute preferences: a meta-analysis", *Psychological Bulletin*, *126*(4). 593.

Kouassi, A. (2016). Why Africa needs female scientists. Retrieved from:http://www.mastercardfdn.org/why-africa-needs-female-scientists

Kouzes, J. M., & Posner, B. Z. (2012). *The leadership challenge* (6th ed.). John Wiley& Sons.

Kuhn, D. (2009). *The age of Confucian rule: The Song transformation of China*. Harvard University Press.

Kuhn, T. S. (1962). A rationale for mixed methods (integrative) research programmes in education. *Journal of Philosophy of Education*, *42*(2), 287-305.

Kuhn, T. S. (1970). *The road since structure: philosophical essays, 1970-1993, with an autobiographical interview*. University of Chicago Press.

Kusi, H. (2012). *Doing qualitative research, a guide for researchers*. Emmpong Press.

Kwaramba, M. & Mukanjari, S. (2013). The quest for gender equity through internationalisation strategiesat higher education institutions in the Western Cape, South Africa. In C. Sehoole & J. Knight (Eds), *Internationalisation of*

African higher education: Towards achieving the MDGs, (pp. 53-72). Sense Publishers.

LaCosse, J., Sekaquaptewa, D., & Bennett, J. (2016). STEM stereotypic attribution bias among women in an unwelcoming science setting. *Psychology of Women Quarterly*, 1-20.

Lake, K. (1994). *Integrated curriculum.* Retrieved from www.curriculumassociates.com/ professionaldevelopment/topics/Integrated Curriculum/extras/lesson1/ReadingLesson1.pdf

Lambert, M., Perrino, E. S. & Barreras, E. S. (2012). Understanding the barriers to female education in Ghana. Retrieved from www.bluekitabu.org/bluekitabu.../ understanding_the_barriers_.pdf

Lamborn et al., (1992*). Student engagement in academic work.*

Leaper, C. (2014), "Parents' socialization of gender in children", Encyclopedia on Early Childhood Development, available at: http://www.child-encyclopedia.com/gender earlysocialization/ according-experts/parents-socialization-gen-der-children.

Leaper, C., Farkas, T. & Brown, C.S. (2011), "Adolescent girls' experiences and gender-related beliefs in relation to their motivation in math/science and English". *Journal of Youth and Adolescence, 41*(3). 268-282.

Lee, H., & Pollitzer, E. (2016). *Gender in science and innovation as component of inclusive socioeconomic growth*. Portia Ltd.

Leggon, C. B. (2006). Women in science: Racial and ethnic differences and the differences they make. *Journal of Technology Transfer, 31*, 325-333.

Leifer, C., Kress-Gazit H., Weeden K., Meulen M. C. H. V. D., Clancy, P., & Sassler S. (2015). The truth about discrimination in science, from six female professors. Retrieved from https://qz.com/473961/the truth-about-discrimination-in-sciencefrom-six-female-professors

Leney, K. (2003). D*ecolonization, independence and the politics of higher education in West Africa.* The Edwin Mellen Press.

Leslie, S. J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, *347*, 262–265. http://dx.doi.org/10.1126/science.1261375

Livio, M. (2003). The golden ratio: *The story of phi, the world's most astonishing number*. Broadway Books.

Loewus, L. H. (2015, April 2). Education Week, when did science education become STEM? [Web log post]. Retrieved from http://blogs.edweek.org/edweek/ curriculum/2015/04/when_did_science_education_become_STEM.html

London, B., Rosenthal, L., & Gonzalez, A. (2011). Assessing the role of gender rejection sensitivity, identity, and support on the academic engagement of women in nontraditional fields using experience sampling methods. *Journal of Social Issues, 67*(3), 510 – 530

Lundgren, L. E., & Prah, R. (2009). African feminist academia: towards a militant enterprise for feminist scholarship in Africa. *Gender and Behaviour*, *16*(1), 10863-10873.

Lundgren, N., & Prah, M. (2010). Disappearing dodos? Reflections on women and academic freedom based on experiences in Ghana and the United States. In S. Arnfred & A. A. Ampofo (Eds.), *African feminist politics of knowledge: Tensions, challenges and possibilities*. Nordic Africa Institute.

M. G., & Wood, W. (2010). "Self-regulation of gendered behavior in everyday life." *In Sex Roles, 62,* 635-646. doi:10.1007/s11199-010-9761-y

Magwa, S. & Magwa, W. (2015). *A guide to conducting research: a student handbook.* Strategic Book Publishing.

Mama, A. (2011). Rethinking African universities: Gender and transformation. Retrieved from http://www.barnard.edu/sfonline/africana/mama_01.htm#text1

Mama, A., & Barnes, T. (2007). Rethinking universities. *Feminist Africa, 8*(1), 7

Manuh, T., Gariba, S., & Budu, J. (2007). *Change and transformation in Ghana's publicly funded universities: A Study of Experiences, Lessons and Opportunities*. James Curry

Maranto, C. L., & Griffin, A. E. (2011). The antecedents of a 'chilly climate' for women faculty in higher education. *Human Relations, 64*(2), 139-159. https://doi.org/10.1177/0018726710377932

Marginson, S., Tytler, R., Freeman, B., & Roberts, K. (2013). *STEM: Country comparisons.* Australian Council of Learned Academies

Markus, H. R., & Conner, A. L. (2014). *Clash!: 8 cultural conflicts that make us who we are*. Penguin.

