

**WOMEN IN SCIENCE AND TECHNOLOGY IN HIGHER EDUCATION IN GHANA:
POLICY ENVIRONMENTS AND EXPERIENCES**

Thesis submitted to the Faculty of Graduate and Postgraduate Studies

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ABSTRACT

In the current era of globalization, knowledge-based innovations are critical for socio-economic development. In most African countries, however, the level of African-based research and development is minuscule. In addition, there continues to be a considerable gender gap in higher education throughout Africa, where male enrolments far outweigh female enrolments, particularly in the science and technology (S&T) fields. This gender discrepancy has raised concerns about the factors that underlie reduced female enrolment in S&T programs in African universities. Equally intriguing, in view of the relative scarcity of women in the S&T fields, there is surprisingly little knowledge concerning the attributes and the experiences of those African women who do enrol and teach in S&T fields, and who thus can serve as role models for younger girls who have an interest or the potential for pursuing studies in these fields.

In Ghana, although policy initiatives have been undertaken to increase women's participation in higher education, women remain underrepresented in science and technology (S&T) fields, particularly, at the graduate education level. To gain a better understanding of how some women have overcome longstanding obstacles to gender equality in S&T, my dissertation focused on the evolving status of 24 African women in three S&T graduate education programs – Africa Centres of Excellence (ACE) – in two universities in Ghana. To shed light on the factors that facilitate or hinder women's participation in S&T graduate programs, a qualitative inquiry, into the experiences and perceptions of these women was undertaken. The conceptual framework presents the sequence of three approaches: (a) advocacy to raise consciousness about underlying gender-disparity issues; (b) a gender-affirmative-action approach to recruit and train a critical mass of female scientists and researchers; and (c) promotion of gender mainstreaming as a way of bringing gender perspectives into the universities' cultures. This framework has been complemented by the structuration theory that has been useful in illuminating the experiences and perceptions of the women in the S&T ACE graduate programs in Ghana. These conceptual and theoretical frameworks have helped elucidate how the development and effective implementation of gender policies and procedures can lead to the transformation of institutional, social and global structures. Structures in turn can impact women's agency and help overcome gender disparity in S&T higher education.

The analysis of the women's stories provided insights into the intersection of gender, socio-cultural factors, organizational cultures, and how gendered challenges impacted the professional aspirations of the women academics in the two public universities studied in Ghana. Beyond a better understanding of women's experiences, this study helps us understand gender inequalities and the societal norms and practices, as well as patriarchal forces that permeate societies and impose structural barriers to women's advancement. The study also helps to address a major research gap concerning the forces that affect, for better or worse, women's experiences and potential academic contributions in S&T in Ghana and elsewhere in the world and adds to the broader literature on women's experiences in male-dominated fields.

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DEDICATION

To all the people who have supported me in diverse ways in making me who I am today, most importantly my parents, brother and husband whose love, encouragement and support were invaluable gift to me. To everyone mentioned directly and indirectly, particularly, my children whose unconditional love, support and patience gave me the strength to continue, and for that I give the Lord great praise. I dedicate this work to all girls and women, particularly my daughter, who love and pursue science and technology education and careers. May your journey be recognized and valued!

TABLE OF CONTENTS

| | |
|--|-------------|
| ABSTRACT..... | ii |
| ACKNOWLEDGMENTS..... | iv |
| DEDICATION..... | v |
| TABLE OF CONTENTS..... | vi |
| LIST OF TABLES..... | xii |
| LIST OF FIGURES..... | xiii |
| LIST OF ACRONYMS AND ABBREVIATIONS..... | xv |
| CHAPTER 1: UNDERREPRESENTATION OF WOMEN IN GRADUATE SCIENCE AND TECHNOLOGY EDUCATION..... | 1 |
| 1.1 Overview of the Study..... | 1 |
| 1.2 Rationale for this Dissertation..... | 4 |
| 1.3 Gender as a Socio-Cultural Construct..... | 5 |
| 1.4 Objectives of the Research..... | 7 |
| 1.5 A Note on Terminology..... | 8 |
| 1.6 Organization of the Study..... | 9 |
| CHAPTER 2: THE WOMEN IN HIGHER EDUCATION - THE STRUGGLE FOR EQUALITY IN S&T..... | 12 |
| 2.1 A Global Overview..... | 12 |
| 2.1.1 Gender Inequality in Formal Education from Primary to Tertiary Levels..... | 12 |
| 2.1.2 Gender Disparities in S&T..... | 16 |
| 2.2 Women in Higher Education in Sub-Saharan Africa..... | 16 |
| 2.2.1 Gender Inequality in Higher Education..... | 18 |
| 2.2.2 Gender Inequality in S&T Education..... | 19 |
| 2.3 Obstacles Faced by Girls and Women in the Pursuit of S&T Higher Education..... | 20 |

| | |
|--------------------------------------|----|
| 2.3.1 Psychological Obstacles | 20 |
| 2.3.2 Attitudinal Obstacles | 23 |
| 2.3.3 Institutional Obstacles | 25 |
| 2.3.4 Socio-Cultural Obstacles | 28 |

CHAPTER 3: OVERCOMING GENDER DISPARITIES IN S&T - GLOBAL STRATEGIES AND POLICIES 33

| | |
|---|----|
| 3.1 Gender, Power, and the Struggle for Women’s Empowerment..... | 33 |
| 3.2 Gender Equality..... | 36 |
| 3.3 Strategies and Policies Used to Address Gender Inequality in S&T Higher Education | 37 |
| 3.3.1 Consciousness-Raising | 38 |
| 3.3.2 Affirmative-Action | 39 |
| 3.3.3 Gender Mainstreaming | 43 |

CHAPTER 4: WOMEN IN S&T HIGHER EDUCATION IN GHANA 48

| | |
|--|----|
| 4.1 Ghana: The Geographic, Socio-economic and Socio-cultural Contexts..... | 48 |
| 4. 2 Evolution of the Educational System | 51 |
| 4.2.1 Primary to Secondary Education | 51 |
| 4.2.2 Tertiary Education | 54 |
| 4.3 Gender Inequality in S&T Higher Education in Ghana | 55 |
| 4.4 Gender Inequality at the University of Ghana | 58 |
| 4.5 Gender Inequality at KNUST..... | 63 |
| 4.6 Obstacles to Access and Retention of Women in S&T in Ghana | 65 |
| 4.7 Research Questions | 67 |

CHAPTER 5: CONCEPTUAL AND THEORETICAL FRAMEWORKS 69

| | |
|--|----|
| 5.1 Conceptual Framework for Policy Analysis | 70 |
| 5.1.1 Consciousness-Raising | 72 |
| 5.1.2 Affirmative-Action Approaches and Gender Mainstreaming | 73 |

| | |
|---|------------|
| 5.2 Theoretical Framework | 75 |
| 5.2.1 The Concept of Agency | 76 |
| 5.2.2 The Concept of Structure..... | 77 |
| 5.2.3 Structuration Theory..... | 78 |
| | |
| CHAPTER 6: METHODOLOGY-MULTIPLE QUALITATIVE CASE STUDY | |
| APPROACH..... | 83 |
| | |
| 6.1 Study Sites – Africa Centres of Excellence | 84 |
| 6.1.1 West Africa Centre for Crop Improvement..... | 85 |
| 6.1.2 West African Centre for Cell Biology of Infectious Pathogens..... | 87 |
| 6.1.3 Regional Water and Environmental Sanitation Centre in Kumasi..... | 90 |
| 6.2 Research Participants (University Administrators, Instructors, and Students)..... | 92 |
| 6.2.1 Ethical Considerations..... | 92 |
| 6.2.2 Recruitment of Research Participants..... | 93 |
| 6.2.3 Profile of the Participants | 94 |
| 6.3 Data Collection Process | 101 |
| 6.4 Data Analysis: Identification of Different Elements of Relevant Data..... | 103 |
| 6.5 Limitations of the Study..... | 105 |
| 6.6 Summary | 106 |
| | |
| CHAPTER 7: GENDER-EQUALITY POLICIES AND STRATEGIES IN GHANA: | |
| CONSCIOUSNESS RAISING, AFFIRMATIVE ACTION, AND/OR GENDER | |
| MAINSTREAMING?..... | 107 |
| | |
| 7.1 National Policies and Procedures Supporting Gender-Equality Environments..... | 108 |
| 7.1.1 National Approach to Mainstreaming Gender into Development Efforts..... | 108 |
| 7.1.2 National Science, Technology and Innovation Policy (2010)..... | 111 |
| 7.1.3 Gender Equality in Education: Policies, Initiatives, and Plans | 111 |
| 7.2 Description of Universities’ Policies and Procedures..... | 115 |
| 7.2.1 University of Ghana..... | 116 |

| | |
|--|------------|
| 7.2.2 Kwame Nkrumah University of Science and Technology | 119 |
| 7.3 Discussion of National, University, and ACE Policies and Procedures | 121 |
| 7.3.1 National Gender-Equality Policies Analyses | 123 |
| 7.3.2 Gender-Policy Implementation at the University of Ghana (WACCI and WACCBIP) | 127 |
| 7.3.3 Gender-Policy Implementation at KNUST (RWESCK) | 128 |
| 7.4 Analysis of Gender-Policy Implementation at WACCI, WACCBIP and RWESCK..... | 130 |
| 7.4.1 Consciousness of Gender Issues | 130 |
| 7.4.2 Affirmative-Action Approach | 132 |
| 7.4.3 Gender Mainstreaming | 134 |
| 7.4.4 Comparison of the Policy Environments of the Three Centres | 135 |
| 7.5 Conclusion: Consciousness-raising, Affirmative Action, & Gender Mainstreaming in S&T in Ghana | 137 |
| CHAPTER 8: WOMEN’S EXPERIENCES AND PERSPECTIVES | 141 |
| 8.1 Social and Institutional Structures: Challenges of and Obstacles to Pursuing Graduate Education and Careers in S&T..... | 142 |
| 8.1.1 Socio-Cultural Views of the Place of Girls and Women in Society..... | 142 |
| 8.1.2 Institutional Constraints..... | 146 |
| 8.1.3 Summary of Challenges and Obstacles | 149 |
| 8.2 The Evidence of Misalignment and Subjective Experience of Tension | 150 |
| 8.2.1 Women’s Reproductive Role Versus their Professional Responsibilities..... | 150 |
| 8.2.2 Challenges of Scheduling Home Versus Academic Requirements..... | 151 |
| 8.2.3 Workplace Politics and Environments | 155 |
| 8.2.4 Summary of the evidence of misalignment and subjective experience of tension..... | 159 |
| 8.3 Agentic processes fostered by supportive global, institutional and social structures | 161 |
| 8.3.1 Personal Agency..... | 161 |
| 8.3.2 Factors Supportive of Women in S&T Higher Education..... | 166 |

| | |
|--|------------|
| 8.3.3 Supportive Gender-Equality Policies and Strategies..... | 174 |
| 8.3.4 Women’s Perceptions of the Status of Girls Vis-à-Vis S&T Education | 179 |
| 8.3.5 Summary: Supportive Factors | 180 |
| 8.4 Conclusion..... | 181 |
| CHAPTER 9: OVERCOMING GENDER INEQUALITY IN S&T GRADUATE EDUCATION IN GHANA..... | 184 |
| 9.1 From Consciousness-raising to Gender Mainstreaming: Policies and Procedures | 185 |
| 9.1.1 Gendered Policies and Procedures: National Level | 185 |
| 9.1.2 Gendered Affirmative Action at the University Level | 187 |
| 9.1.3 The impact of gender practices and procedures on the three ACEs..... | 188 |
| 9.2 Framing Gender Equality in S&T Higher Education..... | 190 |
| 9.2.1 Consciousness-Raising/Affirmative Action/Gender Mainstreaming | 191 |
| 9.2.2 Impact of Structuration Theory | 192 |
| 9.3 From Structure to Agency: Experiences and Perspectives of the Female Participants..... | 192 |
| 9.4 Long Road from Affirmative Action to Gender Mainstreaming | 195 |
| 9.5 Contribution to Knowledge..... | 196 |
| 9.6 The Way Forward: Recommendations and Areas for Future Research..... | 198 |
| REFERENCES..... | 204 |
| LIST OF APPENDICES | 234 |
| Appendix 1: Sample Formal Letter..... | 234 |
| Appendix 2: Policies and Plans: Gender and Tertiary Education in Ghana..... | 235 |
| Appendix 3: Data Collection, Rationale, Sources and Analysis | 242 |
| Appendix 4: Invitation to Participate in a Doctoral Research Project | 244 |
| Appendix 5: Interview Protocol - Students | 247 |
| Appendix 6: Interview Protocol - Instructors..... | 249 |
| Appendix 7: Interview Protocol-Administrators..... | 250 |
| Appendix 8: Dissertation Timetable | 251 |

| | |
|---|-----|
| Appendix 9: Coding the Case Study (Using a Multiple Case Approach)..... | 253 |
| Appendix 10: Approval Letter - WACCI..... | 254 |
| Appendix 11: Approval Letter – WACCBIP | 255 |
| Appendix 12: Approval Letter - RWESCK | 256 |
| Appendix 13: Ethics Certificate – University of Ottawa | 257 |
| Appendix 14: Consent Form – WACCI Students | 259 |
| Appendix 15: Consent Form – WACCBIP Students | 263 |
| Appendix 16: Consent Form RWESCK Students..... | 267 |
| Appendix 17: Consent Form Instructors and Administrators-WACCI..... | 271 |
| Appendix 18: Consent Form-Instructors & Administrators-WACCBIP | 275 |
| Appendix 19: Consent Form-Instructors & Administrators-RWESCK..... | 279 |

LIST OF TABLES

| | |
|--|-----|
| Table 2.2. <i>Gender distribution in faculties of sciences by country in 2011</i> | 19 |
| Table 3.1. <i>Percentage of Women in management positions in Sweden, 1990 & 2010</i> | 41 |
| Table 4.1. <i>Gender distribution of students in higher education in Ghana from 2008-2016</i> | 56 |
| Table 4.2. <i>Gender distribution of students in S&T higher education by faculty, 2011-2012:</i> <i>UMTG</i> | 57 |
| Table 4.3. <i>Gender distribution of employees in mining companies in 2014: Ghana</i> | 58 |
| Table 4.4. <i>Gender distribution of students from 2010-2011 to 2014-2015: University of Ghana,</i> <i>Faculty of Law</i> | 59 |
| Table 4.5. <i>Gender distribution of students by academic year from 2010-2011 to 2014-2015:</i> <i>University of Ghana, Faculty of Medicine</i> | 61 |
| Table 4.6. <i>Gender distribution of undergraduate and graduate students from 2011-2016: KNUST</i> | 63 |
| Table 4.7. <i>Gender distribution of students from 2010-2011 to 2014-2015: Faculty of</i> <i>Engineering, KNUST</i> | 64 |
| Table 6.1. <i>List and profile of participants: students/instructors/administrators</i> | 96 |
| Table 6.2. <i>List and profile of participants: administrators/instructors</i> | 100 |

LIST OF FIGURES

| | |
|--|----|
| <i>Figure 3.1.</i> The gender mainstreaming model..... | 44 |
| <i>Figure 4.1.</i> Administrative map of Ghana | 49 |
| <i>Figure 4.2.</i> Gender distribution of lower secondary school completion in Ghana in 2016..... | 53 |
| <i>Figure 4.3.</i> Gender distribution of primary, secondary and tertiary education in Ghana in 2013..... | 53 |
| <i>Figure 4.4.</i> Gender distribution of students in 2012-2013 and 2015-2016: University of Ghana | 59 |
| <i>Figure 4.5.</i> Gender distribution of Masters and PhD students in 2012-2013: University of Ghana | 60 |
| <i>Figure 4.6.</i> Gender distribution of academic staff from 2012-2013: University of Ghana | 62 |
| <i>Figure 4.7.</i> Gender distribution of non-academic staff from 2012-2013: University of Ghana... | 62 |
| <i>Figure 5.1.</i> Policies and procedures for achieving gender equality in S&T higher education in Ghana | 71 |
| <i>Figure 5.2.</i> Key interfaces of structure and agency | 75 |
| <i>Figure 6.1.</i> Gender distribution of students from 2014-2015 to 2016-2017: WACCI..... | 86 |
| <i>Figure 6.2.</i> Gender distribution of faculty and administrators from 2016-2017: WACCI..... | 86 |
| <i>Figure 6.3.</i> PhD in agricultural science, 2018 graduating class: WACCI..... | 87 |
| <i>Figure 6.4.</i> Gender distribution of faculty and administrators in 2017: WACCBIP..... | 88 |
| <i>Figure 6.5.</i> Gender distribution of students from 2014-2015 to 2016-2017: WACCBIP | 88 |
| <i>Figure 6.6.</i> Head of department, biochemistry, cell and molecular biology: WACCBIP | 89 |
| <i>Figure 6.7.</i> Participant at the Third Annual Conference in Accra: WACCBIP | 89 |
| <i>Figure 6.8.</i> Gender distribution of PhD students from 2015-2016 to 2016-2017: RWESCK..... | 91 |

Figure 6.9. Graduate students practical field work: RWESCK..... 91

LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|------------|---|
| AAU: | Association of African Universities |
| ACE: | Africa Centre of Excellence |
| AFFESTIM : | Association de la francophonie à propos des femmes en sciences, technologies, ingénierie et mathématiques |
| AGRA: | Alliance for a Green Revolution in Africa |
| IMF: | International Monetary Fund |
| AWSE: | African Women in Science and Engineering |
| BPI: | Baraka Policy Institute |
| CEGENSA: | Centre for Gender Studies and Advocacy |
| CIA: | Central Intelligence Agency |
| CRC: | Convention on the Rights of the Child |
| EFA: | Education for All |
| ESP: | Education Strategic Plan |
| EU: | European Union |
| FAWE: | Forum for African Women Educationalists |
| FCUBE: | Free Compulsory Basic Education |
| GAA: | Girls Advocacy Alliance |
| GAAS: | Ghana Academy of Arts and Sciences |
| GAD: | Gender and Development |
| GDO: | Gender Desk Officer |

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| GER: | Gross Enrolment Ratio |
| GES: | Ghana Education Service |
| GNA: | Ghana News Agency |
| GoG: | Government of Ghana |
| GPA: | Grade Point Average |
| GPRS: | Growth and Poverty Reduction Strategy |
| GoG: | Government of Ghana |
| GSS: | Ghana Statistics Services |
| HIV/AIDS: | Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome |
| ICPD: | International Conference on Population and Development |
| ICT: | Information Communication and Technology |
| ICT4AD: | ICT for Accelerated Development |
| ILRI: | International Livestock Research Institute |
| IMF: | International Monetary Fund |
| IT: | Information Technology |
| KNUST: | Kwame Nkrumah University of Science and Technology |
| LFA: | Logical Framework |
| MDAs: | Ministries, Departments and Agencies |
| MDG: | Millennium Development Goal |
| M&E: | Monitoring and Evaluation |
| MoE: | Ministry of Education |

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| MEST: | Ministry of Environment, Science, and Technology |
| MESTI: | Ministry of Environment, Science, Technology and Innovation |
| MoGCSP: | Ministry of Gender, Children and Social Protection |
| MoESS: | Ministry of Education, Science and Sports |
| MOWAC: | Ministry of Women and Children's Affairs |
| NAB: | National Accreditation Board |
| NABPTEX: | National Board for Professional and Technician Examinations |
| NARI: | National Agricultural Research Institution |
| NCWD: | National Council on Women and Development |
| NCTE: | National Council for Tertiary Education in Ghana |
| NERIC: | National Education Reform Implementation Committee |
| NGOs: | Non-Governmental Organizations |
| NGP: | National Gender Policy |
| NSC: | National Science Council |
| NSS: | National Service Scheme |
| PASS: | Participatory Approach to Student Success |
| PhD: | Philosophy Doctor |
| R&D: | Research and Development |
| RWESCK: | Regional Water and Environmental Sanitation Centre in Kumasi |
| SLTF: | Students Loan Trust Fund |
| S&T: | Science and Technology |

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| STEM: | Science Technology Engineering and Mathematics |
| STI: | Science Technology and Innovation |
| STIE: | Science, Technology and Innovation Education |
| SMTE: | Science, Mathematics and Technology Education |
| SDG: | Sustainable Development Goal |
| TVET: | Technical and Vocational Education and Training |
| UDHR: | Universal Declaration of Human Rights |
| UG: | University of Ghana |
| UK: | United Kingdom |
| UN: | United Nations |
| UNCTAD: | United Nations Conference on Trade and Development |
| UNDP: | United Nations Development Programme |
| UNESCO: | United Nations Educational Scientific and Cultural Organization |
| USA: | United States of America |
| WACCBIP: | West African Centre for Cell Biology and Infectious Pathogens |
| WACCI: | West Africa Centre for Crop Improvement |
| WASSCE: | West Africa Senior Secondary School Certificate Examination |
| WID: | Women in Development |

CHAPTER 1: UNDERREPRESENTATION OF WOMEN IN GRADUATE SCIENCE AND TECHNOLOGY EDUCATION

1.1 Overview of the Study

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 Program 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 programs, the right to education was recognised. 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. Yet in many parts of the world, institutions of higher education have not kept pace with increasing demand. Accordingly, young people with critical knowledge and skills are often in short supply (Ndulu & Gracio, 2009; World Bank, 2014a). In sub-Saharan Africa, the need for higher education, particularly in science and technology (S&T), is acute.