Markus, H. R., & Hamedani, M. G. (2007). Sociocultural psychology: The dynamic interdependence among self-systems and social systems. In S. Kitayama & D. Cohen (Eds.), *Handbook of cultural psychology* (pp. 3– 46). New York, NY: Guilford Press.

Master, A. & Meltzoff, A. (2016), "Building bridges between psychological science and education: cultural stereotypes, STEM, and equity", *Prospects, 46*(2) 215-234.

Master, A., Cheryan, S. & Meltzoff, A.N. (2016), "Computing whether she belongs: stereotypes undermine girls' interest and sense of belonging in computer science". *Journal of Educational Psychology*, *108*(3). 424-437.

Matskewich, H. E., & Cheryan, S. (2016). *Comparing stereotypes and attitudes across STEM fields* [data files and codebooks]. Retrieved from osf.io/6gmn5

Maxcy, S. J. (2003). Pragmatic threads in mixed. *Handbook of Mixed Methods in Social & Behavioral Research*, *51*.

Mbow, P. (2000). Academic freedom and the gender issue: A report from Senegal. In E. Sall (Ed.), *Women in academia: Gender and academic freedom in Africa* (pp. 64 78). CODESRIA

McComas W. F. (2014). STEM: Science, technology, engineering, and mathematics. In W. F. McComas (Ed.), *The language of science education* (pp. 102-103). SensePublishers. doi: https://doi.org/10.1007/978-94-6209-497- 0_92

McEwen, B. (2013). How interests in science and technology have taken women to an engineering career. *Asia-Pacific Forum on Science Learning and Teaching*, *14*(1), 1-23.

McMillan, J. H., & Schumacher, S. (2010). *Research in Education: Evidence-Based Inquiry, My Education Lab Series*. Pearson.

Merrillin, J. F. (2009). Intersectionality and STEM: The role of race and gender in the academic pursuits of African American women in STEM. *Journal of Progressive Policy & Practice*, *2*(3), 273-293.

Meyer, G. R., & Penfold, D. M. (1961). Factors associated with interest in science. *British Journal of Educational Psychology*, *31*, 33–37.

Miller, M. (2015). *The Internet of things: How smart TVs, smart cars, smart homes, and smart cites are changing the world*. Que Publishing.

Ministry of environment, science technology and innovation (2017). *Policy on science technology education*. Retrieved from https://mesti.gov.gh.

Mirahmadizadeh, A., Delam, H., Seif, M., & Bahrami, R. (2018). Designing, constructing, and analyzing Likert scale data. *Journal of Education and Community Health*, *5*(3), 63-72.

Mlambo, Y. A., & Mabokela, R. O. (2016). It's more flexible: Persistence of women engineers in the academy. *European Journal of Engineering Education*, *42*(3), 1-15.

Moeller, J., Salmela-Aro, K., Lavonen, J. & Schneider, B. (2014). Does anxiety in science classrooms impair math and science motivation? *International Journal of Gender, Science and Technology*, *7*(2), 126.

Montuschi, E. (2014). Scientific Objectivity. In N. Cartwright and E. Montuschi (Eds.). *Philosophy of social science: A new introduction*. Oxford: Oxford University Press (Chapter 7) 123-144.

Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research*, *1*(1), 48-76.

Morgan, D. L. (2014). Pragmatism as a paradigm for social research. *Qualitative Inquiry*, *20*(8), 1045-1053.

Morganson, V. J., Jones, M. P., & Major, D. A. (2010). Understanding women's underrepresentation in science, technology, engineering, and mathematics: The role of social coping. *The Career Development Quarterly*, *59*(2), 169-179

Morimoto, S., Zajicek, A., Hunt, V., & Lisnic, R. (2013). Beyond binders full of women: NSF Advance and initiatives for institutional transformation. *Sociological Spectrum*, *33*(5), 397-415.

Morley, L. (2010). Gender mainstreaming: Myths and measurement in higher education in Ghana and Tanzania. *Compare*, *40*(4), 533-550.

Morse, J. M. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research*, *40*(2), 120-123.

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences*, *109*(41), 16474–16479.

Mujawamariya, D., Boucher, M., Mavriplis, C. (2014). Comment intéresser les filles aux STIM?. Mujawamariya, D. & Sethna, C. (2005). L'Université d'Ottawa à l'égard des défis de l'équité en emploi et en éducation. *Éducation et Francophonie*, *33*(1) ,105-123.

Multon, K. D. (2002). Development of the distance from privilege measures: A tool for understanding the persistence of talented women in STEM. *Journal of Psychoeducational Assessment*, *30*(1), 88-102.

Murray, S. L., Meinholdt, C., & Bergmann, L. S. (1999). Addressing gender issues in the engineering classroom. *Feminist Teacher*, *12*(3), 169–183

Nardi, P. M. (2018). *Doing survey research: A guide to quantitative methods*. Routledge.

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. Department of Education.

National Council for Tertiary Education (2014). Summary of basic statistics on public colleges of education 2012/2013. Retrieved from http://ncte.edu.gh/.

National Research Council. (1995). *National science education standards*. National Academy Press.

National Research Council. (1996). *From analysis to action: Undergraduate education in science, mathematics, engineering, and technology*. National Academy Press

National Science Foundation & U.S. Department of Education. (1980). *Science and engineering education for the 1980's and beyond.* The National Science Foundation.

National Science Foundation. (1996). *Shaping the future: New expectations for undergraduate education in science, mathematics, engineering, and technology*. Report by the Advisory Committee to the National Science Foundation Directorate for Education and Human Resources.