Consequently, the scale of African-based science research and development (R&D) is minuscule, and the continent continues to rely heavily on R&D conducted in industrialized countries (Maclure, 2006; Teferra, 2015). In addition, the gender gap in S&T is even more compelling, with male enrolment far outstripping female enrolment, especially at the graduate level (LaCosse, Sekaquaptewa, & Bennett, 2016). Because current undergraduate and graduate science students are the science teachers of the future, it is evident that the relatively small numbers of women in S&T today will impact the ability to bridge the S&T gender gap in secondary schools, and more so, in undergraduate and graduate programs in the future. This is unfortunate, given the fact that vast numbers of women in Africa represent untapped human capital that could enhance the S&T workforce. Undeniably, “gender equality in employment, mainly in S&T disciplines, is currently one of the greatest development challenges facing countries globally, including those in Africa” (Anyanwu & Darline, 2013, p. 400). This problem is further accentuated by the low participation of women in S&T administrative positions.

Indeed, reflecting the low participation rates of female students in higher education, the numbers of women occupying senior levels in higher education institutions remain relatively few.

There are a number of well substantiated reasons for this gender disparity in higher education in sub-Saharan Africa. Educational opportunities for girls and young women remain strongly influenced by patriarchal perspectives of the place of women in society, resulting in many families attaching more importance to the education of boys than girls (Machira, 2013; Wolf, McCoy, & Godfrey, 2016). Gender stereotypes and a shortage of skilled and trained teachers and role models, particularly female teachers, have contributed to gender disparity in education. The prejudice against women in S&T education is particularly relevant for higher education, which requires more financial support from families and is often perceived to be unnecessary for women whose expected roles are essentially house-keeping and child-bearing. Prevailing structures of tertiary institutions which mirror entrenched patriarchal structures have also exacerbated the widespread gender disparities (Walker, 2015), as have failures to implement policies that are ostensibly designed to promote gender equality.

Nevertheless, as Morley (2011a) argues, “the distribution of HE, [higher education], has become a policy priority for reasons of social justice and economic development” (p. 341). This reference to social justice is significant. By underscoring the necessity of fair and equitably distributed benefits in all aspects of society, social justice explicitly in practical terms necessitates equal access and participation of girls and women in all educational, economic, social, and political structures (Baily & Holmarsdottir, 2015). Partly in response to these gender-related constraints, the promotion of equal access to S&T education has emerged as a topical social issue. The advantage of including women in the S&T workforce, in leadership and decision-making positions, is now gaining acceptance. As a result, proactive strategies to foster gender equality in higher education have had the effect of enabling women, albeit in fewer numbers than men, to gain access to S&T tertiary education programs. The creation of equal opportunities related to gender effectively means the elimination of obstacles, biases, prejudices and gender stereotypes that impede women’s participation in the formal economic sector. These sentiments have been incorporated in Sustainable Development Goals (SDGs) which acknowledge that gender equality is not only an essential human right, but is required for a peaceful, prosperous and sustainable world (UN, 2015a). Consequently, SDG #5 espouses

women's full and effective participation, and equal opportunities to provide leadership at all levels of decision-making in political, economic and public life (UN, 2015a).

Adherence to the various international agreements aiming to improve education and promote girls and women's education in S&T programs clearly will require shifts in national policies and priorities. Fair distribution of public goods such as education is in turn contingent upon how inequality is understood by policy-makers, and by willingness of those in political power to tackle the problems of social inequality (Molla, 2012). To overcome gender inequality in Ghanaian society in general, and in education in particular, aiming to mitigate the adverse effects of gender inequality on the country's socio-economic development efforts (Effah, 2011), "it is imperative to question the way in which the problem of gender inequality is framed in the equity policies and strategies put in place" (Molla, 2012, p. 194) to fully address the issue. Policies are naturally political. They therefore require critical scrutiny in order to assess the extent to which they have the potential to bring about the distribution and redistribution of resources and opportunities. This is particularly salient in Ghana, a West African country that has witnessed tremendous growth in various sectors over the past decade, but where challenges remain concerning inequitable access to higher education along the lines of gender and socio-economic divisions (Arthur & Arthur, 2015).

Indeed, while tertiary education in Ghana has seen a steady increase in accessibility over the last two decades (Atuahene & Owusu-Ansah, 2013), the ratio of female enrolment is currently well below that of men (Arthur & Arthur, 2015), and evidence indicates that numerous forms of discrimination continue to hinder women's upward mobility within Ghana's patriarchal society (Boateng, 2015). In particular, in light of the significance of S&T for a country's development, a key challenge for Ghana is the gender gap in enrolment and retention in S&T disciplines, particularly at the master's and doctoral levels. For example, the average female student admission at the University of Science and Technology in Ghana at the graduate level was 27.2% from the academic year 2011-2012 to 2015-2016 (KNUST, 2017). In response, successive national governments in Ghana have introduced various initiatives and policies to overcome gender inequality in Ghanaian society in general, and in education in particular, aiming to mitigate the adverse effects of gender inequality on the country's socio-economic development efforts (Effah, 2011). As early as 1970, the central government created the National Council on Women and Development (NCWD) and initiated several policies aiming to promote

gender equality in education, including in the area of S&T. In the late 1980s the Science, Technology, and Mathematics Education Program (STME) was introduced to increase girls' participation in S&T and to address the gender gap and misconceptions about girls' aptitude for S&T (Andam, Amposah, Nsiah-Akoto, Gyamfi, & Hood, 2013). Since the mid-1990s, in order to remedy persistent gender-based disparity in education, affirmative action policies have been introduced in the university admissions' process (Atuahene & Owusu-Ansah, 2013). These included quota systems and reductions in minimum grade requirements for the admission of female students. In 2015, the National Gender Policy (NGP) provided guidelines that higher-education institutions are encouraged to adopt and adapt to their institutional strategies.

Given the significance of policies in addressing gender disparities in higher education, the two main aims of this dissertation are to examine: a) policies that ostensibly aim to augment the participation of women in higher education in Ghana, and b) the extent to which they have affected, among other factors, the trajectories of women who have succeeded in gaining access to S&T fields either as university graduate students, or as instructors and administrators in S&T fields.

1.2 Rationale for this Dissertation

My decision to study women in science in the African context arose from personal observations and intellectual questions related to my previous professional experiences. In 2003, as a lecturer at the United States International University (USIU) in Nairobi, Kenya, I had the opportunity to work as a strategic planner and education consultant as part of a four-person project team assigned to examine programmatic problems associated with high school level dropout rates and low levels of enrolment in Somalia. While working on the assignment, I learned that very few female students continued on to tertiary education. Since our role as consultants was to increase student enrolments, especially among women, we developed affirmative-action measures that became integrated into tertiary education admission policies. Soon after, in 2007, I joined the International Livestock Research Institute (ILRI) in Nairobi, Kenya, where, I managed the Bioscience eastern and central Africa (BecA) Capacity Building Project. The goal was to award fellowships to master's and doctoral students from eastern and central African universities majoring in agricultural science. Although the project aimed to recruit at least 30% female scientists, in fact very few women applied. We barely managed to

achieve a 20% female participation rate. Shortly after, a special concession was implemented in order to attain that percentage. These two assignments in Somalia and in Kenya allowed me to gain a better understanding of the real educational challenges facing young women that today still plague the African continent, and have stimulated my desire to pursue a career in public policy and international development work.

In the year 2014, given my passion for science and my aspiration to take part in development programs with hopes of helping improve girls' and women's S&T educational experience, I had the opportunity to coordinate the preliminary phase of the *Africa Centres of Excellence (ACE)* Project in Ghana, a collaborative initiative that is being undertaken by the World Bank in conjunction with the Association of African Universities (AAU). Supported by the national governments of nine countries in west and central Africa hosting a total of 22 centres, the project was launched in 2014. The dual goals of the four-year project are to develop and strengthen the capabilities of S&T graduate-level programs while simultaneously augmenting women's enrolment in S&T fields so as to reinforce the contribution and status of female researchers and graduate students in these programs.

When working with the ACE project, I made several disconcerting observations. Each of the 22 ACEs has a centre director and a deputy director. Yet no woman held a position as a director, and only two of the centres had female deputy directors. Of the 11 project steering committee members, only one was a woman. In addition, the AAU, the agency that administered the ACE project, had no woman on its management team. During one project monitoring visit to St. Louis, Senegal, I observed that of 22 masters and doctoral students admitted to the engineering program, only five were women. Working within this context, I had first-hand experience of the day-to-day realities of the patriarchal practices limiting women's participation in leadership roles in S&T education. These unsettling observations led to my desire to undertake doctoral studies so as to better understand the underpinnings of the gender-disparity issues in S&T graduate education in Ghana and elsewhere in Africa. To comprehend the issue of gender, it is imperative to understand of the concept of gender. What is gender?

1.3 Gender as a Socio-Cultural Construct

In order to examine gender policies related to higher education and the experiences of women who have gained access to higher education, either as graduate students or as university

instructors and administrators, I will first describe the concept of gender and how it contributes to inequalities. Gender is a social construct rooted in social, economic, political and cultural conventions (Connell, 2009). Through upbringing and socialization, gender constructs are founded on ideas and actions that are widely regarded as typically male or female (Evans, 2011; Sinnes & Løken, 2014). These differentiated roles not only differ across contexts but evolve over time (Abagre & Bukari, 2013). They emerge early on in life when children are subjected to established social expectations and practices that often lead to disparities of access and experience (Unterhalter, 2007). In patriarchal societies, commonplace assumptions ascribe men as often naturally more competent or capable of doing particular tasks, while women are more suited for others (Connell, 2009; Evans, 2011). This is exemplified by popular perspectives that men are best suited for technical and scientific activities while women are more suited for professions of nursing and care giving (McEwen, 2013). These activities reinforce socially-sanctioned norms around masculine and feminine roles and expectations of men and women in society. “The existence of any given gender regime is shaped by rules and norms fostered and enforced by both patriarchal structures and ideologies” (Stromquist, 2015, p. 62).

Conformity to prevailing values and norms that underlie such assumptions invariably result in differentiated learning and workplace roles assigned to men and women. Unfortunately, however, in patriarchal societies stringent gendered presuppositions that divide men and women can lead to unwarranted discrimination and marginalization of girls and women that is not only detrimental to women, but undermines the development prospects of societies (Baric, 2013). As Baily and Holmarsdottir (2015) have argued, “gendered expectations can restrain people in physical, emotional and cultural ways and can prevent people from attaining equitable and just treatment” (p. 838). For girls especially, gendered practices such as coming-of-age rites and social pressure to marry and have children at a young age often result in perpetual gendered marginalization and threats to their safety (Baily & Holmarsdottir, 2015). Gendered differentiation has likewise long been associated with the multiple obstacles that girls and women face in the pursuit of formal education. To counter such gender inequality effectively in different societal contexts, it is therefore essential to develop knowledge bases that will inform the design and implementation of gender equality policies and, more broadly, will illuminate cultural and socio-economic factors that can redress gender imbalances. This dissertation

contributes to our understanding of gender inequality in access to education by examining policies and practices and offers strategies for addressing these barriers to girls' S&T education.

1.4 Objectives of the Research

Although there has been research on gender inequalities in tertiary education in Ghana, literature that focuses on women in S&T fields, particularly at the graduate level, is scarce. While there is compelling evidence that enrolment in graduate-level S&T education is inequitably distributed in favour of males in Ghana, there is limited understanding about the various impediments to the enrolment of women in such programs. It is therefore necessary to examine the relative efficacy of policies that have been put in place that are ostensibly designed to overcome these obstacles and thence increase female enrolment in S&T university programs. Equally important, however, there is a need to understand the characteristics and the experiences of African women who do study and teach in S&T fields. Such knowledge is necessary if such women are to serve as role models for thousands of girls in primary and secondary schools who have an inherent interest in, and potential for, the pursuit of studies in these fields. This knowledge is also necessary to help improve discriminatory practices and procedures that hinder girls and women's participation in S&T fields.

This dissertation therefore has set out to examine these catalysts of female enrolment in graduate level Ghanaian S&T university programs. The first is to assess the types of policies that have been put in place to encourage and facilitate women's enrolment in S&T programs, and the relative effectiveness of such policies. For this study, three typologies of gender-related policies will be examined – those that can be defined as fostering *consciousness-raising* on gender issues; those that are designed as *affirmative action* measures that aim specifically to foster gender *equity* by increasing the participation of women as students, instructors, and administrators in graduate S&T education and research; and those that can be regarded as *gender mainstreaming* that aim to normalize gender *equality* as a feature of everyday practices.

The second focus of this dissertation is to examine the personal, cultural, and socio-economic factors that have enabled the relatively few women to gain access to S&T graduate programs in Ghana. Gender, after all, is not a neutral phenomenon. It is therefore vital to consider the real-life experiences of these women in order to better inform policies and procedures that aim to foster gender equity, and over the long term, gender equality, in S&T

fields in Ghana. Through the lenses of structuration theory that postulates the interconnectedness of structure and agency, I examine how African women were transformed into highly motivated scientists and technologists. For this second focus of the dissertation, research fieldwork focused on a cohort of women studying and working in three university centres in Ghana – two in the University of Ghana, and one in the Kwame Nkrumah University of Science and Technology (KNUST) – all of whom are engaged in the aforementioned ACE Project. Apart from the serving as an optimal way to build and sustain excellence in higher education in Ghana, these centres also aim to augment female participation in S&T fields.

From this theoretical perspective, it is possible to elucidate how structures of inequality occur, how they are interconnected in complex ways, and how they can be overcome. Field research was conducted in two phases. The first phase involved the collection, collation, and analysis of policies and procedures that have been put in place to overcome gender disparity in S&T education in Ghana. This required analysis of policy documents that was supplemented by one-on-one interviews with several administrators. These interviews added useful insights regarding gender policies established for the ACE project. The second phase consisted of a qualitative inquiry into the experiences and perceptions of women who had achieved entry into graduate-level S&T programs as students, instructors, or administrators. The guiding objective of these interviews was to assess the relative influences of gendered policies and other sociological factors (personal, cultural, and socio-economic), in addition to family, social, institutional and global structures that influenced their educational opportunities, choices, and experiences.

1.5 A Note on Terminology

- Parity – connected to numbers – focuses on equal representation of both men and women in a specific context. In education, it relates to achieving 50% female participation and 50% male participation. In most cases, parity is achieved by the use of affirmative action policy.
- Equity – connected to affirmative action – focuses on fair treatment of both women and men. It requires the provision of differential treatments (including affirmative action) based on the conditions and needs of the marginalized groups. The objective is mostly to level the playing fields. Equity leads to equality in access, participation and success in the education sector.

- Equality – connected to mainstreaming – focuses on gender inclusiveness as the norm. Equality assumes similarity in different attributes: status, capacity or opportunity.
- Gender equality means promoting fairness and social justice while providing equal opportunities for every student and staff.
- Feminism is an emancipatory process that allows marginalized individuals to acquire the necessary power and opportunities to reinvent themselves and be empowered.
- Intersectionality denotes the interaction between gender, race, and other types of differences in individual lives, social practices, institutional arrangements, and cultural ideologies, and the results of these interactions in terms of power relations.
- The ACE project is science-based in the three centres that were the sites of my field research. Consequently, I will refer to all three programs encompassing the disciplines of “science and technology” (S&T). However, the centre situated in KNUST one of the centres is specifically related to science, technology, engineering and mathematics (STEM) teaching and research. In reference to this centre alone, I will use the term STEM to describe the KNUST centre.
- While ACE is officially referred to as a “project”, given its extensive scope, in many respects it can be characterized as a “program”. Therefore, throughout this thesis I will refer to it interchangeably as “project” and a “program”.
- Tertiary education is the educational level following the completion of secondary education. It includes universities as well as trade schools, colleges and higher vocational education and generally culminates in the receipt of certificates, diplomas, or academic degrees. Higher education includes undergraduate and postgraduate education often delivered at universities, academies, colleges, seminaries, conservatories, and institutes of technology. Higher education is also available through certain college-level institutions, including vocational schools, trade schools, and other career colleges that award academic degrees or professional certifications. In this dissertation, both terms will be used interchangeably.

1.6 Organization of the Study

The study is divided into nine chapters. Following this introductory chapter, Chapter 2 provides an overview of gender inequality in formal education in general, and specifically as it

affects women in S&T in higher education. In this chapter, I focus on gender inequality around the globe before narrowing to the African context. To better understand the factors that hinder girls and women's S&T education and the different perspectives that have been used to explain the phenomenon, I examine obstacles faced by girls and women in S&T higher education.

Chapter 3 presents gender issues and the struggle of women for empowerment. It highlights strategies of consciousness and advocacy, affirmative-action (e.g., gender-equity policies in the workplace and educational policies related to girls' education, particularly in the realms of S&T), and the promotion of gender mainstreaming to advocate for gender equality and social justice.

Chapter 4 examines the education system in Ghana and barriers faced by girls and women participating in S&T programs. It provides a general overview of the evolution of the current education system with emphasis on higher education. It covers gender disparity in Ghanaian education, in general, and gender disparity in S&T in higher education, in particular. The chapter highlights the obstacles faced by Ghanaian women in the pursuit of higher education in S&T according to the literature. The chapter concludes with the research questions.

Chapter 5 focuses on the conceptual framework made up of three approaches: consciousness-raising; affirmative action and gender mainstreaming. This is complemented by the theoretical framework which is structuration theory used as a lens to help explain the women's experiences and perspectives.

Chapter 6 covers the study methodology. A multiple qualitative case study was selected as being the most appropriate way to delve into the participants' lived experiences. It includes ethics considerations, the negotiation of entry to research sites, data collection and analysis methods, and the limitations of the study.

Chapter 7 consists of the review and analysis of policy and procedure documents related to gender. It focuses on national policies and initiatives relating specifically to gender issues. The chapter also examines higher-education policies pertaining to gender at the University of Ghana and at KNUST. These policy documents have been complemented by one-on-one semi-structured interviews with centres and/or university administrators. The chapter concludes with the analysis and discussion of policy documents and interviews.

Chapter 8 presents the results of interviews of female students, instructors, and administrators from WACCI and WACCBIP at the University of Ghana and RWESCK at

KNUST. The chapter provides information on the obstacles and constraints that the participants have experienced and/or perceived as hindrances to women's participation in S&T disciplines at the three centres. It also presents the evidence of misalignment and subjective experience of tension. The chapter highlights agentic processes fostered by supportive global, institutional and social structures, such as parents and teachers' support, affirmative-action approaches and gender-supportive plans and procedures that have helped participants overcome these challenges and enabled them to gain access to and succeed in graduate S&T programs.

Chapter 9 reflects on the findings, the contribution of this study to knowledge of gender disparities in the Ghanaian S&T field, and strategies that can be used to overcome gender disparity in S&T higher education, mainly at the graduate level. The role of structuration theory in identifying sources of discrimination that Ghanaian women have had to overcome to gain access and succeed in S&T programs at the graduate level is also discussed. The structuration theory is used to illuminate women's experiences and perspectives. Finally, the chapter discusses policy implications, offers recommendations, and suggests areas for future research.

In the next three chapters, I provide a comprehensive assessment of prior scholarly contributions in the area of gender inequalities in S&T globally, in sub-Saharan Africa, and in Ghana. The literature review reveals what has been learned and accomplished in this area of investigation and what still needs to be accomplished. The literature review provides an opportunity to summarize and synthesize previous findings in a way that allows the researcher to gain new perspectives (Boote & Beile, 2005). According to these authors and Glesne (2016), a clear and concise literature review is always a good basis for both methodological and theoretical refinement, thus enhancing the quality and efficiency of subsequent research.

CHAPTER 2: THE WOMEN IN HIGHER EDUCATION - THE STRUGGLE FOR EQUALITY IN S&T

Formal education is a basic human right. It is indispensable for economic, political, and social development. It is an essential tool and a key mechanism for democracy and for positive societal transformation (David, 2011; McGrath, 2010). In addition, in ideal circumstances, education functions as a great “social equalizer” (Bailey & Graves, 2016, p. 683), enabling diverse groups of children from all walks of life to acquire the skills and knowledge that will prepare them for adult life as productive citizens contributing to social development (Jowi, Knight, & Sehoole, 2013). Unfortunately this ideal is often not realized. Despite the prevalence of research pointing to the significant role education plays in the development of society, many individuals, mainly women and the poor, have little or no opportunity for good-quality education (UN, 2015b). Overall, there continue to be socio-economic disparities and gender inequalities in all aspects and at all levels of educational systems.

In this chapter, drawing mainly from scholarship of the past 20 years, I provide an overview of gender inequality in formal education, in general, and gender inequality in S&T higher education, both globally and in sub-Saharan Africa. In so doing, I discuss various obstacles that girls and women face in the pursuit of S&T higher education and the different perspectives that explain these obstacles and the subsequent disparities that ensue.

2.1 A Global Overview

2.1.1 Gender Inequality in Formal Education from Primary to Tertiary Levels

Over the past several decades, there has been growing global concern about the lack of rapid progress in girls’ participation in formal education. A large body of scholarly literature has addressed gender inequality in the developed world, and suggestions for reducing the gender gap are well documented (Asimengo-Boahene, 2006). In response to this endemic gender inequality problem, international organizations such as the UN and other development partners have initiated a number of education programs and have promoted girls and women’s participation in education.

At the 1990 UNESCO World Conference on Education for All (EFA) in Jomtien, Thailand, world leaders reaffirmed the right of all children to basic education and committed

themselves to undertaking the necessary steps to achieve the goals of EFA. The initiative encouraged all leaders to strive toward primary education for every child (boy and girl) and a massive reduction of adult illiteracy by the year 2000. Yet a decade later, with universal basic education still unattained in many countries, the Dakar EFA Declaration of 2000 that followed re-affirmed the goals of Jomtien. These were reinforced by the promulgation of the Millennium Development Goals (MDGs) in 2002, of which two (#2 and #3) asserted respectively the achievement of universal primary education and progress towards gender equality and empowerment respectively by the year 2015 (UNDP, 2000).

Reports published at the end of the MDGs implementation cycle in 2015 revealed that generally much had been accomplished in relation to the goals related to education and gender (UNESCO, 2015a). Net primary-school enrolment in developing regions reached 91% in 2015, up from 83% in 2000, and the literacy rate among youth aged 15 to 24 had improved globally from 83% in 1990 to 89% in 2010 (UN, 2015b). The number of out-of-school children of primary-school age worldwide had fallen by almost half, and in most countries considerable progress towards achieving gender parity, or near-parity, at primary and even secondary school levels had been achieved in 2013. Nevertheless, women represented an estimated two-thirds of the world's 774 million illiterate adults (UNESCO, 2014), and there were still marked gender inequalities in tertiary education both in terms of student populations and those holding academic positions (UNESCO, 2014). Moreover, there is substantial evidence that urban-rural and class-based disparities exist within education system and these in turn have accentuated gender differentiation in schooling (Makama, 2013). In a 2008–2012 survey undertaken by the UN in 63 developing countries, children in the most deprived households were four times as likely to be out of school as children in the wealthiest homes. Considerable disparities in enrolment rates were also reported in all regions and between urban and rural locations across countries, between well-off and poor children, and between girls and boys (UN, 2015b). As Stromquist (2006) has observed, “throughout the developing world, rural populations benefit less from schooling than urban populations, and girls in poor and ethnic minority families face greater obstacles to education than boys of similar backgrounds” (p. 146).

These disparities in access to good-quality education reflect socially constructed limitations on the life choices facing girls and women in particular (Nudzor, 2015). For example, throughout the developing world, families routinely expect girls to participate much more than

boys in domestic work, helping their mothers perform household chores and caring for their younger siblings. When parents have insufficient resources to enrol all children in school, far more often than not they prefer sending their sons to school and will overlook their equally talented daughters (Nudzor 2015; Okeke-Ihejirika, 2009). Indeed, many parents regard the education of a girl as a lost investment, since the fruits of education will benefit the family she will eventually marry into (Raynor, 2005). A Bengali proverb, “educating girls is like watering your neighbour’s tree” (Raynor, 2005, p. 83), reflects that view. This biased perspective is further reinforced by the argument that daughters, once they are married, will be obliged to continue to perform tasks such as caring and nurturing that seldom require formal education (Aubrecht & Mackenzie-Lay, 2015).

Established from childhood through social interactions in home communities, and often in schools as well, differential levels of support and motivation for girls invariably influence their aspirations and ultimate learning achievements (Makama, 2013). This sex-selective process is in fact a key contributing factor to gender inequality in formal education in general and higher education in particular. The organizational cultures of formal education systems are in fact very much influenced by ingrained social structures that have shaped mainstream educational discourse and the professional identity of educators (Cherkowski & Bosetti, 2014). This is especially evident in higher education where gender is a crucial element in the organization and division of labour that has effectively limited women’s upward mobility (Benshop & Brouns, 2003; Morley, 2011b). Social practices and gendered power relations symbolically and materially construct and regulate women’s everyday experiences of higher education (Morley, 2006). As Aubrecht & Mackenzie-Lay (2015) have argued, “Sexism and gender-based discriminations are interwoven in the very fabric of university life” (p.122).

This is exemplified by the fact that overall women account for a minority of the world’s researchers (UNESCO, 2015b). This has been historically evident in developed (Northern) countries. A recent large scale study conducted by Monroe, Choi, Howell, Lampros-Monroe, Trejo, and Perez (2014) revealed that within American academia women being underrepresented and underpaid in comparison to their male peers. Likewise in Canada, in 2013 across all academic disciplines women represented 24% of full professors, 38% of associate professors, 46% of assistant professors, and 56% of lecturers/instructors (Hango, 2013). According to the 2012 edition of the Euro politics Commission’s report, women were still the minority within the

research sector in Europe: they represented only 33% of the research community, and just 20% of senior academics were women.

Throughout the developing world gender disparities have been far more acute. To some extent this is explained by the fact that even when women have gained access to higher education as graduate students, this has not led them to high level career opportunities in fields of research (UNESCO World Atlas, 2012). Nevertheless, entrenched gender roles and intercultural relations have created structural barriers to women's professional aspirations (Sithole et al., 2013). Due to their social status as mothers and home-makers, the underlying processes and principles of the structure of higher education often make it difficult for women to meet entry-level positions and promotion requirements, particularly (Berggren, 2011). Women are frequently part-time workers juggling both career and family life (Benshop & Brouns, 2003).

Gender discrimination against women takes place in subtle and complex ways in higher education. It occurs via informal networks, coalitions, and exclusions, as well as by formal arrangements in classrooms and boardrooms (Morley, 2011b). Gender inequalities persist in the higher ranks of academia, which in turn affects retention. A large number of female scholars opt out of the academic sector very early in their careers due to marginalization. A study conducted by Nielsen (2017) revealed that "early-career female researchers face a number of marginal kicks or drawbacks, producing constrained career choices and preventing some of them from successfully translating their capabilities into sufficient scientific rewards and career advancement" (p. 149). As Kennedy (2015) observes, the university is "'man centred' ... in that it privileges and prepares men for leadership and power positions, which reproduces masculinist traditions within the university setting" (p. 129). This is apparent in the customary congregation of women academics in lecturer positions with limited opportunities for promotion (Acker, 2008; 2012; Sang, 2016). "The presence of men and absence of women in seniority in higher education means that men often have more opportunities to exercise power negatively" (Morley, 2011c, p. 103). This pattern of discrimination is essentially a form of hegemony that serves to maintain a gendered political foundation (Gülden, 2013). It has perpetuated discrimination of girls and women, and in so doing has limited economic progress because a large part of society's human resources are neglected (Tsikata, 2009). "Equality of educational opportunity, equity or diversity and social justice, across the educational spectrum, has become some of the key issues about

higher educational policies, practices or provisions globally” (David, 2011, p.147). This applies particularly to the fields of science and technology.

2.1.2 Gender Disparities in S&T

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, Wolter, Latsch, & Hannover, 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, Langdon, McKittrick, Khan, & Doms, 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, Wolter, Latsch, & Hannover, 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, Richardson, & Devos, 2012).

2.2 Women in Higher Education in Sub-Saharan Africa

Higher education in sub-Saharan Africa was instituted by colonial regimes to train future (male) African leaders for the development of their respective countries (Okeke-Ihejirika, 2009).

With the end of colonial rule, national universities were established, with most emulating the models of the former colonial powers (Lindow, 2011; Teferra, 2015). These higher education institutions proliferated in the 1950s and 1960s at the pinnacle of the movement towards independence (Mkude, 2011). As in the former colonial countries, public universities in sub-Saharan Africa have been portrayed as essential for political, economic, and intellectual decolonization for corresponding national development ambitions (Mwapachu, 2010). During the two decades following the success of independence movements across much of the African continent in the early 1980s, high hopes were invested in the rapid expansion of formal-education systems (Mama, 2003). Yet as Mohamedbhai (2008) has argued, in much of the developing world “higher education institutions [in Africa] experienced a rapid increase in student enrolment ... [known] as ‘institutional’ massification without an accompanying increase in financial, physical and human resources” (p. vii). This spontaneous, ill-prepared increase in enrolment inevitably had a detrimental effect on “the physical infrastructure, the quality of teaching and learning, research, the quality of life of students, etc.” (p. vii). This has been especially evident in sub-Saharan Africa where countries face a significant challenge in meeting growing annual demands for access to higher education (Teferra & Altbach, 2004). Participation in higher education in sub-Saharan Africa remains far behind that in other parts of the world in 2011 (Effah, 2011). As Table 2.1 shows, gross participation in tertiary education in sub-Saharan Africa in 2011 was the lowest in the world at 8%, compared to the global average of 30%.

Table 2.1 *Global distribution of tertiary education, 1995 and 2011*

| Region | 1995 (%) | 2011 (%) |
|----------------------------------|----------|----------|
| North America and Western Europe | 60 | 77 |
| Central and Eastern Europe | 33 | 68 |
| Latin America and the Caribbean | 17 | 42 |
| East Asia and Pacific | 10 | 30 |
| Central Asia | 23 | 24 |
| Arab States | 14 | 23 |
| South and West Asia | 6 | 18 |
| Sub-Saharan Africa | 4 | 8 |
| World | 15 | 30 |

Note: Adapted from Marginson (2016, p. 294)

Moreover, ironically, even as enrolments in higher education have increased, albeit slower than the popular demand would require, for many university graduates higher education has not translated into increased employment opportunities. Access to education, considered as the main path to upward mobility in many parts of Africa, has become excessively inequitable with worrisome gender disparities, evidence of gender inequalities.

2.2.1 Gender Inequality in Higher Education

In many African countries, higher education is regarded as a critical force for modernization and development. Yet, the highest level of gender disparity in tertiary enrolment ratios in the world has been found in sub-Saharan Africa (Assie-Lumumba, 2006; Mabokela & Mlambo 2015). Challenges related to women's access and gender inequality in higher education in sub-Saharan Africa are unparalleled (Teferra & Altbach, 2004). Gender biases prevailing in much of sub-Saharan Africa have been internalized and exemplified in the higher education contexts (AAU, 2006). Consequently, gender issues are assessed with apprehension and misgiving, and gender advocacy is often dismissed and criticized as an intrusive western concept to African traditions (AAU, 2006). Such ideological viewpoints and social climates have caused the structures of higher education to reflect existing power relations in society (Okeke-Ihejirika, 2009).

For many reasons, women are highly underrepresented among faculty and administrators, particularly, in senior level decision making position and administrative ranks (Johnson, 2014). Gender inequalities are significantly rooted in the highly patriarchal culture and history of sub-Saharan Africa, and thus impact perceptions, reasoning, and practices in higher education in the region (Maree & Maree, 2007). This patriarchal culture thwarts women's authority and relegates them to subordinate positions. African cultures, for example, generally promote marriage and motherhood as women's paramount goals in life (Adusah-Karikari, 2008). Conflicts in managing their multiple roles as mothers, wives, and employees have therefore led many women to abandon or interrupt their careers. The impact of family dynamics, the rarity of mentoring and networks, and the power of "old boys" networks have been other key concerns (Adusa-Karikari, 2008).

2.2.2 Gender Inequality in S&T Education

African countries continue to face a shortage of S&T specialists, in part because, as in many countries around the world, there is an overall shortage of individuals with graduate degrees in S&T. Gender inequality is likewise most pronounced in S&T programs, with lack of access being one of the major contributing factors. While women in other regions of the world face many obstacles in gaining access and pursuing careers in S&T, in general, the situation is much more conspicuous in sub-Saharan Africa (Mabokela & Mlambo 2015). Table 2.2 presents gender distributions of instructors in physical science, technology, engineering and mathematics faculties in 10 Southern African countries in 2011. The table shows that Mozambique had the lowest percentage of female representation in S&T faculties (23%), while Angola had the highest percentage (40%). In all 10 countries, men were in the majority.

Table 2.2 *Gender distributions in faculties of sciences by country in 2011*

| Country | Female (%) | Male (%) |
|--------------|------------|----------|
| Angola | 40 | 60 |
| Botswana | 28 | 72 |
| Lesotho | 26 | 74 |
| Malawi | 37 | 63 |
| Mozambique | 23 | 77 |
| Swaziland | 28 | 72 |
| Tanzania | 30 | 70 |
| Namibia | 39 | 61 |
| South Africa | 39 | 61 |
| Zimbabwe | 24 | 76 |

Note. Adapted from Morna & Jambaya-Nyakujara (2011, p. 95)

The limited number of women role models, especially at the graduate level, further exacerbates the lack of interest in pursuing careers in S&T (Jones, 2011; Ochwa-Echel, 2011). Women from rural areas who do manage to complete S&T programs and pursue careers in the field rarely go back to villages or rural areas to teach or conduct research simply because of lack of opportunities to do so (Kwesiga, 2002; Ochwa-Echel, 2011). As a result these women do not

serve as role models and mentors for young girls and women in these areas. In addition, however, women who choose education and a career in S&T over their societally assigned roles¹ face many other challenges such as institutional constraints, and socio-cultural obstacles (Ochwa-Echel, 2011). They are often relegated to lower positions where they have little influence over the structure and culture of departmental proceedings (Mlambo & Mabokela, 2016). Gender inequality in S&T programs and rigid conformity on the basis of stringent gendered presuppositions that divide men and women can likewise generate stress among girls and women confronted with daily discrimination and marginalization (Baric, 2013).

2.3 Obstacles Faced by Girls and Women in the Pursuit of S&T Higher Education

Concerns about gender disparity in higher education, have led scholars to examine common differentiated obstacles that young girls and women face in higher education, especially in S&T fields. These can be characterized as follows: a) psychological; b) attitudinal; c) socio-cultural; and d) institutional. What follows is an overview of these obstacles.

2.3.1 Psychological Obstacles

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 S&T 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, Salmela-Aro, Lavonen, & Schneider, 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, Salmela-Aro, Lavonen, & Schneider, 2014). Female students also experience less intrinsic motivation and more withdrawal

¹ As stated in the introductory chapter, women are commonly regarded as fit for housework and child-rearing. They are viewed as being suited for nursing and caring professions.

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 S&T. For example, Schulze and Heerden's (2015) study explored six motivational factors mostly related to classroom environment: (a) self-efficacies², (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, Lee, McCarthy-Donovan, Hwang, Yim, & Seo (2015) demonstrated that low parent interest in S&T influences the intrinsic motivation of adolescents and their pursuit of an S&T 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" (p. 1481).

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, DeWitt, Osborne, Dillon, Willis, & Wong, 2013). Moreover, girls and women tend to value social sciences and humanities such as art, linguistics, and education, thus

² Students' self-efficacy beliefs relate to their views about "their capabilities to perform the tasks necessary to achieve a desired outcome" (Hutchison, Follman, Sumpter & Bodner, 2006, p. 39).

³ Confucianism is a religion, or the way of life promoted by Confucius in the 6th–5th century before Christ and followed by the Chinese people for more than two millennia. Its influence has also extended to other countries, particularly Korea, Japan, and Vietnam (Weiming, 2018).

developing interest in professional careers traditionally assigned to women such as teaching, social work, nursing, etc. (Roy, Mujawamariya, & Lafortune, 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 S&T 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 S&T. Women who undertake “hard or masculine-oriented” (Boateng, 2015, p. 41) disciplines are therefore regarded as violating societal patriarchal norms concerning education and specifically S&T. Thus, the imminent risk of setbacks deters women from pursuing a career in S&T (Faulkner, 2000; Mlambo & Mabokela, 2016).

Building on previous work related to the negative impact of emotions generated by S&T learning environments on student rationality, Chiang and Liu (2014) investigated the emotional experiences of S&T undergraduate students. They concluded that gender, teaching methods, criticism, and learning assignments influence *academic emotions* in three contexts: “attending science class, learning scientific subjects, and problem solving” (p. 908). Teaching and learning processes generate these emotions, a wide array of observed feelings such as “happiness, tiredness, fatigue, anxiety, anger, and disappointment” (p. 909) that students experience within S&T learning environments and specific actions associated with S&T learning. 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. Hence the use of a variety of lesson plans and teaching methods to accommodate diverse psychological attributes with the aim of assisting students in managing their academic emotions is necessary.

Numerous studies have revealed that women are regularly exposed to stereotypes and discrimination (Di Bella & Crisp 2016). Cheryan, Plaut, Davies, and Steele, (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, Vescio, Loken, & Lo, 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 S&T challenges to internal causes like lack of aptitude and competence while men's S&T setbacks are usually blamed on external factors such as inappropriate circumstances or regrettable situations (Cundiff, Vescio, Loken & Lo, 2013). S&T environments are unwelcoming to women (LaCrosse, Sekaquaptewa, & Bennett, 2016). Consequently, women internalize these negative gender stereotypes and are convinced that they have lower capabilities in S&T disciplines than men. These beliefs support the dissociation of women from S&T, generating lower interest in S&T careers. Additionally, gender stereotypes related to S&T aptitude are very detrimental to women. Hence, women are more likely to view themselves as the target of gender discrimination.

2.3.2 Attitudinal Obstacles

As the gender gap in S&T programs persists, extensive insight into the attitudes of female students towards S&T programs becomes essential. A number of scholars have asserted that negative attitudes toward S&T impede student interest in S&T careers (Dorpenyo, 2011; Gokhale & Machina, 2014).