National Science Teachers Association, (2019). *NSTA position statement: The Next Generation Science Standards*. Retrieved from https://www.nsta.org/about/positions/ngss.aspx

NGSS Lead States. (2013). *Next generation science standards: For states, by states.* National Academies Press.

Nicholls, C. M., & Ormston, R. (Eds.). (2013). *Qualitative research practice: A guide for social science students and researchers*. sage.

Ofori, E., & Sampson, G. S., (2012). The effects of agricultural cooperatives on smallholder livelihoods and agricultural performance in Cambodia. In *Natural Resources Forum* (Vol. 43, No. 4, pp. 218-229). Blackwell Publishing Ltd.

Ofosu-Mireku, J. (2004). *One of the guys: Ghanaian women engineers and scientists* (Order No. NQ96864). Available from ProQuest Dissertations & Theses Global. (305084495). Retrieved from http://libproxy.txstate.edu/login?url =http://search. proquest.com/docview/305084495?accountid=5683

Olitsky, S. (2006). Facilitating identity formation, group membership, and learning in science classrooms: What can be learned from out-of-field teaching in an urban school? *Science Education, 91,* 201-221. doi10.1002/sce.20182

Oloka-Onyango, J. (1992). The legal control of tertiary institutions in East Africa: The case of Makerere University', WWA Africa Development.

Olorundaw, A. C. (2010). Gender gap in science and technology education in Nigeria. *International Journal of Education and Evaluation*, *5*(3), 6-13.

Opeyinka, J., Cohen, L., & Mallon, M. (2017). Constructing Scientific Careers: Change, Continuity and Context. *Organization Studies*, *27*(8), 1131–1151. https://doi.org/10.1177/0170840606064105

Page-Bucci, H. (2003). *The value of Likert scales in measuring attitudes of online learners.* Retrieved August 20,2007 from http://www.hkadesinbns.co.uk/ websites/msc/reme/likert.htm

Pajares, F. (2005). Gender differences in mathematics self-efficacy beliefs. In A. M. Gallagher & J. C. Kaufman (Eds.), *Gender differences in mathematics: An integrative psychological approach* (pp. 294–315). Cambridge University Press.

Pandor, N. (2011). *South Africa must attract more women to science*. Retrieved from:http://www.scidev.net/global/education/opinion/south-africa-must-attract-morewomentoscience-1.htm

Pattern, M. L., & Newhart, M. (2017). *Understanding research methods: an overview of the essentials*. Taylor and Francis.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. SAGE Publications, Inc.

Petrina, S. (2007). *Advanced teaching methods for the technology classroom.* Information Science Publishing. doi: 10.4018/978-1-59904-337-1.ch009

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology*, *95*, 667–686.

Plonsky, L. D. (2017). Quantitative research methods. *In the Routledge handbook of instructed second language acquisition* (505-521). Taylor and Francis I

Plurkman, A. L. (2015). Engaging Foucault to better understand underrepresentation of female STEM faculty. In *2013 ASEE Annual Conference & Exposition*, 23-489.

Potter, D. S. (2006). *A companion to the Roman Empire*. Blackwell.

Prah, M. (2002). Gender issues in Ghanaian tertiary institutions: Women academics and administrators at Cape Coast University. *Ghana Studies*, *1*, 1-53.

Prentice, D. A., & Carranza, E. (2002). What women and men should be, shouldn't be, are allowed to be, and don't have to be: The contents of prescriptive gender stereotypes. *Psychology of Women Quarterly*, *26*, 269 –281. http://dx.doi.org/10.1111/1471-6402.t01-1 00066

Prentice, D. A., & Miller, D. T. (1996). Pluralistic ignorance and the perpetuation of social norms by unwitting actors. *Advances in Experimental Social Psychology*, *28*, 161–209. http://dx.doi.org/10.1016/ S0065-2601(08)60238-5

Quimby, J. L., & DeSantis, A. M. (2006). The influence of role models on women's career choices. *Career Development Quarterly*, *54*(4), 297-306.

Rambaree, K. & Knez, I. (2016). “Effects of ethnicity and gender on youth health”, *Cogent Social Sciences*, *2*(1), 1186136.

Rathgeber, E. M. (2003). Women universities and university-educated women: The current situation in Africa. In D. Teferra & P. G. Altbach (Eds.), *African higher education: An international reference handbook* (pp. 82-92). Indiana University Press.

Ravitch, D. (2010). *The death and life of the great American school system: How testing and choice are undermining education*. Basic Books

Reed, P. A. (2018). Reflections on STEM, standards, and disciplinary focus. *Technology & Engineering Teacher, 77*(7), 16-20.

Reid, E. (2012). *The thriving child: Parenting successfully through allergies, asthma and other common challenges*. Center Street Hachette Book Group.

Reihl-Sisca, S. J. (1989). Long-Term Care: Is There Still A Role for Nursing?. *Residential versus Community Care: The Role of Institutions in Welfare Provision*, 166-184.

Reinking, A. & Martin, B. (2018). “The gender gap in STEM fields: theories”. *Movements and Ideas to Engage Girls in STEM*, *7*(2), pp. 2254-7339

Rhodes, P. J. (2006). *A history of the classical Greek world: 478–323 BC*. Blackwell history of the ancient world. Blackwell.

Ridgeway, C. L. (2001). Gender, status, and leadership. *Journal of Social Issues, 57*, 637– 655. http://dx.doi.org/10.1111/0022-4537.00233

Robson, C. (2002). Real world research: *a resource for social scientists and practitioner researchers* (2nd Ed.). Blacwell Publishers.