Gokhale and Machina (2014) investigated undergraduate student attitudes toward information technology (IT). They asserted a correlation between exposure to IT and positive attitudes toward IT, meaning that the more exposure women have to information technology the more positive the attitudes they develop. The findings revealed that men have more positive attitudes towards IT than women and believe that they have more job opportunities in IT when

compared to women. Female students, on the other hand, think that the IT field is skewed in favour of men. Women need to have more and earlier exposure to computers and other technological tools to be able to develop more positive attitudes toward IT.

Hence, attitudes contribute to the underrepresentation of women in S&T (Dorpenyo, 2011). “The social construction of information technology as gendered practice” (Abbiss, 2008, p. 153) is the issue of concern rather than the IT schooling. For example, the computer industry promotes a “masculine computer culture, mainly computer gaming” (p.156), which is essentially conceived by men for male consumers. The gender-biased images in those computer games tend to appeal to men while women find them socially inappropriate and boring (Gokhale, Rabe-Hemp, Woeste, & Machina, 2015). Since the majority of the designers are men relying solely on males’ perspectives, it is evident that most computer game designs appeal more to men than women. It is obvious that adopting a gender neutral position in the design and analysis of prototypes makes it difficult to see how the underlying social structures and values are detrimental to women. As demonstrated by Rode (2011), ignoring inherent gender differences in the S&T fields simply perpetuates the marginalization of women. Moreover, the underrepresentation of girls and women in the S&T fields hinders the optimization of female’s contribution to scientific and technological discoveries and designs as well as the highly acclaimed knowledge-based economies (Ghiasi, Larivière, & Sugimoto, 2015). In addition, students who are already in S&T programs need to persist in order to complete their degrees. *Persistence* is defined as an individual’s firm determination to complete a course of action in spite of difficulty or opposition in order to succeed in accomplishing his or her goals (Griffith, 2010). The high attrition rate in S&T proves that many students whose first choice is S&T do not necessarily major in that area. This is particularly true for women.

The persistence in S&T is much lower for female students than for males. For instance, in South African S&T institutions, the attrition rate for females is twice that of men. In fact, the female attrition rate is estimated at 50% (Mitchley, Dominguez-Whitehead, & Liccardo, 2014). An in-depth examination of the issue has shown that educational experiences, especially during the first two years of an S&T program, influence a student’s decision to persist (Griffith, 2010). The discouraging elements of female students’ experiences in S&T fields include (a) the length of time required for completing the program; (b) the high level of competition in S&T classes; and (c) grades, academic achievements, and preparation of students (Griffith, 2010). It is obvious

that S&T education programs are mostly longer and more expensive than humanities and social sciences programs and are highly competitive and thus less appealing to women.

2.3.3 Institutional Obstacles

While psychological/cognitive and personal attitudes are believed to have contributed to women's underrepresentation in the S&T fields, institutional obstacles also negatively affect women's pursuit of S&T programs. Stout, Dasgupta, Hunsinger, and McManus (2011) posited that gender stereotypes and academic cultures influence women's achievements in S&T. Girls and women are exposed to the "message that their in-group is worse in S&T programs compared to their male peers" (p. 255). S&T disciplinary cultures are "gendered and have a gendering effect of their own" (Gilbert, 2009, p. 24) 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 S&T fields as primarily suited to boys, a notion that is reinforced in S&T textbooks that very rarely refer to the work of female scientists (Stout et al., 2011). Invariably, therefore, female students often view S&T 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 S&T educators and teachers," (Stoilescu & McDougall, 2011, p. 312), and elementary and secondary schools S&T teaching practices often ineffectively prepare girls to succeed in S&T learning environments (Mujawamariya, Boucher, & Mavriplis, 2014). Hence, females and males start their undergraduate study programs with different levels of experience and exposure to S&T. For instance, female students have less experience in computers than their male colleagues at the beginning of the S&T educational program, and for most females, computer science is not their initial major (Stoilescu & McDougall, 2011). Cheryan, Plaut, Davies, and Steele's (2009) study revealed that the stereotypical computer science context reduces women's "sense of belonging

⁴ Masculinity relates to a society in which psychological gender roles are plainly clear. Men are supposed to be authoritative, strong, while women are supposed to be humble and caring (Hofstede, Hofstede, & Minkov, 2010).

⁵ (Reflecting on gender, for example, a girl learns in childhood that the cultural prescription for femininity includes caregiving and childrearing, these are then incorporated into her emerging and lasting schemas of gender belief systems (Eagly and Koenig, 2006) and she might adjust her behaviours and aspirations accordingly (Diekman & Eagly, 2000; Fida Afiouni and Charlotte M. Karam, 2013, p.551).

and interest” (p. 1045) in S&T. It is evident that teaching/learning practices in S&T education need to adopt a gender sensitive approach to allow both women and men to benefit from the learning environment.

Students’ often competitive learning environment is mentioned as a major hindrance to retention, mainly in S&T courses. Nonetheless, teachers continue to make matters worse by adopting competitive teaching methods that are not particularly favourable to girls (Gaudet, Mujawamariya, & Lapointe, 2008; Samson, 2014) even though a number of studies have demonstrated that girls and women perform better in a cooperative learning environment (Mitchley et al., 2014). These practices tend to exacerbate the ethical and social problems that challenge students in S&T education and suggest a lack of efficiency in tackling the issue of gender disparity in S&T classes (Lewis, Lang, & McKay, 2007; Stoilescu & Egodawatte, 2010).

Teaching approaches can enhance or limit students’ ability to understand the content of the subject being taught. The focus of teaching/learning should be on mutual engagement between the institutions and students (Ulriksen, Møller, & Holmegaard, 2010). Furthermore, researchers could focus more on S&T teaching practices than student aptitudes (FAWE, 2005). The use of gender-sensitive teaching methods is as important as the learning environment in encouraging students to develop an identity in the S&T field (Hughes, Nzekwe, & Molyneaux, 2013).

Another factor that leads to the avoidance of S&T disciplines is the infrequency of relationships between students and role models. Human beings are social animals and wish to fit or belong to specific groups (Leaper, 2015). As Cheryan and Plaut (2010) pointed out, the more students identify experts in the field with apparent hopes for success, the more interest they develop in the field (Logel, Walton, Gregory, Spencer, Iserman, Von Hippel, & Bell, 2010). In a nutshell, the lack of role models and mentors in S&T fields contributes to gender disparity (Rosenthal, London, Levy, Lobel, & Bazile, 2013).

Carell, Page, and West (2010) suggested that the professor’s gender has little impact on male student performance in math and science classes. However, it has a powerful effect on female student performance. Therefore, the instructor’s gender can also perpetuate gender disparity in S&T higher-education programs. Gender stereotyping exists in school curricula and academic programs, given the fact that some subjects and courses such as S&T disciplines are considered masculine, while secretarial studies and home economics are deemed feminine

(Okeke-Ihejirika, 2009). Efforts to address the issue seem to fall short of tackling the root causes of the problem. A study conducted by Chikunda (2014) in an attempt to address gender disparity in Zimbabwean universities, revealed that there was underlying tensions in S&T teacher education program – due to patriarchal views – that hindered the progress towards gender-responsive curriculum practices despite numerous gender-related policies available with potential to transform curriculum. The inability to transform the S&T learning and work environments negatively affects the experiences of girls and women in the S&T fields. The metaphor of “*chilly climate*” has been used to categorize women’s experiences –Feeling of isolation and solitudes is generated by the ‘chilly’ classroom climate that extends to the workplace (Sulaiman & Almuftah, 2010, p. 508).

The solitudes of academic women are mainly due to discrimination, prejudice and stereotypes leading to marginalization that brings about many challenges such as lack of mentors, subtle exclusion from promotion and tenure procedures among others (Whittaker, 2013). This was reflected in Patricia Palulis’ narration of her traumatic experience in the process of her obtaining tenure and promotion at her educational institution. Her struggles started with the introduction of a new theoretical perspective, “*the language of écriture feminine*”, into her writing that collided with her tenure and promotion application (Palulis, 2015, p. 81). Her application has been deferred by the Faculty Teaching and Personal Committee, supposedly to give her more time to establish her independence as a researcher, despite the fact that all the required evaluators rated her work favourably. Palulis (2015) noted: “I found myself entangled in the discursive spaces that had journeyed with me ... and have sheltered me and inspired my writings” (p. 81). This awkward position based on institutional discrimination and impediments led to her marginalization as she was abandoned by her colleagues who treated her differently. This led to total isolation and solitudes that deepened throughout her ordeal (Palulis, 2015). Palulis’ experience is closely linked to what Collins termed ‘outsider/within’ social location which is a peculiar marginality. Collins (2000) points out that “being in outsider-within locations can foster new angles of vision on oppression” (p. 28). For example, members of the oppressed groups often have unique experiences that transpire from their location as insiders such as members of academia and outsiders, female academics whose experiences and views are excluded from mainstream scholarship (Collins, 2000; Intemann, 2010).

There is strong evidence that recruitment and promotion patterns in academia are oftentimes opaque and based on social structures (Van den Brink, Benschop, & Jansen, 2010). Women in academia struggle for identity and power for “the land of Academia is territorial [while] cartographies of gender persist” (Palulis, 2015, p. 96). Essentially, gender disparity at senior levels of academia is generally interpreted as lack of ambition rather than the absence of opportunity (Benschop & Brouns, 2003, Sang, 2016). Monroe and Chiu (2010) stated that “tenure status is not easily transported because higher education is not an open labour market” (p. 307). Moreover, women who seek entry into male-dominated fields are expected to adapt to the norms and values of these fields, where patriarchal and stereotypical ideas of how women should behave are enforced (Mlambo & Mabokela, 2016).

Despite decades of efforts aimed at increasing women’s representation in S&T fields, women remain stubbornly underrepresented at the highest levels of many S&T disciplines. Furthermore, among individuals who earn PhDs in S&T fields in the U.S., disproportionate numbers of women fail to turn up among the ranks of assistant professors, and among those women who pursue academic jobs at U.S. colleges and universities, a disproportionate number fail to obtain tenure (Goulden, Frasch, & Mason, 2009; Shalala et al., 2007). Explanations for the gender disparity in S&T fields have been hotly debated for decades, (Hayes & Bigler, 2013) and the discourse is active as ever. Sometimes, women who are well qualified choose not to apply for positions of power. There seems to be self-imposed boundaries that prevent women from seeking decision-making positions. It is apparent that women are often judged harshly, not only by men but interestingly by women who are the worst critics of fellow women (Whittaker, 2015).

As many scholars have argued, discrimination against women, especially in S&T programs, stems from a combination of social, cultural, and structural factors (Osborne, Simon, & Collins, 2003; Sinnes & Loken, 2014). In this section, I have provided a general overview of the negative effects of society and culture on girls and women’s formal education, but it is also important to discuss socio-cultural factors that create barriers to girls and women’s access and participation in S&T higher-education programs.

2.3.4 Socio-Cultural Obstacles

The home environment is another primary contributing factor to gender disparity in S&T fields. S&T culture is still mostly regarded as authoritative, competitive, impartial, and male-

dominated. Chikunda (2014) demonstrated how “parents' perceptions of their children's academic abilities predict the children's confidence in their academic abilities” (Eccles, 2015, p. 120). Additionally, parents’ beliefs about their children's capabilities differ according to the sex of their children (Eccles, 2015). “Cross-culturally, communal personality traits such as warmth and concern for others are ascribed to women, whereas agentic personality traits such as assertiveness and competitiveness are ascribed to men” (Bosak, Eagly, Diekmann, & Sczesny, 2018, p. 116).

The culturally shared gender stereotype that males are naturally more talented in math than females causes parents to somewhat overstate their sons' math abilities while underestimating their daughters' math aptitudes. Consequently, some parents tend to believe that their daughter's math success is more related to hard work and their son's success is due to talent (Eccles, 2015; Fredricks & Eccles, 2005). The common view of the labour market also impacts girls and women’s upbringing. In addition to the home environment, societal culture also contributes to gender disparity in S&T, notably in sub-Saharan Africa (Muringa & Makaudze, 2014; Sinnes & Loken, 2014). Hofstede, Hofstede, and Minkov (2010) defined *culture* as attitudes, ideas, beliefs, values, and knowledge shared by members of a social group. Women have been disproportionately disadvantaged due to their limited access and unequal opportunities. Lack of education has been a strong visible barrier to female participation in the formal sector. Therefore, women are marginalized and become too dependent over their spouses.

With regard to socio-cultural obstacles, *patriarchy* has been one of the most tenacious contributors to gender inequality in higher education. The situation of women globally is entangled in issues of male domination over women (Akita, 2010). Patriarchy, with its roots in early civilization, exists in most human societies and has been enhanced by cultural values based on male dominance (Akita, 2010). Patriarchy relates to the institutionalization of male domination over females while reiterating and preserving the gender roles, attitudes, and social stereotypes between the sexes (Dlamini & Adams, 2014). Makama (2013) summarized patriarchy as the hierarchical structure observable in all aspects of society mainly culture, education, religion, and politics. In the African context, patriarchy is reflected in the assignment of roles based on cultural values and perspective in a hierarchal way so that men are dominant, and women are subordinate (Machira, 2013). Patriarchy is an ideology linked to all social establishments such as family, religion, law, the economy and schooling, among others.

Patriarchal ideologies connect women to motherhood, caregiving and frugal values, while men are portrayed as assertive, aggressive and protective of their families and thus responsible for their financial well-being (Ridgeway, 2011, Stromquist, 2015). The ideology of patriarchy entrusts men with most social advantages, such as property ownership, education, training, and economic power, while limiting women to the home and agricultural work (Machira, 2013).

Chikunda (2014) provided insight into how patriarchy impacts teaching styles and curricula while reinforcing gender inequality in higher education, particularly in S&T programs. Teacher trainers are somewhat affected by their own norms and values and are often unable to pinpoint gender discrimination in their programs (Chikunda, 2014). Therefore, when developing teaching materials, teacher trainers do not think that it is necessary to take into consideration social and cultural forces that sometimes influence scientific knowledge (Chikunda, 2014). Teacher trainers need first to be cognizant of gender issues to be able to efficiently sensitize future teachers about gender awareness issues (Chikunda, 2010, 2014; Mujawamariya, 2013). The concept of patriarchy is an essential tool in the analysis of gender relations and power. It is best analysed as a set of discourses that are institutionally established rather than as an ideology that is either insubstantial or economically determined (Walby, 1989, 2011). Therefore, it is necessary to challenge patriarchy in order to improve the situation. Research on gender and S&T is essential to “de-gender S&T fields” (Lucht, 2016, p. 67).

The hegemonic relations of gender shape the expectations of society and consequently the life aspirations of individuals (Molla & Cuthbert, 2014). The hegemonic relations also reflect and reinforce the dynamics of social relations in a more extensive society that subordinates women (Mauthner & Edwards, 2010). The socio-cultural expectations embedded in women’s lives and roles place pressures, especially on ambitious women, limiting the boundaries for every female (Molla & Cuthbert, 2014). In parts of Nigeria, as in some sub-Saharan African countries, it is observed that “womanhood is reduced to a mere infidel and a second-class citizen; hence, there is the commonality of a general belief system that the best place for women is in the ‘Kitchen’” (Makama, 2013, p. 115). The assigned gender roles provide distinct social interpretations of girls’ and boys’ personal aspirations (Lynch & Nowosenetz, 2009). These traditional gender roles are linked to cultural beliefs, norms, and values.

The dominant patriarchal society sets up the boundaries for the consistent unequal positioning of women in families by allowing gender-differential terms in inheritance rights and

legal adulthood (Makama, 2013). Mbiti's (1969) study (as cited in Mboyo, 2014) argues that there are several laws, customs, set forms of behaviour, regulations, rules, observances and taboos that constitute the moral code and ethics of a given community or society. Any violation of this code of behaviour is considered evil, wrong or bad, because it is believed to be an annihilation of the accepted social norm and value. Africans have traditionally been very conscious of the social dimension of morality. Consequently, any serious breach of the moral order has a social aspect believed to have adverse effects on the whole community (Mboyo, 2014). Young women, particularly in rural areas, experience customary family pressures as gender-role stereotypes and societal discourses encourage them to get married early (Gudhlanga & Chirimuuta, 2012). These norms also penalize women who transgress them (Ogbogu, 2011; Makama, 2013).

Discrimination against women stems from a combination of social, cultural, and structural factors. Together with concerns about access, gender equality requires addressing multiple oppressions such as the intersection between poverty, social-class, power, and race, all of which generate further disadvantages (Holmarsdottir, 2013). In contrast with the situation in primary and secondary education in sub-Saharan African countries, tertiary education has not benefitted from the attention required for success. Gender equality requires that multiple oppressions and concerns about access be addressed.

The issue of gender inequality in higher education, in general, and S&T fields in particular, is a complex one. In this chapter, the focus has been on women in higher education and their struggles for equality, particularly in S&T disciplines. Gender inequality in S&T higher education is caused by a combination of several factors. On the one hand, gender stereotypes, a shortage of skilled, trained teachers and mentors, especially female role models, and the inability of governments to implement gender policies are contributing to this endemic disparity. On the other hand, gender roles assigned to men and women, psychological, attitudinal, and institutional factors; science curricula; biased instructional materials and teaching methods and socio-cultural obstacles contribute to the underrepresentation of women in S&T fields worldwide and intertwine to cause gender inequality in S&T higher education.

To explain the factors that underlie gender disparity in S&T higher education, I have examined the issue from many perspectives (cognitive, attitudinal, institutional and socio-cultural). Culture and patriarchy are often detrimental to gender-sensitive practices. Hence,

women continue to struggle for equality in S&T fields globally because of the many obstacles and constraints they face. This phenomenon is partly due to a power struggle in their daily social interactions, and so addressing structural inequalities in higher-education institutions necessitates a closer look at gendered experiences and power relations within such institutions.

Leaders, policy makers, social activists, and foreign and local development agencies in sub-Saharan Africa have consistently expressed concern over women's underrepresentation in higher education as a big stumbling block to social, economic, and political development. Women's socio-economic contributions, their access to and participation in public decision-making processes, as well as their overall contributions to socio-economic development, are more and more linked to obtaining tertiary-education degrees. Effective development strategies require the participation of both women and men on an equal basis.

CHAPTER 3: OVERCOMING GENDER DISPARITIES IN S&T - GLOBAL STRATEGIES AND POLICIES

Historically women have been excluded from access and from key decision-making processes in S&T disciplines. This exclusion, which has shaped and perpetuated gender inequalities in these disciplines, has been a product not only of cultural and historical factors but also of the patriarchal nature of S&T higher-education institutions favouring men. There is ample evidence that the underrepresentation of women in S&T education at the highest ranks of the academic profession is mainly the result of discriminatory practices and power imbalances (Beckman, 2014).

Three decades of discussions have brought about the implementation of an array of strategies and policies at local, national, regional, and international levels to address gender-inequality issues in the S&T fields. As a result of initiatives put in place to overcome gender inequality in higher education, specifically in S&T disciplines, in recent years there has been a modest increase in the participation of women in S&T education and workforce worldwide (Little & León de la Barra, 2009).

In this chapter, I examine how gender and power are intertwined and contribute to gender inequality and the oppression of women. I then discuss the struggle for women's empowerment and the strategies and policies that have been used to mitigate the negative impact of gender and power in education and workplaces. I highlight three main strategies for overcoming gender inequality in S&T higher education and empowering women globally: (a) consciousness-raising, (b) gender affirmative action, and (c) gender mainstreaming. The chapter concludes with a discussion of the challenges faced by institutions of higher education in the implementation of gender mainstreaming.

3.1 Gender, Power, and the Struggle for Women's Empowerment

In many parts of the world, women and men are brought up to emulate feminine and masculine role expectations respectively, and those expectations require divergent approaches to power (Mendelberg & Karpowitz, 2016). Men are socialized to maintain self-discipline over their emotions, a characteristic which is expected of those in positions of power (Hey, 2011). Women, on the other hand, are raised to develop caring and nurturing instincts associated with subordination (Hey, 2011). The differences in male and female socialization affect the exercise

of power. As Mendelberg and Karpowitz (2016) have argued: “gender affects how power is instantiated, reinforced, or undermined when people exercise voice” (p. 24). Similar to gender, the concept of *power* has been of interest to several researchers, who have used various perspectives and conceptualizations to explain the phenomenon. Scholars investigating power relations have consistently been drawn to Foucault’s (1980, 1982) conceptualization of power. According to Foucault (1982), power is felt everywhere in the daily interactions between individuals or groups of people. It is unconsciously present in all volatile situations and impacts all social debates. Even though power is not permanent, it is likely to change based on circumstances (Foucault, 1970). Power is thus the daily drama of class struggle linked to different forces (Foucault, 1977): “power is the thing that says no, it is the super-ego; it is the prohibition that functions only alongside repression, renunciation” (p. v). Allen (2008) on the other hand perceives power in terms of oppression and domination. Oppression constitutes unequal daily interactions between individuals or groups of people based on stereotypical cultural beliefs, prejudices, and structural and hierarchical distributions of power (Allen, 2008). Rather differently the notion of domination refers to institutional or structural barriers that inhibit self-determination.

Power also broadly refers to the ability, means, and capacity to act (Krane, Ross, Barak, Rowse, & Lucas-Carr, 2012). Sometimes power denotes force and strength, enabling one group of people to exercise dominance over other groups (Krane et al., 2012). Patriarchy, for example, is a complex form of power relations that legitimizes men’s domination over women. Even though “power is transactional, it always has costs and benefits for its holders” (Hey, 2011, p. 212). In fact, different types of resources are associated with power. The most common examples are *economic power*, emanating from wealth, ownership of the means of production, and income, and *positional power* linked to a position of authority (Logan & Huntley, 2002, Naidu, 2010). In patriarchal systems, men hold positional power over women.

Conceptualizations of power sometimes conceal or twist relevant evidence (Rolin, 2009). For example, workers afraid of losing their employment may choose to not testify against their boss, thus suppressing pertinent evidence. Husu’s (2001) empirical study of gender-based prejudices in academia revealed that it is oftentimes challenging for victims to report experiences of discrimination because such negative experiences are often emotionally and socially problematic for the accusers. Power relations often appear “as vehicles of domination when they

constrain an individual or a group's choices in a way that is harmful to the individual or the group" (Rolin, 2009, p. 219). Moreover, various aspects of inequality and power generate domination and subordination within the social fabric (Rogers & Kelly, 2011). Power is sometimes monopolized and used by specific groups of people to obtain and maintain economic and social control (Corus & Saatcioglu, 2015). This alludes to Gramsci's (1971) notion of *hegemony*, i.e., a coercive power emanating from the combination of values and norms imposed by dominant social forces. From a hegemonic perspective, the privileged group acquires power and preserves its dominance by propagating prevailing views, norms, and values throughout society. Ironically this dissemination of the dominant group's perspectives is done with the consent of the marginalized group (Gramsci, 1971). For example, education is not only a dominant force for social transformation but also a useful tool for disseminating hegemonic values.

While hegemony relates to the notion of marginalizing some groups and privileging others, it is not a fundamentally oppressive type of power (Sannino & Vainio, 2015). Thus, cultural hegemony is shrouded, subtle, and generally accepted as it is supported by predominant institutions (Angelique, 2012). Both privileged and marginalized groups simultaneously engender hegemony because "dominance based on consensus is a contradictory phenomenon that is historically constructed and thus bound to transformations" (Sannino & Vainio, 2015, p. 508). The structure of higher education institutions emulates the notion of power. In fact, the hierarchical structure of higher education workforces suggests an archaic and institutionalized sexism (Tettey, 2010). Yet as Romero-Hall, Aldemir, Colorado-Resa, Dickson-Deane, Watson, and Sadaf (2018) have observed, in academia social and cultural discourses imposed by patriarchal norms generate male hegemony in S&T that suppresses women's voices and subdues scholarship that threatens men's dominance.

Ironically, however, even though education may be at the root of some of the gender issues related to power differentials between men, women, and society at large, it also provides an opportunity for social development and heightened critical consciousness (Unterhalter & North, 2010). Highlighting the viewpoints and experiences of the powerless in university settings and enabling their voices to be heard is essential to the goal of social equality (Choo & Ferree, 2010). Likewise the enactment of strategies counteracting patriarchal hegemony and bridging

longstanding gender gaps in higher education, particularly in S&T fields, are ways in which carefully crafted policy initiatives can engender progressive change.

3.2 Gender Equality

The concepts of equity and equality are often used interchangeably due to the fact that equity leads to equality. In circumstances where men and women have disparate needs, responsibilities, and access to resources, gender equity relates to promoting fairness and social justice in allocating resources and opportunities for women and men. Rather differently, equality refers to the normative equitable distribution of responsibilities, resources, and power across both genders. “While equality can often mean treating everyone the same, equity involves providing people with what they need in order to achieve equality”. (Baily & Holmarsdottir, 2015, p. 832)

In this study, even though the focus is on gender equality both equity and equality will be used because equality and equity intersect and interact. Gender equity requires access to and participation of girls and women in all educational, economic, social, and political structures (Baily & Holmarsdottir, 2015; Singh, 2011) through gender affirmative action. It also relates to processes of empowerment whereby women develop the capacity to become effective agents of their own transformation. It involves the acquisition of skills and knowledge in diverse economic, psychological, cognitive, and political dimensions (DeJaeghere & Wiger, 2013; Stromquist, 2006).

International organizations associated with the United Nations (UN) and many non-governmental organizations (NGOs) have long advocated for gender equality. The 1995 Fourth Conference on Women held in Beijing⁶ was a significant breakthrough in global efforts for women’s rights. This event was followed by the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW)⁷, which laid the groundwork for advocacy for gender equality and women’s empowerment (Greenberg, 2009). Because it has been shaped by varying disciplinary and political perspectives (DeJaeghere & Wiger, 2013), the concept of gender equality has multiple meanings and has been the focus of several different approaches aimed at

⁶ The Beijing Conference on Women was the Fourth World Conference on Women. Titled “Action for Equality, Development and Peace”, it was convened by the UN September 4–15, 1995, in Beijing (UN, 1995),

⁷ On 18 December 1979, the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) was adopted by the United Nations General Assembly. “CEDAW calls for the ‘adoption of temporary special measures aimed at accelerating de facto equity between men and women,’ which is the definition of affirmative action.” (Appiah, 2015, p. 271)

enhancing the socio-economic status of women. The “women in development approach” (WID) has focused on the inclusion of women in economically productive activities (DeJaeghere & Wiger, 2013; Greenberg, 2009; Okeke-Ihejirika, 2009). The “gender and development approach” (GAD), on the other hand, has asserted the need to analyse and directly address institutionalized patriarchy and gender disparity (DeJaeghere & Wiger, 2013). According to the GAD approach, men and women should work together to address gender-equality issues (Greenberg, 2009). Accordingly the corresponding idea of “gender as socially constructed roles, responsibilities, and power [has moved] development thinking away from biological attributes (sex)... toward looking at how men and women relate to one another” (p. 51).

Another way of considering gender disparity has been through the capabilities approach which has been referred to “a broad normative framework for the evaluation and assessment of individual well-being and social arrangements, the design of policies, and proposals about social changes” (Robeyns, 2005, p. 94). Capabilities consist of functions that an individual can perform as a result of available opportunities (Boni & Walker, 2013; Sen, 1999, 2009). From this perspective human well-being is dependent on the possibilities of what one can be, what one is capable of doing, and the exercise of one’s capabilities (Nussbaum, 2011; Walker, 2015; Wilson-Strydom, 2015). These different interpretations of gender equality are often sources of debate. Nonetheless, “the use of multiple discourses suggests that specific local adaptations of WID, GAD, and capabilities-based approaches may all be useful in the work toward gender justice” (DeJaeghere & Wiger, 2012, p. 557). These approaches inform the meaning of gender equality in different contexts. Substantive equality necessitates the elimination of obstacles that restrain women’s access to resources and services and the limitation of power differentials between men and women while promoting women participation in decision-making. In education, for instance, the notion of gender equality extends beyond access to educational opportunities and the quality of education. In S&T fields, therefore, gender equality is a goal that connects the empowerment of women and the elimination of gender disparities.

3.3 Strategies and Policies Used to Address Gender Inequality in S&T Higher Education

Fair distribution of public goods such as education is contingent upon how the problem of inequality is understood by policy actors, as well as those in political power, and the degree to which they have the political will to tackle the challenge of gender inequality (Molla, 2012).

That being said, adherence to various international agreements aimed at improving education, particularly girls and women's education in S&T programs does require policy initiatives. Policies, however, are largely political in nature. They derive from the assumptions, values, and claims of decision-makers that are revealed in the extent to which policy formulation translates into subsequent action or inaction (Molla, 2012).

In addressing major social problem such as gender inequality in higher-education S&T disciplines, three sequential processes generally occur. These are: (a) consciousness-raising, (b) affirmative-action, and (c) mainstreaming. Below I shall elaborate on each of these approaches towards the promotion and enhancement of gender equality in S&T higher education.

3.3.1 Consciousness-Raising

Consciousness-raising has been an important means of instigating social change (Kelland, 2016). This is because, as patriarchy is often ingrained in social and educational institutions, there is a need for a change of mentalities and behaviours (Stromquist, 2013). Gender consciousness-raising through education, advocacy, popular media, and public demonstrations has been a vital catalyst for policy formulation and implementation. The creation of advocacy groups has also been a common way of raising consciousness about gender issues in S&T. In the sub-Saharan African context, Machira (2013) has called for development practitioners such as NGOs and advocacy groups such as the Forum for African Women Educationalists (FAWE)⁸ and the African Women in Science and Engineering to promote, encourage, and help girls and women to pursue education to the highest level, especially in S&T. The role of such advocacy groups are especially useful in rural areas in sub-Saharan Africa where girls and women are mostly subjected to patriarchal and other discriminatory cultural practices that hinder their formal education (Dlamini & Adams, 2014; Unterhalter & North, 2010).

The dissemination of research on gender has further helped to raise global awareness about gender inequality and facilitate increased participation of girls and women's education. As well, the creation of university research units devoted to women and girls in science has enhanced research efforts while helping to sensitize, motivate, and encourage young girls to consider careers in S&T. A typical example of such a research unit is "la Chaire Marianne-

⁸ FAWE is a pan-African non-governmental organization founded in 1992 by five women ministers of education to promote the education of girls and women in sub-Saharan Africa by making sure they have access to schools and are able to complete their studies and fulfill their educational aspirations (FAWE, 2005).

Marechal" (Varin, Dionne, Bernard, Lacroix, & Riopel, 2008, p. 117) in Quebec that actively promotes girls and women's participation in S&T. These research units can also help to reduce stereotypes and biases that hinder recruitment and retention of girls and women in S&T.⁹ Nevertheless, in much of sub-Saharan Africa, "while there has been progress in raising awareness and challenging gender stereotypes in the media and popular culture, as well as in engaging men as partners, the battle to change the mindset is still far from won" (Ndulo & Grieco, 2009, p. 2).

3.3.2 Affirmative-Action

While being aware of an issue is an important step towards change, it does not necessarily mean that all stakeholders will take actions to change their views, ways of life, and behaviours. Oftentimes, "males publicly support equity, but behind closed doors work to promote the interests of the boys' club, while women are put in their place, in the kitchen where they belong" (Dlamini, & Adams, 2013, p. 128). Without full commitment, the required change of habits and practices are unlikely to take place. Beyond consciousness-raising, concrete actions are imperative.

Affirmative-action approach is ordinarily adopted by institutions and workplaces trying to remedy past discriminatory practices while promoting racial, ethnic, and gender inclusiveness (Resnik, 2005). In efforts to foster inclusive education, many countries have introduced affirmative-action programs by giving preferential admission to education for groups that have consistently faced discrimination (Bertrand, Hanna, Sendhil, & Mullainathan, 2010). Similarly, employers have introduced equal-opportunities clauses in their human-resource policies so as to diversify their workforce. The creation of equal opportunities related to gender is designed to eliminate obstacles, biases, prejudices, and gender stereotypes that impede women's participation in formal economic activity.

In education, three main approaches to affirmative action have been used for student admission and staff recruitment: (a) quota systems (b) preferential treatment, and (c) outreach programs (Oppenheimer, 1996; Resnik, 2005). A *quota system* allots specific percentages for disadvantaged groups so as to admit desired numbers of candidates into various university

⁹ A typical example of such a research unit is the Chaire Marianne-Mareschal (Varin, Dionne, Bernard, Lacroix, & Riopel, 2008) in Quebec, which actively promotes women and girls and women's participation in S&T.

programs based on gender, ethnic group, race, or other criteria. For example, Bertrand et al. (2010) have indicated, in state-controlled colleges in India, more than 50% of admission spaces have ordinarily been allotted to members of lower-caste groups. Somewhat similar to a quota system, *preferential treatment* identifies specific criteria of particular groups as a key basis for candidate selection. Rather different are *outreach programs*¹⁰ that inform and encourage targeted groups to apply to an educational institution or program (Resnik, 2005). Overall, affirmative-action policies have been used successfully in many parts of the world to increase admission rates of disadvantaged groups in higher-education institutions and to promote a diverse workforce.

There are numerous well documented examples of gendered affirmative action policies. Peterson's (2011) study of gender-mix policy (a form of preferential treatment) in Sweden revealed it to be an efficient means to increase the relative number of female senior managers in higher education. The policy stipulated that "management teams (vice-chancellors and pro-vice-chancellors, deans and pro-deans) should be composed of at least one woman and one man, thereby creating gender-balanced teams" (Peterson, 2011, p. 622). Swedish higher education has set a quota of 40% for women in all academic positions and committees. Consequently, when applications for these positions are scrutinized, the sex of candidates is an essential criterion. Without this gender-mix approach to appointments, it is likely that men would have continued to dominate in the name of academic meritocracy (Peterson, 2011). The gender-mix policy has helped to increase the percentage of women managers in Swedish higher-education institutions dramatically between 1990 and 2010: it rose by 30%. Table 3.1 below provides more detailed information on the increase of the percentage of women managers within 20 years.

¹⁰ "An outreach program is method for increasing the diversity of the pool from which selections are made, such as informing minority students about a college or university and its admissions requirements; programs to encourage minority students to attend college; and programs that encourage women or minority students to consider careers in math, science, or the professions" (Resnik, 2005, p. 78).

Table 3.1 *Percentage of women in management Positions in Sweden, 1990 & 2010*

| Position | 1990 | 2010 |
|---------------------|------|------|
| Vice-chancellor | 14% | 43% |
| Pro-vice-chancellor | 19% | 60% |
| Dean | 3% | 31% |
| Pro-Dean | 0% | 46% |

Note. Adapted from “The gender mix policy: Addressing gender inequity in higher education management” Peterson (2011).

A similar study done by Lucht (2016) examining policies aiming to address gender-equity issues in S&T higher education and research also revealed positive results. Contrary to the widespread assumption that graduate physics programs and the S&T research workforce are generally male-dominated, the author’s ethnographic case study of a physics laboratory in a German technical university found more women than men at the PhD and postdoctoral levels. Three main factors contributed to the high level of female participation: (a) policy initiatives aimed at promoting gender equity in science; (b) organizational aspects exhibited by the research community under investigation; and (c) a more open-ended professional culture of physics. The study revealed that gender equity policies of the physics laboratory fostered recruitment and organizational norms that encouraged interactions between women and men of different educational and professional backgrounds (Lucht, 2016).

A further example of affirmative action is recounted by Bertrand et al. (2010) who investigated a program that sought to extend opportunities and raise income for lower-caste groups, including females, in engineering colleges in India. Contrary to the arguments of some critics that the affirmative-action program would displace some groups of students to the benefit others, the study showed that affirmative-action policies were actually successful measures for simultaneously increasing diversity and allocating resources to relatively disadvantaged families. Similarly, in 2012 at the University of Brazilia, 20% of the admission slots were set aside for students who self-identified as Black (Francisa & Tannuri-Pianto, 2012). After comparing displaced and displacing applicants, the authors noted that racial quotas had been somewhat useful in improving equity. However the findings also revealed that the scale and scope of redistribution were insufficient, suggesting that the majority of Brazilians had little chance of attending college. Although the affirmative-action policies had been instrumental in promoting

equity: however, more still needed to be done to give access to many more disadvantaged students.

In sub-Saharan Africa, affirmative action approaches in higher education institutions have been formally adopted as a part of a revitalization process focusing on inclusion and increased quality, access, and equity (Singh, 2011). Yet the affirmative-action policies implemented by many African institutions of higher education have generally had limited effect and are nowhere close to creating the levels of inclusion required, considering the magnitude of the systemic inequities in the institutions and society at large (Singh, 2011). This was exemplified in Zimbabwe when the central government introduced a policy of universal education that prohibited gender discrimination in education while promoting gender-inclusive policies and procedures. A study conducted to assess the gender responsiveness of the curriculum in Zimbabwe revealed that the effect of the policy on the admissions of female students had been limited and that the proportion of new school entrants remained largely unchanged (Gudhlanga, Chirimuuta, & Bhukuvhani, 2012).

One weakness of using only affirmative action as a means of reducing gender discrimination is that disadvantaged groups who are admitted into programs as a result of affirmative-action policies are often expected to assimilate without any attempt being made to address the institutional and social factors that may have been the root causes of the gender disadvantage in the first place (Wilson-Strydom, 2011). This was the case in Zimbabwe where institutional notions of gender and gender equity were misplaced, leading to limited achievement of the objectives (Chauraya, 2014). While the affirmative action policies led to an increase in the number of students admitted into the universities, those benefitting from the policies felt socially excluded and stigmatized. This led to the realization that greater emphasis on consciousness-raising should precede, or at the very least follow, affirmative action policies. While gender affirmative action has been successful in helping attain gender parity¹¹ in most cases, it is clear that it is not the strongest or only approach to solving the problem of gender inequality in educational institutions or in workplaces.

¹¹ Gender parity relates to an equal representation of males and females in a specific context.

3.3.3 Gender Mainstreaming

While gender affirmative action measures can be successful in increasing educational and employment opportunities for women on a short term basis, they rarely resolve deep-rooted gender stereotypes (Peterson, 2011). Increasing the number of women in power positions will not automatically effect the transformation of entrenched structural and cultural barriers (Peterson, 2011; Stromquist, 2013). Gender-equality interventions require more than just admitting students or recruiting staff into programs. Instead, for sustainable change a focus must be on gender mainstreaming that denotes the realization of gender equality across all social, economic, and political sectors. Gender mainstreaming in effect aims at the full-fledged transformation of deep-rooted values and relationships that are fostered by patriarchal power and privilege (UNESCO, 2002). It is “a process of assessing the implications for women and men for any planned action in legislation, policies or programs, in any area and at all levels with the ultimate goal of achieving gender equality” (Assefa, Nigussie, & Zelele, 2013, p. 65). In so doing, it incorporates normative gendered assumptions, processes, and intended outcomes in policy development and implementation (Karlsson, 2010; Unterhalter, 2007). It encompasses social justice and the promotion of gender *equality* within institutions (Hlalele & Alexander, 2012). This requires access and participation of girls and women in all educational, economic, social, and political structures.

In recent years, particular attention has been paid to gender mainstreaming in workplaces, with appeals for women’s rights and equal pay for equal work as well as labour market equality, child care issues and work/family balance (Berggren, 2011; Herman & Lewis, 2012). This has implications for employment in S&T fields, with calls for the improvement of recruitment processes and the provision of mentors to guide and advise new employees regarding how to achieve a balance in work/family life situations. This emphasis of family-friendly policies are essential for gender mainstreaming so that women are enabled to pursue S&T careers while accommodating the needs of family life (Weisgram & Diekman, 2014). This is reflected in policies that facilitate the possibilities of men as well as women to take time off the job to care for their children. Such policies have been enacted by the National Science Foundation (NSF) in the U.S. and the Natural Sciences and Engineering Research Council (NSERC) in Canada (Weisgram & Diekman, 2014). This has resulted in increased female participation in the S&T workforce and in university graduate programs. In Canada, for example, the total number of

women enrolled in S&T programs increased from 3% in 1975 to 20% in 2009, while in Germany, in 2014, 9.4% of all professorships in physics were held by women in comparison to 2.7% in the year 2000 (Lucht, 2011). In education more broadly, gender mainstreaming entails the inclusion of women's and men's experiences in the design, implementation, monitoring, and evaluation of educational policies and programs, equal opportunities for girls and boys, the production of gender sensitive curricula, and the full adoption of gender sensitive teaching practices (Tiessen, 2005).