Rosenkrantz, P., Vogel, S., Bee, H., Broverman, I., & Broverman, D. M. (1968). Sex-role stereotypes and self-concepts in college students. *Journal of Consulting and Clinical Psychology, 32*(3), 287–295.

Rosenthal, L., London, B., Levy, S. R., & Lobel, M. (2011). The roles of perceived identity compatibility and social support for women in a single-sex STEM program at a coeducational university. *Sex Roles, 65*(9), 725-736. https://doi.org/10.1007/s11199-011-9945-0

Rosser, S. V., & Taylor, M. Z. (2009). Why we are still worried about women in science? *Academe, 95*(3), 327-346.

Roy, A. Mujawamariya, D. & Lafortune, L. (dir.). (2014). Des actions pédagogiques pour guider les filles et les femmes en STIM: Sciences, technos, ingénierie et maths, (p. 91-102). Québec, Presses de l’Université du Québec.

Rudman, L.A., Ashmore, R. D., & Gary, M. L. (2001). "Unlearning" automatic biases: The malleability of implicit stereotypes and pre-judice. *Journal of Personality and Social Psychology, 81*,856–868

Ryan, R. M., & Deci, E. L, (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*, 54-67.

Sadker, D., Sadker, M., & Zittleman, K. M. (2009). *Still failing at fairness: How gender bias cheats girls and boys in school and what we can do about it*. Simon & Schuster

Salinger, G. & Zuga, K. (2009). Background and history of the STEM movement. The overlooked STEM imperatives: *Technology and Engineering*, 4-9

Salkind, N. J. (2017). *Tests & measurement for people who (think they) hate tests & measurement*. Sage Publications.

Salman M., & Ademi, L. (2012). Underrepresented faculty play a disproportionate role in advancing diversity and inclusion. *Nature Ecology & Evolution*, *3*(7), 1030–1033. https://doi.org/10.1038/s41559-019-0911-5

Salman M., & Ademi, L. (2015). Improving student learning and engagement in stem disciplines using team-based learning. *Proceedings of the Australian Conference on Science and Mathematics Education (Formerly UniServe Science Conference).*

Sambo, S. I., Sule, B., Oche, O. M., Gana, G. J., Yahaya, M., Khalid, I., & Bello, M. A. (2018). *Teachers improvement of mathematics achievements in rural schools of Mopani District: implications for professional development* (Doctoral dissertation).

Sanders, M. (2009). STEM, STEM education, STEMmania. *The Technology Teacher, 68*(4), 20-26.

Sans, V. (2016). Towards dial-a-molecule by integrating continuous flow, analytics and self-optimisation. *Chemical Society Reviews*, *45*(8), 2032-2043.

Savigny, H. (2014). Women, know your limits: cultural sexism in academia. *Gender and Education*, *26*(7), 794–809.https://doi.org/10.1080/09540253.2014.970977

Schulze, S., & van Heerden, M. (2015). Learning environments matter: Identifying on the motivation to learn science. *South African Journal of Education*, *35*(2), 1-9.

Schunk, D.H. & Pajares, F. (2002). "The development of academic self-efficacy", In Wigfield, A. and Eccles, J.S. (Eds), *Development of Achievement Motivation,* 15-31.

Senadza, B. (2012). Education inequality in Ghana: Gender and spatial dimensions. *Journal of Economic Studies, 39*(6), 724–739, https://doi.org/10.1108/01443581211274647

Severiens, S. & Ten Dam, G. (2012). "Leaving college: a gender comparison in male and female dominated programs", *Research in Higher Education, 53*(4), 453-470.

Seymour, E. (1995). The loss of women from science, mathematics, and engineering undergraduate majors: An explanatory account. *Science Education*, *79*, 437–473.

Seymour, E., & Hewitt, N. M. (1997). Talking about leaving: Why undergraduates leave the sciences. Westview Press

shanghugly, M. R. (2013). A Campus-Wide Study of STEM Courses: New Perspectives on Teaching Practices and Perceptions. *CBE—Life Sciences Education*, *13*(4), 624–635. https://doi.org/10.1187/cbe.14-06-0108

Sherman, J. (1979). Predicting mathematics performance in high school girls and boys. *Journal of Educational Psychology*, *71*(2), 242.

Shikongo, A. N. (2010). *Biology teachers' views and attitudes towards practical work in the Khomas region, Namibia* (Doctoral dissertation, Stellenbosch University).

Shin, J., Lee, H., McCarthy-Donovan, A., Hwang, H., Yim, S., & Seo, E. (2015). Home and motivational factors related to science-career pursuit: Gender differences and gender similarities. *International Journal of Science Education*, *37*(9), 1478-1503.

Silverman, D. (2015). *Interpreting qualitative data*. Sage.

Smith, D. A., (2005). Asian Americans and cancer clinical trials: A mixed-methods approach to understanding awareness and experience. *Cancer*, *104*(S12), 3015-3024.

Smith, J. L., Handley, I. M., Zale, A. V., Rushing, S., & Potvin, M. A. (2015). Now hiring! Empirically testing a three-step intervention to increase faculty gender diversity in STEM. *BioScience*, *65*(11), 1084-1087.

Spelke, E. S. (2005). Sex differences in intrinsic aptitude for mathematics and science?: A critical review. *American Psychologist, 60,* 950 –958. http://dx.doi.org/10.1037/0003-066X.60.9.950

Springer, L. & Stanne, M. E. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of Educational Research, 69*(1), 21-51.

Stake, R. E. (2006). *Multiple case study analysis*. The Guilford Press.