According to the model developed by Rummana et al. (2011) for effective gender mainstreaming (Figure 3.1), it is necessary to integrate gender in all aspects of institutional programs, procedures, and practices. Institutional capacity building should be addressed through mentoring programs and regular assessment of gender issues. Additionally, stakeholders have to be informed and conscious of gender issues.

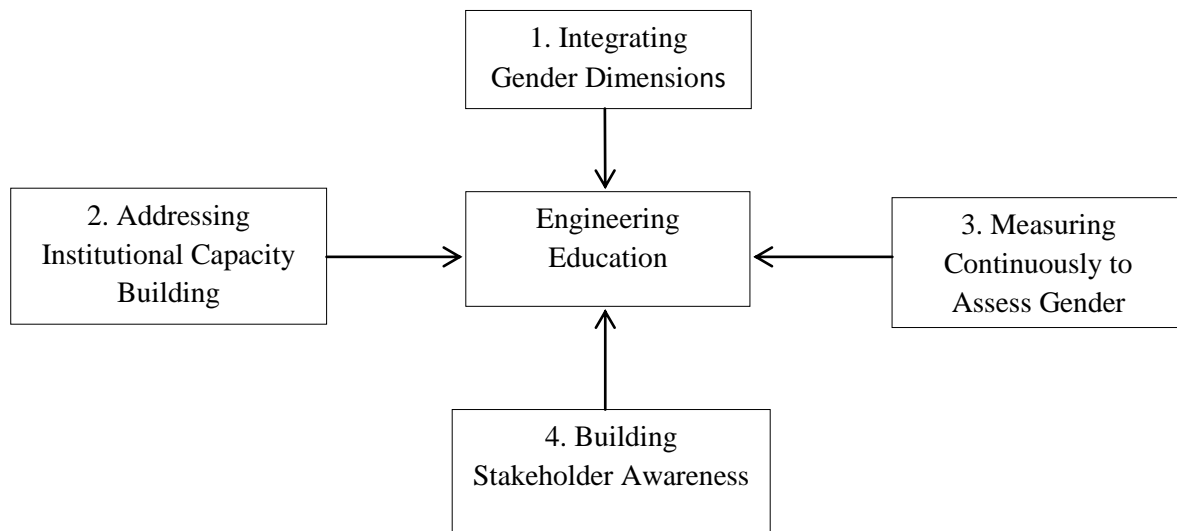


Figure 3.1. The gender mainstreaming model

Adapted from “A model for mainstreaming gender perspective in engineering education in Bangladesh: Some recommendations”. (Rummana, Ferdaus, Rashid, & Chowdhury, 2011, p. 1190)

In order to ensure the sustainability of gender mainstreaming, decision-makers and all stakeholders have to acknowledge the centrality of gender as a social and institutional construct

and agree to work together for gender equality, and ideally gender expertise should be involved in all stages of policy formulation and implementation.

Not all gender-mainstreaming policies in the workplace have been fully enacted as intended. Indeed, there are numerous instances where the rhetorical mainstream policies are far from the expected outcomes. For example, Stratigaki (2005) has referred to lack of political will and the hierarchical structure of the European Union (EU) legislative and administrative processes that resulted in poor implementation of gender-mainstreaming strategies in EU countries. In South Africa, Karlsson's (2010) study of a gender-mainstreaming strategy in one provincial education department shed light on how difficult it has been for the South African Department of Education to mainstream gender at the local level. The challenge arose from the fact that the technical interventions associated with the policy were considerably hampered by lack of resources and, particularly, by an inadequate policy framework (Karlsson, 2010). This has been a common occurrence in many developing countries, particularly those that have ratified international policy interventions such as MDGs, EFA, SDGs, and CEDAW, but have fallen short in providing the trained human resources and financial support necessary to move the gender-mainstreaming agenda forward (Karlsson, 2010).

A similar study conducted by Morley (2010) in two higher-education institutions in Ghana and Tanzania demonstrated that the implementation of policies designed to foster gender mainstreaming often fail to "address the micro-level relays of gendered power that continue to subordinate women" (p. 547). Such outcomes bring about contradictions and tensions as women continue to experience discrimination in their daily interactions. As a result, gender mainstreaming interventions are reduced to tokenistic representations of women in higher education environments, while female students and staff continue to face discriminatory practices (Morley, 2010). While leaders frequently endorse declarations and conventions espousing the notion of gender mainstreaming, too often they are unwilling or unable to follow up with the necessary apparatus for implementation. Consequently, the practical "implementation, monitoring and evaluation of gender policies, programs, and activities continue to elude those charged with the responsibilities of accounting to the public as the gap between policy and practice widens" (p. 2).

Gender mainstreaming is a complex undertaking. Major obstacles and limitations to gender mainstreaming include: "ineffective institutional and policy implementation agencies,

cultural, traditional practices and patriarchal dominance, low conscious participation of women in decision-making ..., lack of adequate resources...weak monitoring” (Assefa, Nigussie, & Zeleke, 2013, p. 67). Moreover, well-articulated objectives often do not necessarily lead to successful gender mainstreaming at the organizational and institutional levels. To be successful and sustainable, gender mainstreaming policies must address substantial challenges by ensuring that sufficient resources and political will are available for policy implementation at all levels (Langeveld, Vijfhuizen, & Gondwe, 2012). In addition, there is need for a solid knowledge base of context specific gender issues. This is especially critical for higher education in sub-Saharan Africa. While the global community has faced the challenge of access and inclusion of women in S&T higher education and workforce, sub-Saharan African universities face not only gender-disparity challenges but also a paucity of research output that denounces the phenomenon and suggests effective solutions.

Teferra (2015) suggests that “Africa's contribution to global knowledge production has long been pegged at less than 1%” (p. 93). The limited financial and technical resources, the paucity of journal subscriptions and the heavy teaching loads seem to have contributed to this scarcity (Maclure, 2006). African institutions need strong research capacity. Overcoming the shortage of research entails training individuals at various levels in the research process and providing the funding required for building a more robust research capacity. The purpose of this dissertation on gender-related challenges in S&T higher education in Ghana is to address this knowledge gap.

The chapter specifically focused on strategies that have been used to overcome gender inequality in S&T fields, particularly in higher education and in the workplace, and have achieved concrete outcomes. The chapter concludes with an analysis of the challenges to positive results in gender mainstreaming. Given the small increases in enrolment in S&T programs, especially in sub-Saharan African countries, the need exists to take action that will help reduce the gender gap in S&T higher education while promoting women’s empowerment. Hence, the struggle for women’s empowerment continues.

I started the chapter by describing the concept of power and how it leads to domination and oppression. The issue of gender discrimination has been debated globally over the years, and laws have been passed in many countries, yet there has only been limited progress to date. Solutions to gender inequality have also been discussed, with emphasis on the need for

promoting gender equality leading to women's empowerment. I discussed the various policies and procedures put in place at international, national, local, and institutional levels to overcome the problems of gender disparity in higher education, particularly in graduate S&T education.

The factors that militate against effective gender mainstreaming include lack of awareness of gender issues and lack of political will. Decision-makers and all stakeholders have to admit that gender is an issue and agree to work together for gender equality. Furthermore, gender equality has multiple meanings depending on the situation, the institutional culture, and the decision-makers. Different theories require different foresight, and such views shape institutional efforts to address gender disparity. It is important that gender expertise be involved at all stages.

CHAPTER 4: WOMEN IN S&T HIGHER EDUCATION IN GHANA

In contrast with most other sub-Saharan African countries, Ghana's system of higher education has experienced tremendous growth in enrolment over the past 10 years (Morley, 2010; Effah, 2011; Atuahene & Owusu-Ansah, 2013). Yet despite the tremendous surge in enrolment, full gender parity has not been reached, especially at the graduate level. A large number of women who would be eligible for graduate education do not have access and are thus excluded from the formal socio-economic sector. In addition, those women who are able to gain access to higher education often tend to opt for humanities and social sciences rather than S&T disciplines. This has exacerbated gender inequality in S&T fields at tertiary institutions. To gain a better understanding of the situation, I review below existing information on Ghana and its education system.

Chapter 4 begins with an overview of Ghana highlighting its population, administrative, political, economic, and social contexts. Although this study focuses on S&T higher education in Ghana, the nature of the education system at the elementary and secondary levels has serious implications for more advanced levels: secondary schools admit primary school graduates, and institutions of higher education recruit secondary school graduates. Hence, the chapter shows the evolution of the current education system from primary to higher education, paying particular heed to obstacles faced by Ghanaian women in the pursuit of higher education, mainly in S&T disciplines. I conclude the chapter by stating the research questions.

4.1 Ghana: The Geographic, Socio-economic and Socio-cultural Contexts

Ghana, formerly the Gold Coast, is located in West Africa, bordering the Gulf of Guinea (the Atlantic Ocean) to the south. It is bordered by Burkina Faso to the north, Côte d'Ivoire to the west, and Togo to the east. Ghana was the first sub-Saharan African nation to attain independence from Britain in 1957. It became a republic in 1960, paving the way for other African colonies to follow the same path (Boateng, 2015; Lindow, 2011).



Figure 4.1. Administrative Map of Ghana

Adapted from Academia Maps, World Map Online 1998-2018, 1-World, LLC (2018)

Administratively, the country is organized into 10 regions (see Figure 4.1 above) and 138 districts. The 10 main regions are the Ashanti region, the Brong-Ahafo region, the Central region, the Eastern region, the Greater Accra region, the Northern region, the Upper East region, the Upper West region, the Volta region, and the Western region (CIA, 2015). The Southern, Eastern, and Ashanti regions are densely populated. The Ashanti region, with its capital Kumasi, is currently the second most urbanized in the country, after the Greater Accra region whose population is 87.7% urban. The Northern, Upper West, and Upper East regions are mostly rural with sparse educational and economic development. Only 10% of the population of the Northern region resides in urban centres, reflecting internal migration to the south of the country and a pattern of development that has favoured the south over the north (US Library of Congress, 1994). Urban areas in Ghana have customarily been supplied with more amenities—such as educational institutions, government offices, and private-sector institutions providing employment opportunities to citizens—than rural locations (GSS¹², 2014). In 1988, in line with the government’s decentralization policy, district assemblies were created to transfer power and devolve development responsibilities from the centre to local levels (Manuh, Gariba, & Budu, 2007). The Ghanaian economy is predominately agrarian with 46% of the population living in rural areas. Agriculture employs more than half the population on a formal and informal basis and accounts for almost half of the country’s gross domestic product and of export earnings (CIA, 2015).

Ghana’s population is relatively young, with an estimated 57% of the population under the age of 25, and an even division along gender lines (CIA, 2015). Traditionally in Ghanaian society women’s primary role was to give birth, raise children, and care for household needs (Frimpong-Kwapong, 2008; Alhassan, & Odame, 2015). Early marriage, common under customary law, was often arranged or agreed upon by the fathers and other senior kinsmen of the prospective bride and bridegroom. This type of arrangement is still prevalent in the northern parts of the country. In the informal economic sector, Ghanaian women work as small retailers and farmers. In rural areas of Ghana where non-commercial agricultural production is the main economic activity, women till the land to provide food for the household. Overall, women’s annual income is far less than that of men who are generally deemed to be the main bread-

¹² The Ghana Statistical Service (GSS) is a government institution that is mandated to collect, collate, assess, and disseminate official statistics on Ghana (Ezebuio, 2018)

winners. While there has been considerable improvement in the standard of living of Ghanaian women over the past several decades, the prevailing division of wealth along gender lines continues to relegate them into positions subordinate to men.

4. 2 Evolution of the Educational System

4.2.1 Primary to Secondary Education

Education in Ghana, both formal and informal, is highly cherished and honoured, and has long been regarded as an essential means for improving the lives of individuals (Darkwah, 2010). The evolution of education in Ghana since its early days in the 19th century has involved all levels from preschool, primary, secondary, and teacher training to higher education. In the past decade, Ghana's spending on education has been between 30% and 40% of its annual budget (Akyeampong, 2010). Missionaries introduced formal education to Ghana in the 18th century, and the British colonial government expanded and administered from the late 19th century to the middle of the 20th century (Darkwah, 2010). On achieving independence in 1957 “the newly independent government saw in education the keys to social and economic development” (Akyeampong, 2010, p. 1). Accordingly, the government of Kwame Nkrumah¹³ legislated free universal primary education and devoted particular attention to promotion of girls’ education (Adu-Gyamfi, Donkoh, & Addo, 2016; Asare-Bediako, 2014). Despite numerous bouts of political turbulence, successive governments in Ghana have continued to recognize the crucial role of education in the country’s socio-economic development (MoE, 2013). Accordingly, measures have been and continue to be taken to expand education at all levels. The Ministry of Education (MoE) has overall responsibility for education-sector policy, planning, and monitoring (MoE, 2012). Education delivery and implementation are mandated to ministries, departments, and agencies such as the MoE and Ghana Education Services (GES) at the primary and secondary levels (UNCTAD, 2011). Additionally, in the last two decades, the government of Ghana has engaged in UNESCO to coordinate Education for All (EFA) campaign and the UN’s Millennium Development Goals (MDGs) (UN Report, 2012). At the end of the implementation period for MDGs in 2015, reports revealed that, generally, some progress has been made. Ghana,

¹³Dr. Kwame Nkrumah was the first president of Ghana after independence. He was overthrown in 1966, just a few years after his inauguration (Akyeampong, 2010).

like many developing countries, managed to reduce gender disparity in primary school enrolment across all regions of the country. Nonetheless, considerable inequities still exist, particularly in the Northern and Upper regions of the country (UN, 2015b). In 2015, the government of Ghana endorsed the UN SDGs. Supported by numerous multilateral and bilateral international aid organizations and a multitude of international NGOs, the government is working in collaboration with civil society organizations and the private sectors in efforts to realize the SDGs (UNCG¹⁴, 2017).

The present structure of formal education, which starts at the age of six years, requires six years of primary education, three years of junior secondary school, three years of senior secondary school, and four years in university. Secondary school students who pass the West African Secondary School Certificate Examination (WASSCE) have the option to attend polytechnics, teachers training colleges, or other tertiary institutions (Adu-Gyamfi, Donkoh, & Addo, 2016). Despite the progress made over the years, many girls in Ghana are still not in school due to poverty and gender discrimination (UN, 2015b). In rural areas in Ghana, only 29 % of women are literate compared to 52 % for men (Mabokela & Mlambo, 2015), and low socio-economic status is correlated with low school attendance rates. As Figure 4.2 below shows, there is virtually no gender gap at lower secondary levels of schooling between students from high-income and middle-income families. However, there was an 8% difference between male and female children of parents in the low-income bracket. In fact, the percentage of female students from low-income families was 35% compared to 46% for male students in the same income bracket. In contrast, there was no difference between the attainment of male and female students (95%) from high-income families. It is evident that more children from high-income families tended to complete lower secondary school compared to students whose parents were poor. Moreover, parents with higher education and higher socio-economic status were more likely to send both their sons and daughters to school.

¹⁴ The UN Communications Group (UNCG) is the joint communication platform for UN agencies working in Ghana (UNCG, 2017).

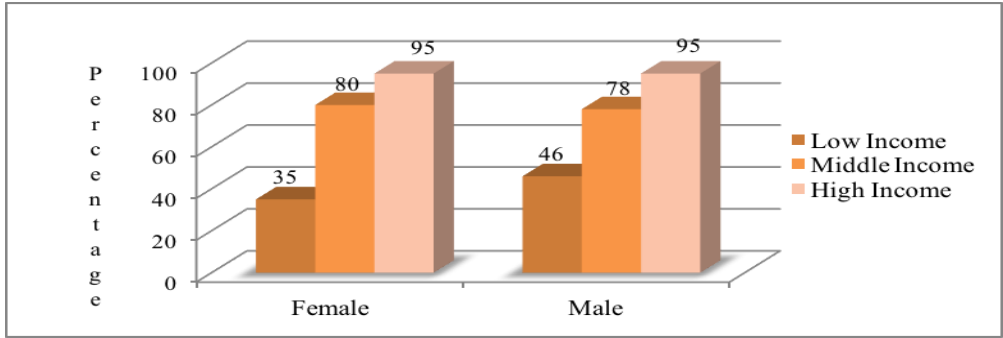


Figure 4.2. Gender distribution of lower secondary school completion in Ghana in 2016
 Adapted from “Working for a world free of poverty: Gender data portal – Ghana” (World Bank 2018a).

In addition, as revealed in Figure 4.3 below, the gender gap was insignificant at the primary level, marginal at the secondary level, and pronounced in favour of male students at the tertiary level. The distribution of enrolment percentages varied from 87.81% in primary school to 9.24% in higher education for females compared to 87.00% in primary school and 15.13% in higher education for males. It is important to note that the gender gap was virtually nonexistent at the primary level. However, at the tertiary level, the participation of males (15.13%) was much higher than that for females (9.24%). This suggests that more girls than boys drop out of school. Indeed, the dropout rate for girls increases with each additional year of education.

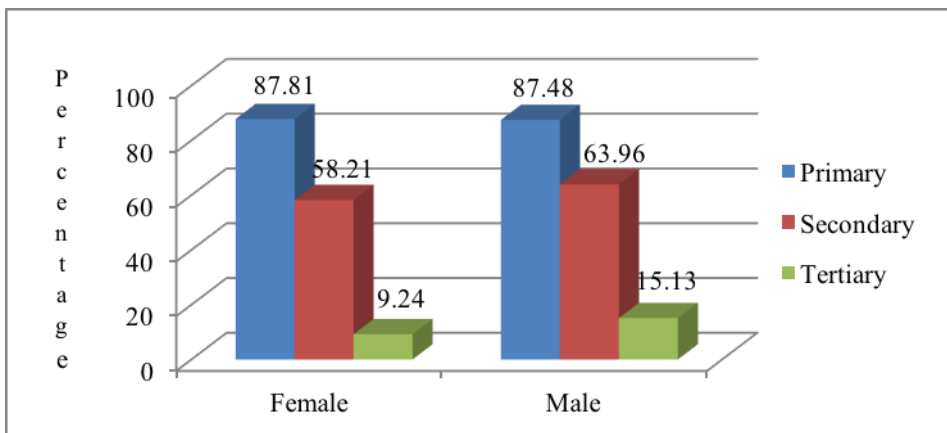


Figure 4.3. Gender distribution of primary, secondary and tertiary education in Ghana in 2013
 Adapted from Ghana Commonwealth of Learning, UNESCO (2015a)

4.2.2 Tertiary Education

Tertiary education in Ghana dates back to the early 1940s during the era of British colonial rule (Atuahene & Owusu-Ansah, 2013). At the time of independence in 1957, the country had only one university and a handful of secondary and primary schools. Like many former British colonies in sub-Saharan Africa, Ghana adopted the British model it had inherited (Tagoe, 2011). This higher education system—historically created to educate men who would offer administrative assistance to the colonial government—became the prototype for the modern university in Ghana (Assié-Lumumba, 2006). The prevailing consensus is that universities play a pivotal role in the country’s development by making it possible to develop human capital in critical areas such as health, agriculture, and engineering by contributing to social development and well-being (Arthur & Arthur, 2016). Hence, “the demand for higher education in Ghana, as in most African countries, has been high” (Manuh, Gariba, & Budu, 2007, p. 31).