Stephens, N. M., & Levine, C. S. (2011). Opting out or denying discrimination? How the framework of free choice in American society influences perceptions of gender inequality. *Psychological Science, 22*, 1231–1236. http://dx.doi.org/10.1177/0956797611417260

Stephens, N. M., Fryberg, S. A., Markus, H. R., Johnson, C. S., & Covarrubias, R. (2012). Unseen disadvantage: How American universities' focus on independence undermines the academic performance of first-generation college students. *Journal of Personality and Social Psychology, 102*, 1178 – 1197. http://dx.doi.org/10.1037/a0027143

Stephens, N. M., Markus, H. R., & Fryberg, S. A. (2012). Social class disparities in health and education: Reducing inequality by applying a sociocultural self model of behavior. *Psychological Review, 119*, 723– 744. http://dx.doi.org/10.1037/a0029028

Stoilescu, D. & Egodawatte, G. (2010). Gender differences in the use of computers, programming, and peer interactions in computer science classrooms. *Computer Science Education*, *20*(4), 283–300. http://dx.doi.org/10.1080/08993408.2010.527691

Stoilescu, D. & McDougall, D. (2011). Gender digital divide and challenges in undergraduate computer science programs. *Canadian Journal of Education 34*(1), 308-33.

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, *100*(2), 255-270. https://doi.org/10.1037/a0021385

Stowell, S. M. (2005). Transforming graduate training in STEM education. *The Bulletin of the Ecological Society of America*, *96*(2), 317-323.

Sturm, S. (2006). The architecture of inclusion: Advancing workplace equity in higher education. *Harv. JL & Gender, 29*, 247.

Sulaiman, N. F. & AlMuftah, H. (2010). A Qatari perspective on women in the engineering pipeline: an exploratory study. *European Journal of Engineering Education, 35*(5), 507- 517.

Sulaiman, Z., Welsh, A., Masek, A. & Campbell, A. (2018). A Review of Themes and Promising Practices in STEM-based Work in Equity, Diversity, and Inclusion.

Syed, M., & Chemers, M. M. (2011). Ethnic minorities and women in STEM: Casting a wide net to address a persistent social problem. *Journal of Social Issues, 67*(3), 435-441.

Tamale, S. & Oloka-Onyango, J. (1997). "Bitches" at the academy: Gender and academic freedom in Africa. In E. Sall (Ed.), *Women in academia: Gender and academic freedom in Africa* (pp. 1-23). CODESRIA

Tamale, S. & Oloka-Onyango, J. (2000). "Bitches" at the academy: Gender and academic freedom in Africa. In E. Sall (Ed.), *Women in academia: Gender and academic freedom in Africa* (pp. 1-23). CODESRIA.

Tashakkori, A., & Creswell, J. W. (2007). Exploring the nature of research questions in mixed methods research. *Journal of Mixed Methods Research*, *1*(3), 207-211.

Tashakkori, A., & Teddlie, C. (eEds.). (2010). *Sage handbook of mixed methods in social and behavioural research*. Sage Publications.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2,* 53–55.

Taylor-Powell, E., & Renner, M. (2003). *Analysing qualitative data*. Available at: http://learningstore.uwex.edu/assets/pdfs/g3658-12.pdf (Accessed 20 May 2016).

Technology (2018, May 17). In Encyclopædia Britannica online. Retrieved from https://www.britannica.com/technology/technology

Teddlie, C., & Tashakkori, A. (2011). Mixed methods research. *The sage handbook of qualitative research*, *4*, 285-300.

Tembasi, A. (2022). *Scientist prioritises research that impacts communities*. University World News, Africa Edition.

Tredoux, C., & Durrheim, M. (2013). Transformative mixed methods research in South Africa: Contributions to social justice. *Transforming research methods in the social sciences: Case studies from South Africa*, 303-316.

UNESCO (2015). Improving access to engineering careers for women in Africa and in the Arab States. Retrieved from http://www.unesco.org/new/en/natural sciences/science technology/engineering/infocus-engineering/women-andengineering-in-africa-and-in-the-arab-states/

UNESCO (2013). Promoting women in science in Africa. Retrieved from http://www.unesco.org/new/en/natural-sciences/science technology/stipolicy/africa/promoting-women-in-science-in-africa/

UNESCO. (2007). Science, technology, and gender: An international report. Author.

UNESCO. (2017). Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM). Author.

UniRank (2005-2023). https://www.4cu.org> Africa> Ghana.

Urban, W. J. & Wagoner Jr., J. L. (2004). *American education: A history* (3rd ed.). McGraw Hill

Van Allen, J. (1976). African women in "modernization" and national liberation. In L. Iglitzin and R. Ross (Eds), *Women in the World: A comparative study* (pp 30-41). Clio Press.

Van den Brink, M., Benschop, Y., & Jansen, W. (2010). Transparency in academic recruitment: A problematic tool for gender equality? *Organization Studies, 31*, 1459–1483.

van der Vleuten, M., Steinmetz, S. and van de Werfhorst, H. (2018). "Gender norms and STEM: the importance of friends for stopping leakage from the STEM pipeline". *Educational Research and Evaluation, 24*(6), 417-436.

Vogt, W. P. (1999). *Dictionary of statistics and methodology*. Thousand Oaks.

Wasasu, Y. J., (2019). Gender disparity in STEM disciplines: A study of faculty attrition and turnover intentions. *Research in Higher Education, 49*, 607-624.