The National Council for Tertiary Education (NCTE) was established in July 1993 by an act¹⁵ of the Ghanaian Parliament, aiming to foster the expansion of tertiary education while providing leadership in the direction, functions, role, and relevance of Ghanaian higher education. In 2012–2013, over 270,000 students in Ghana’s tertiary institutions¹⁶ were enrolled in undergraduate, graduate, certificate and diploma programs in a full range of academic and professional fields (NCTE, 2014). The National Accreditation Board has accredited 21 private institutions to award bachelor’s degrees. Although enrolment totals less than 5,000, but these institutions are expected to become a recognized force during the next decade (NTCE, 2014). Ten public polytechnics offered three-year higher national diplomas in applied business and technology fields (NTCE, 2014). A number of polytechnics have obtained accreditation to offer

¹⁶ The accredited public universities are:

- University of Ghana at Legon, Accra
- Kwame Nkrumah University of Science and Technology, Kumasi
- University of Cape Coast
- University of Education at Winneba
- University of Development Studies, Tamale
- Ghana Institute of Management and Public Administration/Greenhill College, Accra

Bachelor of Technology degree programs. At the same time, teacher training colleges have been upgraded to provide higher level of teacher training up to a diploma level (Effah, 2011).

Presently, Ghana has 18,530 primary schools, 8,850 junior secondary schools, 900 senior secondary schools, 28 teacher training colleges, 20 technical institutions, four diploma-awarding institutions, six public universities, and over 15 private universities in addition to 12 polytechnics, serving a population of almost 30 million Ghanaians. It is evident as well that substantial progress has been made to improve girls' access and participation in education, mainly at the primary and secondary levels, over the last 20 years. Entrance to universities depends on results in the WASSCE following completion of senior high school. Tertiary education admission is highly competitive in Ghana, especially in fields such as medicine, engineering, law, and pharmacy. Female enrolment in tertiary education has experienced a modest increase but has not really benefitted from the increases in enrolment at the primary and secondary levels. Although Ghana has endorsed SDG5 (gender equality and women's empowerment), neither gender equality nor women's empowerment has been achieved in Ghana's system of higher education. Girls and women continue to struggle for access to formal education, particularly in S&T fields.

4.3 Gender Inequality in S&T Higher Education in Ghana

While the fee-free compulsory education policy initiated by Nkrumah made it possible for women to progress to tertiary education, the gender inequality in the Ghanaian education systems that started since the independence of the country has continued till today. From its inception, formal education in Ghana has been gender-biased (Darkwah, 2010). As Table 4.1 shows, even though the rate of female participation in tertiary education has increased steadily over the years (from 2008 to 2016) and more than doubled in the past eight years, increasing from 5.15% in 2008 to 13.37% in 2016, the ratio of women's enrolment currently lag far behind that for men. In fact, in 2014, women represented 12.70% as opposed to 19.14% for men in the same year (UNESCO, 2018).

Table 4.1 *Gender distribution of students in higher education in Ghana from 2008-2016*

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-------------------|-------|-------|------|-------|-------|-------|-------|-------|-------|
| Total | 8.63 | 9.01 | - | 12.09 | 12.23 | 14.39 | 15.96 | 16.23 | 16.07 |
| Female (%) | 5.15 | 6.67 | - | 8.99 | 9.27 | 11.10 | 12.70 | 13.23 | 13.37 |
| Male (%) | 12.16 | 11.38 | - | 15.20 | 15.17 | 17.61 | 19.14 | 19.13 | 18.65 |

Note: Adapted from Sustainable development goals by country – Ghana, UIS-UNESCO (2018).

In addition, girls and women originating from poor backgrounds and those living in rural areas have the most difficulty accessing higher education in Ghana, part due to high perceived opportunity costs and traditional views concerning the appropriate role of women as wives and mothers (Atuahene & Owusu-Ansah, 2013). This relates to power relations between Ghanaian males and females and traditional norms and values that strongly encourage women to fully embrace the gendered role assigned to them (Acheampong, 2014). The patriarchy of Ghanaian society affects S&T fields in education especially (Boateng, 2015; Chege, 2011). While successive governments have paid lip service to the promotion of girls' education, women in traditional Ghanaian society have not been encouraged to embrace science at all levels of the educational system (MEST, 2010). This has created a substantial gap in the ratio of women involved in the learning, teaching, and the practice of S&T and related fields as compared to their male counterparts.

As indicated in Table 4.2, the gender-disaggregated statistics reveal undergraduate level enrolment of women as being only 16% of total admissions at the undergraduate and graduate levels at the University of Mines and Technology (UMT) for the academic year 2011–2012. The number of female students in the undergraduate mathematics program was the lowest (five percent) of all nine departments studied. In fact, no woman was a candidate at the master's level, and only one female student was admitted into a doctoral program. Similarly, a study undertaken by Boateng, Bensah, and Ahiekpor (2012) at the Chemical Engineering Diploma program in Ghana revealed that female enrolments from 2007–2008 to 2010–2011 were consistently under 13 % of the total enrolment.

Table 4.2 *Gender distribution of students in S&T higher education by faculty, UMTG: 2011-2012*

| Faculty/Department | Undergraduate | | Masters | | PhD | |
|------------------------------------|---------------|--------|---------|--------|------|--------|
| | Male | Female | Male | Female | Male | Female |
| Mineral Resource Technology | | | | | | |
| Geomatic Engineering | 43 | 10 | 4 | 0 | 0 | 0 |
| Geological Engineering | 50 | 10 | 12 | 0 | 1 | 0 |
| Mining Engineering | 47 | 10 | 11 | 0 | 1 | 0 |
| Mineral Engineering | 49 | 11 | 5 | 0 | 2 | 1 |
| Petroleum Engineering | 31 | 9 | 0 | 0 | 0 | 0 |
| Engineering | | | | | | |
| Mechanical Engineering | 46 | 8 | 0 | 0 | 0 | 0 |
| Electrical Engineering | 51 | 9 | 8 | 0 | 1 | 0 |
| Mathematics | 68 | 5 | 0 | 0 | 0 | 0 |
| Computer Science | 45 | 10 | 0 | 0 | 0 | 0 |
| Total | 430 | 82 | 40 | 0 | 5 | 1 |
| Percentage (%) | 84 | 16 | 100 | 0 | 83 | 17 |

Note. Adapted from “Enrolment regimes and gender differences in University of Mines and Technology: Implication for gender– equity discourse in multinational Ghanaian mines” (Rufai & Mohammed-Aminu, 2016).

Higher education builds the human resources capacity and impacts the labour market. A shallow pool of competent university graduates in a specific field translates into a scarce workforce in that field. Consequently, gender inequality in S&T education generally leads to gender inequality in the S&T workforce. Given the fact that a limited number of women are trained in the S&T field in Ghana, it is obvious that only a few women are recruited into the S&T workforce. As Table 4.3 below demonstrates, Ghanaian women have not acquired the required skills for S&T related employment due to their lack of education in the field. Sometimes, gender bias in hiring also contributes to the underrepresentation of women in the S&T workforce. This is evident in the scanty representation of women in the mining field in Ghana. In fact, women

represented only 14% of the total number of employees in the mining sector investigated in 2014 (Rufai & Mohammed-Aminu, 2016).

Table 4.3 *Gender distribution of employees in mining companies in Ghana: 2014*

| Mining Company | Sex-Disaggregated | | | Sex-Disaggregated | | |
|-----------------------|---------------------|------|-------|-------------------|------|-------|
| | Number of Employees | | Total | % of Employees | | Total |
| | Female | Male | (#) | Female | Male | (%) |
| Gold Fields, Tarkwa | 96 | 2453 | 2549 | 4 | 96 | 100 |
| Gold Mines | | | | | | |
| Golden Star Resources | 26 | 799 | 825 | 3 | 97 | 100 |
| Bogosso Ltd. | | | | | | |
| AngloGold Ashanti | 44 | 612 | 656 | 7 | 93 | 100 |
| Iduapriem Ltd. | | | | | | |
| Total | 166 | 3864 | 4030 | 14 | 86 | 100 |

Note: Adapted from “Enrolment regimes and gender differences in University of Mines and Technology: Implication for gender– equity discourse in multinational Ghanaian mines”, Rufai & Mohammed-Aminu (2016), p. 6992.

In the following section, I will present figures for selected Ghanaian universities. Although there are six public universities in Ghana, I will describe only two (the University of Ghana and KNUST), the largest universities in the country and the sites of my field study.

4.4 Gender Inequality at the University of Ghana

The University of Ghana, Legon, is the first and largest university in Ghana. Founded 1948, as a liberal arts university, it now has a student body of 38,000 made up of 71% males and 29% females. Based on the most recent statistics, the gender gap has increased from the academic years 2012/2013 to 2015/2016. According to Figure 4.4, female intake at the University of Ghana actually decreased in the academic year 2015–2016 compared to 2012–2013. The statistics on female and male student participation at the University of Ghana in 2012–2013 revealed a gender ratio of 43:57 in favour of males. In 2015–2016, the percentage of female students was only 29% of the total intake, a decrease of 14%.

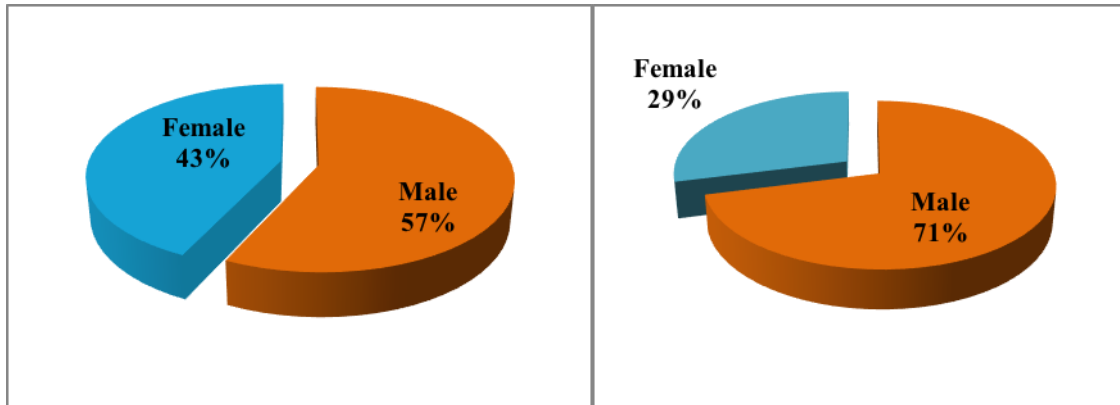


Figure 4.4. Gender distribution of students at the University of Ghana: 2012-2013 and 2015-2016.

Generated from student enrolment statistics (University of Ghana, n.d.)

Moreover, female students tended to enrol in higher numbers in arts and humanities programs than S&T programs. Table 4.4 below shows that the Faculty of Law at the University of Ghana has consistently enrolled a higher number of women than men. The percentages fluctuate between 60.7% in the 2010–2011 academic year and 57.5% in the 2014–2015 academic year. Only in 2011–2012 was female enrolment less than 50% of the intake. The consequence of this high concentration of female students in social sciences, such as law, is fewer women in S&T programs.

Table 4.4 Gender distribution of students at the University of Ghana, Faculty of Law: from 2010-2011 to 2014-2015.

| Academic Year | Students | Gender | | Percentage | |
|---------------|----------|--------|--------|------------|--------|
| | | Male | Female | Male | Female |
| 2010–2011 | 135 | 53 | 82 | 39.3 | 60.7 |
| 2011–2012 | 175 | 96 | 79 | 54.9 | 45.1 |
| 2012–2013 | 139 | 65 | 74 | 46.8 | 53.2 |
| 2013–2014 | 144 | 58 | 86 | 40.3 | 59.7 |
| 2014–2015 | 146 | 62 | 84 | 42.5 | 57.5 |

Note: Adapted from “The state of gender parity, underprivileged and minority enrolments in public universities in Ghana” BPI Research Report (2016).

In addition, the gender disparity is more evident at the graduate level than at the undergraduate level at the University of Ghana. As shown by Figure 4.5 below, the gender disparity between female students and male students has been very significant at both the master’s and PhD levels. For example, the female to male ratio was 39:61 in the academic year 2012–2013 while the ratio at the PhD level was 34:66, suggesting that the higher the level of education the fewer the number of women enrolled.

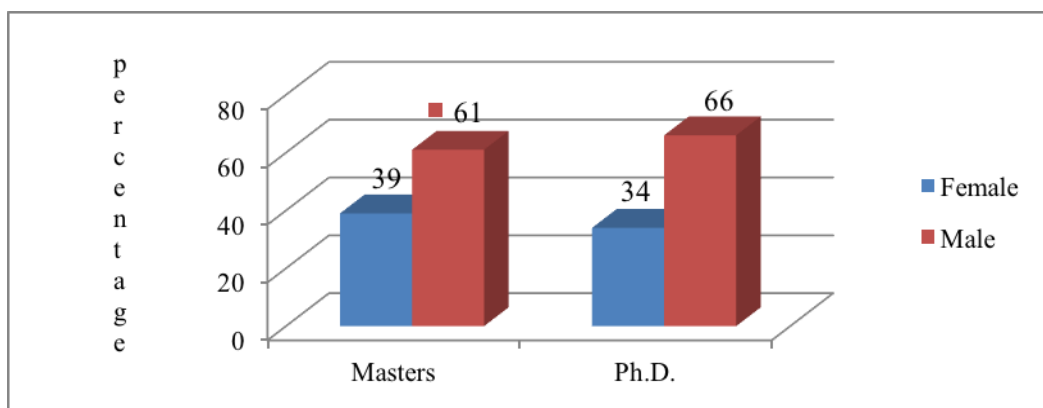


Figure 4.5. Gender distribution of Masters and PhD students at the University of Ghana: 2012-2013.

Generated from the summary of basic statistics on public colleges of education 2012/2013 (NCTE, 2014).

A Baraka Policy Institute¹⁷ (BPI) research report (2016) revealed a tremendous gender disparity in the admissions rates at the Faculty of Medicine of the University of Ghana. Table 4.5 below presents detailed figures about the female intake in this faculty: not only were women underrepresented but the percentage of female students decreased from 40% to 32% over the years between 2010–2011 and 2014–2015.

¹⁷ Baraka Policy Institute (BPI) is a research institute located in East Legon, Accra, Ghana. They conduct research on the state of gender parity and underprivileged and minority enrolment in public universities in Ghana.

Table 4.5 *Gender distribution of students at the University of Ghana, Faculty of Medicine: from 2010-2011 to 2014-2015.*

| Academic Year | Students | Number | | Percentage | |
|---------------|----------|--------|--------|------------|--------|
| | | Male | Female | Male | Female |
| 2010–2011 | 25 | 15 | 10 | 60.0 | 40.0 |
| 2011–2012 | 187 | 120 | 67 | 64.1 | 35.8 |
| 2012–2013 | 239 | 150 | 89 | 62.7 | 37.2 |
| 2013–2014 | 265 | 174 | 91 | 65.6 | 34.3 |
| 2014–2015 | 337 | 229 | 108 | 67.9 | 32.0 |

Note. Adapted from “the state of gender parity, underprivileged and minority enrolments in public universities in Ghana”, BPI (2016)

At the University of Ghana, gender disparity was even more pronounced where females represented only 24% of academic staff (Boateng, 2015). Figure 4.6 below provides gender-disaggregated statistics on academic and non-academic staff for the academic year 2012–2013 at the University of Ghana. Related to the academic and non-academic positions, the statistics show that the higher the rank, the lesser the female representation. The figure reveals that 21% of the professorate was female in the academic year 2012–2013. In the same year the percentage of female assistant lecturers was 42% compared to 19% for senior lecturers (NTCE, 2014). Overall, women were underrepresented at all three levels of the non-academic staff in that academic year.

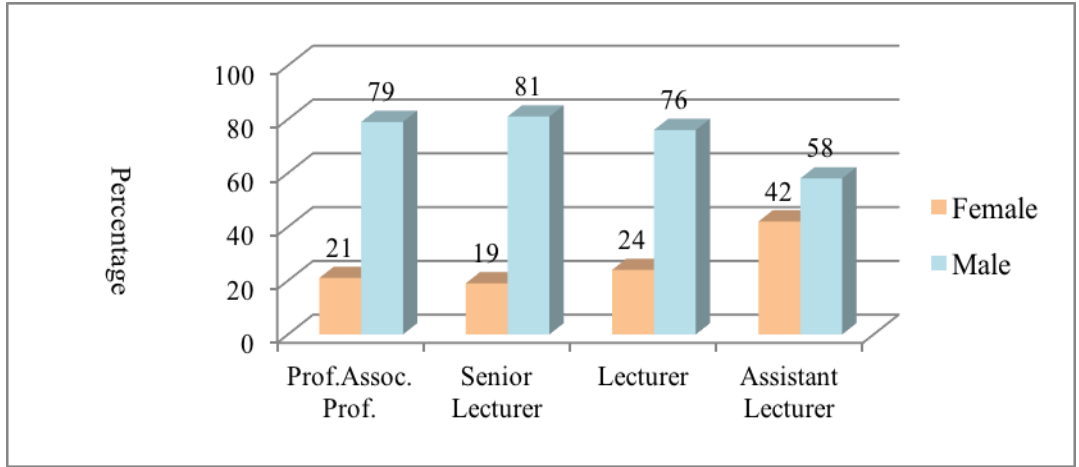


Figure 4.6. Gender distribution of academic staff at the University of Ghana: from 2012-2013. Generated from the summary of basic statistics on public colleges of education 2012/2013 (NCTE, 2014).

While the ratio of senior member¹⁸ was 37:53 at the expense of women, the ratio among senior staff¹⁹ was closer to parity 43:57, still at the expense of women. Meanwhile, gender disparity among junior staff was the highest among all three staff categories and stood at 20:80 in favour of men (see Figure 4.7 below).

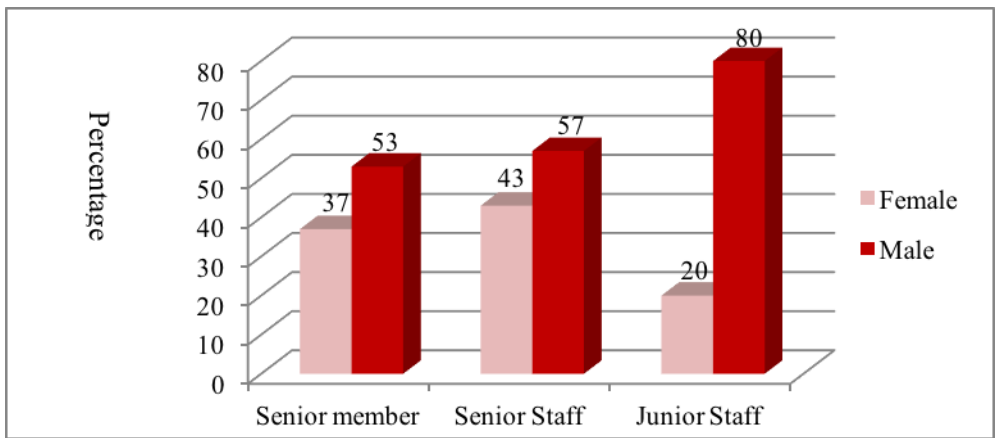


Figure 4.7. Gender distribution of non-academic staff at the University of Ghana: 2012-2013. Note: Generated from the summary of basic statistics on public colleges of education 2012/2013 NCTE (2014).

¹⁸ Senior members are academic, administrative, professional employees and members of Convocation or persons who would become members, if they were not of less than two years standing from their first degrees of equivalent qualifications including all academic members including registrars and heads of various directorates.

¹⁹ Senior Staff includes members of staff not below the rank of Administrative Assistant or its equivalent such as accountants and administrative secretaries.