Wang, J., Hong, H., Ravitz, J., & Ivory, M. (2015). Gender differences in factors influencing pursuit of computer science and related fields. *Proceedings of the 2015 ACM Conference on Innovation and Technology in Computer Science Education*, 117–122. http://dx.doi.org/10.1145/2729094.2742611

Ward, K., & Bensimon, E. M. (2002). Engendering socialization. In K. Renn & A. Martinez Aleman (Eds.), *Women in higher education: An encyclopedia* (pp. 431–434). ABC-CLIO.

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

Watt, H. M., Richardson, P. W., & Devos, C. (2012). (How) does gender matter in the choice of a STEM teaching career and later teaching behaviours? *International Journal of Gender, Science and Technology, 5*(3), 187-206

Welman, J., & Kruger, S. (2001). *Research methodology for the business and administrative sciences*. Oxford University Press.

White House. (2009). President Obama launches "Educate to Innovate" campaign for excellence in science, technology, engineering & math (STEM) education. Retrieved from https://obamawhitehouse.archives.gov/the-press-office/presidentobama-launches-educate innovate-campaign-excellence-science-technology-e

White, D. W. (2014). What is STEM education and why is it important? *Florida Association of Teacher Educators Journal, 1*(14), 1-9.

Williams, J. (2000). How the tenure track discriminates against women. Chronicle of Higher Education. Retrieved from https://www.chronicle.com/ article/How-the-Tenure-Track/46312

Witt, M. G., & Wood, W. (2010). "Self-regulation of gendered behavior in everyday life." *In Sex Roles, 62*, 635–646. doi:10.1007/s11199-010-9761-y

Wolf-Wendel, L., & Ward, K. (2006). Academic life and motherhood: Variations by institutional type. *Higher Education, 52*(3), 487–521.

Wolf-Wendel, L., Ward, K., & Kulp, A. (2016). *How ideal worker norms shape work-life for different constituent groups in higher education*. Jossey-Bass.

Wood, W., & Eagly, A. H. (2012). Biosocial construction of sex differences and similarities in behavior. In M. P. Zanna & J. M. Olson (Eds.), *Advances in experimental social psychology* (Vol. 46, pp. 55–123). Elsevier Inc. http://dx.doi.org/10.1016/B978-0-12-394281- 4.00002-7

Xie, Y., & Shauman, K.A. (2003). *Women in science: Career processes and outcomes*. Harvard University

Yaffe, D. (2018a). Small-town STEM: Rural districts bolster math and science programs with new funding sources, technology and powerful partnerships. *District Administration*, *54*(9), 38-42.

Yaffe, D. (2018b). STEM for Small-Town Schools. *Education Digest*, *84*(3), 49-53.

Yardi, S., Bruckman, A. (2007). What is computing?: Bridging the gap between teenagers' perceptions and graduate students' experiences. *ICER '07: Proceedings of the Third International Workshop on Computing Education Research.* http://dx.doi.org/10.1145/1288580.1288586

Yefimov, V. M. (2004). Two Diputes of Methods, Three Constructivisms, and Three Liberalisms. Part II. *Экономика региона*, *11*(2), 72-85.

Young, D., Rudman, L., Buettner, H., & McLean, M. (n.d). The influence of female role models on women's implicit science cognitions. *Psychology of Women Quarterly*, *37*(3), 283-292

Zakaiya, J. J. (2018). Gender Diversity in a STEM Subfield – Analysis of a Large Scientific Society and Its Annual Conferences. *Journal of the American Society for Mass Spectrometry*, *28*(12), 2523–2531. https://doi.org/10.1007/s13361-017-1803-z

Zander, L., Wolter, I., Latsch, M., & Hannover, B. (2015). Qualified for teaching physics? How prospective teachers perceive teachers with a migration background –and how it's really about "him" or "her". *International Journal of Gender, Science and Technology*, *7*(2), 255-279.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal*, *37*, 215–246.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology*, *25*, 82–91.

Zohar, A., & Bronshtein, B. (2005). Physics teachers' knowledge and beliefs regarding girls' low participation rates in advanced physics classes. *International Journal of Science, 27*, 61- 77.

APPENDICES

APPENDIX A

INTRODUCTORY LETTER TO UNIVERSITIES IN GHANA

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF SCIENCE EDUCATION
DEPARTMENT OF INTERGRATED SCIENCE EDUCATION
P. O. Box 25, Winneba, Ghana
+233(020) 2041077
ise@uew.edu.gh

Our ref. No.: ISED/I.1/Vol.1/27
Your ref. No.:

Date: 17th January, 2023

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION

MISS MARY WEJAAMO AYERIGA

We write to introduce, Miss Ayeriga, a PhD student of the Department of Integrated Science Education, University of Education, Winneba, who is conducting a research titled: **IMPACT OF STEM ON GHANAIAN FEMALE SCIENCE LECTURERS' SOCIAL AND ACADEMIC ENGAGEMENT IN SCIENCE EDUCATION**

We would be very grateful if you could give the assistance required.

Thank you.

Yours faithfully,

MS. ALEXANDRA NORLEY DOWUONA
CHIEF ADMINISTRATIVE ASSISTANT.

www.uew.edu.gh

APPENDIX B

TARGET POPULATION OF THE STUDY

Distribution of Population of the Study

SN	Institution	STEM Education Programmes			
		Science	Technology	Engineering	Mathematics
1	Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development	5	3	2	2
2	C. K. Tedam University of Technology and Applied Sciences	5	2	0	1
3	Ghana Communication Technology University	1	3	2	0
4	Ghana Institute of Journalism	0	0	0	0
5	Ghana Institute of Languages	0	0	0	0
6	Ghana Institute of Management and Public Administration	0	1	0	0
7	Kwame Nkrumah University of Science and Technology	8	3	2	6
8	S. D. Dombo University of Business and Integrated Development Studies	0	0	0	
9	University for Development Studies	0	2	0	0
10	University of Cape Coast	6	2	0	4
11	University of Education, Winneba	4	0	0	2
12	University of Energy and Natural Resources	3	1	0	1
13	University of Environment and Sustainable Development	2	1	0	1
14	University of Ghana	8	3	2	5
15	University of Health and Allied Sciences	4	1	0	1
16	University of Mines and Technology	3	2	2	3
17	University of Professional Studies	0	1	0	0
	Total	49	25	10	26
	Grand Total				110

Source: Human Resource section of various Universities (2022).

APPENDIX C

QUESTIONNAIRE FOR FEMALE LECTURERS ENGAGED IN STEM DISCIPLINES

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
QUESTIONNAIRE FOR FEMALE LECTURERS IN STEM

Dear Respondent,

I am MARY W. AYERIGA pursuing a Doctor of Philosophy in Science education at the University of education, Winneba. As part of my PhD research work in the University of Education Winneba, I am conducting a survey on the topic: *Impact of STEM on Female Science Lecturers' Representation and their Socio-Academic Engagement in Science Education*. Your response to the questions will be handled confidentially. For the study to be successful, your participation will be highly appreciated. Please tick (√) or supply an appropriate response where applicable. You are free to withdraw your participation in the study.

SECTION A: BACKGROUND INFORMATION

(1). Type of University

A) AAMUSTED ☐

B) CKTUTAS ☐

C) KNUST ☐

D). UCC ☐

E) UG ☐

F). UMaT ☐

(2). Age Grouping of Respondents:

A). 20-30 ☐ B). 31-40 ☐

C) 41-50 ☐ D) 51-60 ☐

E). Above 60 ☐

(3). Marital Status

A). Married ☐ B). Single ☐

C) Devoiced ☐

(4). Educational Level/Qualification: A). Masters' degree B). PhD. ☐

(5). Rank: A). Assist Lecturer ☐ B). Lecturer ☐

C). Snr. Lecture ☐ D). Asso. Prof. ☐

E). Full Prof. ☐

(6). STEM –Related Subject taught by Lecturer.

A) Sci. ☐ B) Tech ☐

C) Eng. ☐ D) Maths ☐

(7). Years of Experience as a Lecturer:

A). Less 5 ☐ C). 11-15 ☐

B). 6-10 ☐ D). 16- 20 ☐

E) 21-25 ☐ F) above 25 years ☐

SECTION B: 1. Representation of Female Lecturers in the study of STEM discipline

KEY: STRONGLY DISAGREED (SD), DISAGREED (D), AGREED (A), STRONGLY AGREED (SA)

S/N	STATEMENT	SD	D	N	A	SA
8	The representation of female lecturers in STEM studies are encouraging.					
9	Involvement of female lecturers as role models in STEM education in the past years has enhanced effective teaching of STEM-related subjects.					
10	Female lecturers in STEM education have inherently motivated most female students in the university to choose STEM related programmes.					

11	Gender representation into STEM-related courses is currently in a balance scale with the men.					
12	Difficulty in securing positions in the same geographical area as their partners.					
13	Fewer opportunities for women compared to men for advancement in STEM.					
14	Career path of most successful female lecturers have encouraged or motivated more females to advance into STEM – related careers in academics.					
15	Perceived lack of commitment among women compared to men					

SECTION C: Social, Institutional, Technical and Cultural Challenges Hindering Professional and Academic Growth of Female Science Lecturers

S/N	STATEMENT	SD	D	N	A	SA
	Social Challenges					
16.	Female lecturers feel less marginalized and less opportunities are given to them to develop professionally and academically.					
17.	Less praise is given female lecturers who are involved in STEM education and this hinders their professional and academic growth.					
18.	Lack of role models in the field of STEM education discourage females' professional and academic growth.					
19.	The society perceive STEM education as male dominated careers path, discourage most female from pursuing it which affect their professional and academic growth.					
20.	Unfriendly attitudes by most faculty members hinder female lecturers' professional and academic growth.					

21.	There is unsupportive attitude of female colleagues who are also in STEM education which hinders the professional and academic growth of female lecturers					
22.	Female lecturers in Stem education are labeled as not being fashionable preventing the professional and academic growth in the field.					
23.	Masculinity associated with creativity so female involvement in STEM activities are not encouraged.					
	Institutional and Technical Challenges					
24.	Complex work schedule with long working hours makes it hard to manage family and establish work-family balance coupled with unsupportive employers.					
25.	There are administrative constraints in accessing adequate content material for teaching STEM courses.					
26.	Gender discrimination at workplace - transfers to other places, promotions based on gender, men get paid more than females, profiling female by marriage status and number of children occur in educational institutions.					
27.	There is lack of pedagogical models on how to teach STEM in an attractive way.					
28.	Lack of quality assessment tools, and planning time imped STEM education in tertiary institutions					
29.	Lack of quality assessment tools, planning time, and knowledge of STEM disciplines are challenges and barriers to females' representation in academia.					
30.	Inadequate institutional capacity to support STEM courses such as resources – workloads like many students in university settings,					

	equipment etc affects females in STEM education					
31.	Lack of mentors (women pursing STEM) in tertiary institutions.					
	Cultural Challenges					
32.	Discrimination for women in accessing decision making positions.					
33.	Parents perceive their wards involvement in STEM education programmes prolong their marriages.					
34.	Casting females into supportive roles due to socio-cultural norms.					
35.	Sexism and stereotyping of women's roles exist.					
36.	Hegemonic masculinity influenced by socio-cultural values and beliefs plus organizational gender inequality perceptions among both males and females affect women pursuing STEM education.					
37.	Patriarchy is responsible for the masculine image of STEM.					
38.	Negative traditional beliefs that women are inferior to men are contributing to girls'/ women's lack of enthusiasm for STEM in secondary and tertiary studies.					
39.	Traditional perceptions that "a woman's place" is not the hard sciences.					

SECTION D: Cross-Institutional Collaborations Designed to Enhance the Career Aspirations of the Female Lecturers in STEM Education

S/N	STATEMENT	SD	D	N	A	SA
40.	Well-organized and frequently available professional development learning opportunities with other institutions for STEM initiatives are in place.					
41.	My institution provide opportunity for inter-institution collaboration to enhance our professional growth.					
42.	Annual WiSTEM workshops are organized for all Ghanaian universities to inspire female students.					
43.	There are organized WiSTEM programmes in place for female students in all universities.					
44	There are no regular international WiSTEM conferences for members.					
45.	Seeking institutional collaborative information or research materials helps to promote effective career aspiration among female lecturers.					
46.	There are platforms for collaborative research work among female lecturers in Ghanaian universities.					
47	STEM-related conferences are limited to only institutions that study STEM subjects.					

SECTION E: Network of local and international role models in STEM that exist for the female lecturers in public universities of Ghana

S/N	STATEMENT	SD	D	N	A	SA
48	Female role models in STEM-related studies are sufficient in Ghana's public universities.					
49.	Female scientists are not of good economic standing.					
50.	There are no adequate female science mentors in Ghanaian universities.					
51	WiSTEM chapters/branches exist in all public universities in Ghana.					
52	Female lecturers in STEM-related studies occupy top positions in my university.					
53	There are regular exchange progrommes for females in STEM-related studies in my university.					
54	Majority of female lecturers in STEM-related studies are academic professors in Ghanaian universities.					
55	Award schemes are in place for outstanding females in STEM-related studies.					

SECTION F: Institutional commitment and support systems in place or being envisaged to boost the confidence and capabilities of female science lecturers in STEM.

S/N	STATEMENT	SD	D	N	A	SA
56	Policies to ensure gender balance – laws to support policy of representation are put in place in various universities.					
57	Fostering a sense of belonging among women in STEM and encouraging female					

	students to attend diversity conferences and professional society meetings which invest in students' success.					
58	Adapting classroom science to make it more engaging and interactive, encouraging relational and collaborative learning, and presenting science in a way that emphasizes social and societal connections.					
59	Professional societies and universities could provide structured professional development opportunities, so women can anticipate some of these barriers, plan how to navigate them, and predict important decision points, such as reduced fees for society membership and conference registration.					
60	Fostering an inclusive environment can encourage research or teaching collaborations between junior and senior faculty, increase professional and personal interactions, and reduce professional isolation experienced by new faculty.					
61	Academic departments should recruit senior women in STEM fields to present their technical work as part of department colloquia, brown-bags, and other special events, providing opportunities for these speakers to meet and mentor students.					
62	There is financial support in the form of scholarships for females engaged in					

	STEM-related studies in Ghanaian public universities					
63	Empowers teachers so that they can in turn empower their students to challenge prevailing views about teaching as a last option					

SECTION G: Self-efficacy beliefs of the female lecturers and how those beliefs influence their academic and professional growth.

S/N	STATEMENT	SD	D	N	A	SA
64	My self-efficacy belief has influenced my quality of instructions delivery for student academic and professional growth.					
65	My professional development growth has helped me understand the dignity and worth of every student.					
66	My self-efficacy belief helped me to deal with unexpected events.					
67	My self-efficacy belief helped me to handle whatever comes my way as a female scientist.					
68	My self-efficacy belief has influenced/helped me to do activities in the classroom with confident.					
69	My self-efficacy belief has helped me to solve most problems for my academic and professional growth.					
70	My self-efficacy belief helped me to remain calm when facing difficulties because I can rely on my coping abilities.					

71	My self-efficacy belief have helped me to develop the competence and skill to achieve academic success.					

"THANK YOU"

APPENDIX D

INTERVIEW GUIDE FOR FEMALE LECTURERS ENGAGED IN STEM DISCIPLINES

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

INTERVIEW QUESTIONS FOR GHANAIAN FEMALE LECTURERS IN STEM-RELATED SUBJECTS

Interview Schedule

1. Brief background information about participants:
    - Name of University
    - Age group of participant
    - Marital status
    - Educational qualification
    - Educational rank
    - STEM-related subjects taught by lecturer
    - Number of years of practicing the profession.
2. What is the representation of Female Lecturers in the study of STEM Education in your institution?
3. What impact has STEM education played in your entire life?
4. How does your engagement in STEM education influence your social and academic life at home and work place respectively?
5. What challenges do your face both at home and work through STEM engagement?
6. Does your institution collaborate with other sister universities on STEM programmes?
7. Are there any links with role models and mentors in STEM-related areas within and outside Ghana?
8. What collaborative programmes are being designed in your institution to boost the capacities of females engaged in STEM education?
9. Have you received any support towards your professional development and growth in STEM education from your institution or elsewhere?

10. How does your self-efficacy belief ensure effective teaching delivery on STEM?

Note: Apart from question one the rest are subject to probing

"THANK YOU"