4.5 Gender Inequality at KNUST

Similar to the University of Ghana, gender inequality is equally remarkable at KNUST. Located in Kumasi, Ghana's second largest city, KNUST is the second largest accredited public university in the country. KNUST was established in 1952 and is a predominantly science and technology institution. The current student population is 23,591 students, 72% of whom are male and 28% female (KNUST, n.d.). KNUST is made up of schools of engineering, pharmacy, agriculture, architecture, and other scientifically based schools. Related to women participation at KNUST, their access to higher education has been limited, particularly in S&T programs (Atuahene & Owusu-Ansah, 2013). For instance, the percentage of women enrolled in S&T fields in 2010 was far behind that of men: 28% for women in 2010 compared to 72% for men (Atuahene & Owusu-Ansah, 2013).

Table 4.6 presents gender-disaggregated data for student enrolment at KNUST from 2010–2011 to 2014–2015 in general. In fact, the gender-disaggregated data on undergraduate and postgraduate student participation in S&T programs at KNUST from 2011–2012 to 2015–2016 reflects the student enrolment trend at KNUST. At first sight, there seems to be little difference between the ratios of female participation in undergraduate programs during that time. Indeed, the first two years show a rate of 29% for females, and in the third and fourth year female participation increased an average of 2% per year for both undergraduate and graduate programs with a surge of 12% between the fourth and fifth year at the undergraduate level.

Table 4.6 *Gender distribution of undergraduate and graduate students at KNUST: 2011-2016.*

| Academic Year | Undergraduate | | Graduate | |
|---------------|---------------|------------|----------|------------|
| | Male (%) | Female (%) | Male (%) | Female (%) |
| 2011–2012 | 71 | 29 | 75 | 25 |
| 2012–2013 | 71 | 29 | 74 | 26 |
| 2013–2014 | 78 | 22 | 73 | 27 |
| 2014–2015 | 75 | 25 | 72 | 28 |
| 2015–2016 | 63 | 37 | 70 | 30 |

Note: Generated from statistics of the institutional review report, KNUST (2017)

In addition, as revealed in Table 4.7 below, female students at the undergraduate level are persistently admitted at a lower rate than their male counterparts. The average of female intake from 2010 to 2015 was 13.06%.²⁰ In fact, the academic year 2015 registered the lowest admission rate of female students and was just 7.1%. At this rate, it will take many decades to reach gender parity.

Table 4.7 *Gender distribution of students at the Faculty of Engineering, KNUST: from 2010-2011 to 2014-2015.*

| Academic Year | Students | Number | | Percentage | |
|---------------|----------|--------|--------|------------|--------|
| | | Male | Female | Male | Female |
| 2010–2011 | 1116 | 980 | 136 | 87.8 | 12.2 |
| 2011–2012 | 1153 | 966 | 187 | 83.8 | 16.2 |
| 2012–2013 | 1402 | 1211 | 191 | 86.4 | 13.6 |
| 2013–2014 | 1325 | 1111 | 214 | 83.8 | 16.2 |
| 2014–2015 | 1061 | 986 | 75 | 92.9 | 7.1 |

Note: Adapted from “The state of gender parity, underprivileged and minority enrolments in public universities in Ghana”. BPI (2016)

Overall, as reflected in the statistics discussed above, women are underrepresented in Ghanaian higher education, particularly in S&T programs. The inadequate representation of women in the formal S&T field is the reflection of the lack of opportunities for women in S&T higher education. Consequently, women are less likely to be represented in policy decision-making in favour of more gender equality in S&T (Tsikata, 2009). Despite policy interventions aimed at increasing female participation in the sciences after independence, women’s enrolment in science-based tertiary education in Ghana has followed a general trend in other sub-Saharan African countries (Atuahene & Owusu-Ansah, 2015). There is compelling evidence that these gendered differences in enrolment rates reflect broader social inequalities and differentiated

²⁰ Interestingly, the faculty of medicine at KNUST had a female student enrolment rate that was near parity from 2010/2011 to 2014/2015, with female participation hovering between 44% and 55% (BPI, 2016).

opportunity structures that are embedded in the deep-seated patriarchal culture of Ghana (Acheampong, 2013; Boateng, 2015). It is thus imperative to gain a better understanding of the obstacles women and girls have faced in the pursuit of higher education so as to be able to develop and implement effective policies and procedures to address gender inequality.

4.6 Obstacles to Access and Retention of Women in S&T in Ghana

In Ghana, gender inequality is revealed in all aspects of human life: the economy, security, education, health, politics, etc. Gender inequality does not occur because different people have dissimilar tasks but because various role assignments are valued differently and exhibit varying degrees of power and prestige (Boateng, 2015). In the realm of education, those who advance through the formal system into higher education tend to be the most financially secured sectors of the population (Gaddah, Munro, & Quartey, 2013). Unfortunately, students from low-income families, particularly girls, drop out at a higher rate than girls living in more economically advantageous circumstances (see Figure 4.2 above). Universities in Ghana are themselves inequitably distributed, with most situated in the most economically advantaged regions (Ashanti, Central, Eastern, Volta, and Greater Accra regions) to the detriment of other historically disadvantaged regions (Atuahene & Owusu-Ansah, 2013). For example, 70% of students in public universities in Ghana reside in only three regions: the Greater Accra, Ashanti, and Eastern regions (Arthur & Arthur, 2016; Manuh et al., 2007). Consequently, women from rural areas and low-income families may not have as easy an access to higher education as do their urban peers (Acheampong, 2014; Effah, 2011; Morley, 2010). In fact, there is a consensus in recent studies that higher education in Ghana remains elitist (Mabokela & Mlambo, 2015).

As noted by Nudzor (2012), generally one-third of out-of-school children in Ghana, the majority of whom are girls, are unable to meet the high costs of higher education because of the inability of parents or guardians to provide the financial and material means for their schooling. In rural areas, family resources are often limited, requiring that parents be selective in financial support for their children's education. In most cases, the education of girls is deemed to be less beneficial than that of boys under the assumption that the girl will get married and be cared for by her husband and in-laws (Kilu & Sanda, 2016). In addition, however, throughout much of Ghanaian society, marriage and motherhood are regarded as the primary goals in life for women (Adusah-Karikari, 2008). Generally women's reproductive roles are rated higher than their

educational and professional achievements (Abagre & Bukari, 2013). This prevailing norm is organized around an unwritten social contract, the *gender contract*. It is a social contract that conflicts with the realities of the modern world where women are progressively expected to work not only to provide for the family but also to improve their social status. As Kuenyehia (1995) observes, “despite the reallocation of employment responsibilities, the gender contract remains relatively static, thus entailing women having to adjust their own lives to cope with conflicting employment and family roles” (p. 18–19).

For women who desire to pursue studies and eventual careers in S&T fields, the obstacles they face in gaining access are therefore numerous, based largely on structural inequalities rooted in deep-seated socio-cultural factors, socio-economic circumstances, and gendered social practices within the Ghanaian society. Even though female enrolment is gradually rising, admissions from poorer regions have declined drastically, since more stringent entry requirements favour students from wealthier regions and schools and those with higher socio-economic status (Arthur & Arthur, 2016). Power relations have contributed to lower participation of females in S&T education, given the fact that traditional socio-cultural beliefs and instructional practices perpetuate male hegemony not only in S&T institutions but in Ghanaian society as a whole (Acheampong, 2014). These difficulties are compounded by limited resources allocated to S&T programs in higher education. The scarcity of qualified S&T instructors, especially female faculty who can serve as role models for younger girls, has likewise discouraged female interest in S&T fields and worsened the situation.

In summary, a combination of factors—social perceptions of S&T as associated with males (Kilu & Sanda, 2016; Rufai & Mohammed-Aminu, 2016), the financial hardship experienced by many female students, and school environments that are generally unwelcoming for many girls (Atuahene & Owusu-Ansah, 2013)—have precluded women from pursuing S&T careers in Ghana (Arthur & Arthur, 2016). The socio-cultural gendered division of disciplines has become the national norm, with S&T perceived as a male domain while arts-related courses are attributed to women. The “Ghanaian society is still deeply patriarchal, and ... gender is not only intertwined with other social categorizations in Ghana; it is the centre of intersectionality” (Boateng, 2015, p. 12). Inequitable access of females is a leading impediment, especially in S&T in Ghana (Kilu & Sanda, 2016). Even though female enrolment is gradually rising, admissions from poorer regions have declined drastically, since more stringent entry requirements favour

students from wealthier regions and schools and those with higher socio-economic status (Arthur & Arthur, 2016). Moreover, traditional practices entrenched in masculine organizational cultures continue to hamper the effectiveness of existing legislation and gender policies (Atuahene & Owusu-Ansah, 2013; Mabokela & Mlambo, 2015).

Sixty years after independence, Ghana's education system has made considerable progress, but equitable access, particularly for girls and women, remains a challenge (Akyeampong, 2010). Today, Ghana has a well-developed university system, with many different public and private tertiary institutions and a tertiary enrolment rate that is moderately higher than most sub-Saharan countries (GSS, 2013). However, there is a high level of inequality in the educational system, mainly in S&T higher education. To move the ratio of female/male participation toward parity, the Ghanaian government has taken steps to formulate gender policies and procedures and undertaken other initiatives to promote gender equality in education and strengthen female enrolment in S&T in higher education (MEST, 2010). However, there is no clear evidence as to whether these policies and procedures have been effective in facilitating women's access to post-secondary S&T education while simultaneously reducing longstanding obstacles to their access to graduate education. A key aim of this dissertation, therefore, has been to shed light on the extent to which such measures have in fact had an impact in enhancing women's access to S&T graduate studies and subsequent careers in S&T fields.

4.7 Research Questions

The purpose of this dissertation is to assess the policies and procedures put in place to address gender inequality in higher education and to examine the experiences and perceptions of African women who have achieved entry into graduate level S&T programs in three regional Africa Centres of Excellence as students, instructors, and administrators. It has been useful to highlight the obstacles women have encountered in their access and pursuit of graduate S&T programs, how they have overcome them, and the extent to which recent and current policies have contributed to overcoming these obstacles. To address the purpose of the study, my specific research questions are:

Main question:

What are the experiences of women in S&T graduate programs in Ghana, and to what extent have these women been affected by policies and strategies?

Sub-questions

To what extent are these policies and strategies conceived as: a) forms of consciousness-raising? b) affirmative action? and/or c) gender mainstreaming?

What obstacles have women in S&T graduate programs had to overcome to pursue their studies and careers in S&T fields?

What factors have enabled these women to overcome these obstacles?

In what ways have the aforementioned policies and strategies facilitated women's pursuit of S&T studies and careers?

CHAPTER 5: CONCEPTUAL AND THEORETICAL FRAMEWORKS

The main objective of the study is to generate empirically grounded insights into a host of educational factors and societal forces that influence, for better or for worse, the evolving status of African women in S&T programs at the three Africa Centres of Excellence (ACEs) in Ghana. In earlier chapters, I have shown that gender-related challenges, concerns, and experiences shape the lives of female students, instructors, and administrators in the ACEs. In light of the numerous problems faced by women in participating in S&T programs, I review and analyse relevant policies and procedures put in place by the Government of Ghana, the University of Ghana, and Kwame Nkrumah University of Science and Technology (KNUST) as well as by the three ACEs. The policy analysis is followed by one-on-one interviews to elicit the experiences of a cohort of these women, asking them to provide information about (a) the obstacles they had to overcome to enter graduate S&T programs as students, instructors, and administrators; (b) how their lived gendered experiences have been negatively or positively impacted by global, institutional, social and family structures, and (c) their perceptions of their current status and of S&T education overall.

In this chapter, I first discuss the conceptual framework. The framework is based on a combination of three main approaches (consciousness-raising, affirmative action, and the promotion of gender mainstreaming) – to analyse the policies put in place to address gender disparity issue at the three centres studied – and the adoption of the structuration theory lens as a framework aiming to understand women’s success in pursuing graduate education in S&T. The presentation of the research design includes the structuration theory to help explain how participants’ agencies have been impacted by a variety of structures. To respond to the research questions, first, The policy analysis is followed by one-on-one interviews to elicit the experiences of a cohort of these women, asking them to provide information about (a) the obstacles they had to overcome to enter graduate S&T programs as students, instructors, and administrators; (b) how their lived gendered experiences intersected have been negatively or positively impacted with power relations by global, institutional, social and family structures and cultural and social class issues, and (c) their perceptions of their current status and of S&T education overall. first, I examine the key policies and procedures put in place aimed at enhancing women’s participation in S&T in Ghana, focusing on the three typologies of gender-

related policies – those that can be defined as fostering consciousness-raising on gender issues; those that are designed as affirmative action measures that aim specifically to foster gender equity by increasing the participation of women as students, instructors, and administrators in graduate S&T education and research; and those that can be regarded as gender mainstreaming that aim to normalize gender equality as a feature of everyday practices.

5.1 Conceptual Framework for Policy Analysis

While many factors contribute to gender inequality in S&T programs, the perspectives discussed in Chapter 4 suggest a lack of awareness of the role of gender, institutional cultures, and societal beliefs in shaping girls and women's conception of themselves and of S&T fields. In addition, the inability of higher-education institutions and governments to effectively implement gender policies has contributed to gender inequality in tertiary education in Ghana. This ineffectiveness is mainly due to the fact that most institutions tend to equate gender equality with gender parity while showing little interest in the well-being or the achievements of female students and staff. However, the promotion of gender equality in S&T in Ghana could not only provide opportunities for the achievement of global development goals but would also enhance social justice and fairness by reducing discrimination against women.

To investigate how the development and efficient implementation of gender policies and procedures can help overcome gender inequality in S&T graduate education programs in Ghana, and to determine if there is a relationship between women's prior experience of education, their socio-economic background, and their educational achievements, I have created a conceptual framework to explain policy issues (see Figure 5.1 below). The framework is based on three main approaches: (a) advocacy to raise consciousness about underlying gender-disparity issues in graduate S&T programs; (b) a gender affirmative-action approach to recruit and train a critical mass of female scientists and researchers whose contributions are valuable to the development of the country; and (c) the promotion of gender mainstreaming as a way of normalizing gender in university culture.

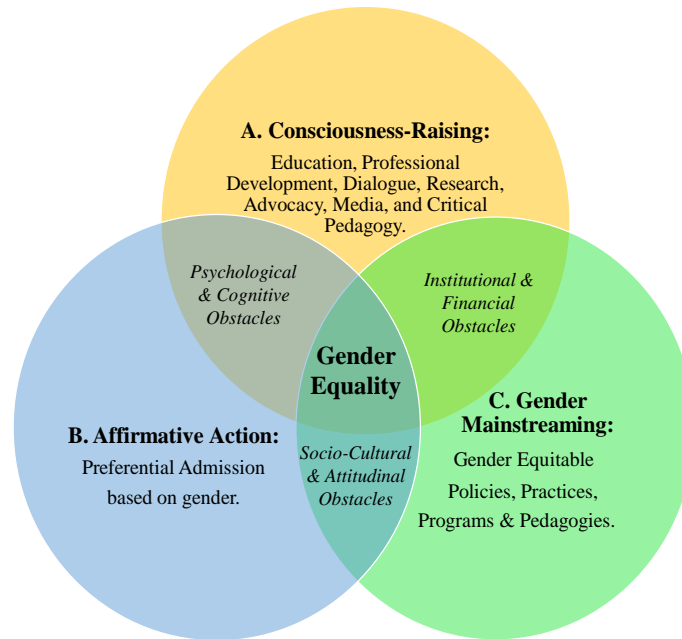


Figure 5.1. Policies and procedures for achieving gender equality in S&T higher education in Ghana

This conceptual framework has been designed under the assumption that the selected Ghanaian institutions are aware of the effect of gender on the higher-education system and have formulated policies and procedures to address gender inequality, particularly in graduate S&T programs. The main goal is ending the inequitable positions of men and women in higher-education institutions in Ghana, notably in the ACEs studied. The Venn diagram graphic has been chosen so as to show that all three approaches have to be used concurrently: each circle intersects with the other. The three circles represent the policies and procedures: circle A represents consciousness-raising; circle B represents the affirmative-action approach, while circle C represents gender mainstreaming. The intersections of the circles represent the obstacles and/or factors – discussed in chapters 2 and 4 – that contribute to gender inequality in higher education. The intersection of circles A and B reflects the psychological and cognitive obstacles and/or factors; the intersection of circles B and C represents socio-cultural and attitudinal obstacles and/or factors, and the intersection of circles A and C represents institutional and financial obstacles. The middle, the intersection of all three circles, represents the expected

impact of the effective implementation of the policies and procedures: gender equality in S&T higher education.

5.1.1 Consciousness-Raising

As argued in the introductory chapter, it is imperative to start every policy debate and discussion by first informing all stakeholders and getting their buy-in. “Consciousness-raising has long been an important activity for social workers engaged in social justice and community organizing with disenfranchised populations” (Wheeler-Brooks, 2009, p. 125). Gender consciousness-raising efforts, including education, advocacy, media campaigns, and a public process, are all essential. To induce change in S&T fields, it is necessary to raise awareness of existing inequalities. Once stakeholders are aware of the situation and are comfortable with the need for change, efforts can then be made to bring about such change.

Consciousness-raising should not be limited to policy-makers. It is imperative that centre directors, heads of departments, faculty, administrators, and the entire university community be involved from day one of the policy debate. In fact, the beneficiaries (both women and men) of these gender policies and procedures must be involved too. Women have been socialized to believe that they are second-class citizens, and most of them are unaware of their rights. To be able to claim these rights and demand equal treatment, they have to realize that education is an entitlement and that they have as much right to higher education—and S&T higher education—as their male counterparts. It is only after becoming aware of the gender issues that stakeholders will be predisposed and willing to change their views and perspectives and will take part in the social transformation leading to women’s empowerment. Useful policy debates necessitate the involvement of all stakeholders such as key policy-makers, administrators, faculty, and students of the two selected study sites (University of Ghana, Legon, and KNUST). Awareness campaigns that comprise activities such as professional developments, debates, meetings, and collective consciousness-raising are good starting points in the drive towards gender equality: they bring gender issues to the fore so that they become part of policy-development debates, leading to subsequent transformation.

The best way to negotiate the various stages of the consciousness-raising process is through dialogue (Mwaanga & Prince, 2016), a technique for exchanging views that aims to help people comprehend “one another’s thoughts, feelings, and values” (p. 19) while encouraging a

collective construction of meaning that helps change opinions and positions. A relevant education practice for raising awareness among women in S&T in higher education is Paulo Freire's²¹ inquiry-based education model, which leads to increasing awareness of the socio-cultural and socio-political environments and how they may, positively or negatively, affect people's lives (Ardovini, 2015; Stromquist, 2014). Freire's approach, known as critical pedagogy, has been used successfully to teach marginalized and oppressed peoples to resist and deconstruct the oppression they have experienced in the world around them. The objective of critical pedagogy is to raise consciousness, leading to empowerment and the cultural emancipation of the oppressed (Ardovini, 2015). This approach leads to critical consciousness. In fact, achieving critical consciousness requires the involvement of participants at multiple levels.

Therefore, awareness campaigns targeting prevailing gender inequalities in S&T in the higher-education context should affect the collective consciousness of stakeholders. Student enrolment data in higher-education S&T programs, for instance, does not reveal the more complicated "life choices" that might be embedded in attending school (Baily & Holmarsdottir, 2015; Dhillon 2011). Consequently, measures of individual engagement in activities (i.e., parity measures) do not accurately reflect unequal power relations. Thus, there is need for marginalized and oppressed people to achieve collective consciousness and, eventually, emancipation leading to empowerment. Political will and collective consciousness have the potential of encouraging stakeholders to advocate for change. Although such sensitization on gender-disparity issues is essential, concrete actions such as gender affirmative action in recruitment and retention and the promotion of gender mainstreaming are required to level the playing field, particularly in S&T higher education in Ghana.

5.1.2 Affirmative-Action Approaches and Gender Mainstreaming

Gender-equitable strategies must include gender affirmative action and gender mainstreaming preceded by consciousness-raising. Awareness leads to new and distinct ways of seeing and understanding gender issues. It is assumed that gender has been one of the criteria for

²¹ A Brazilian educator and philosopher, developed an inquiry-based education model that encourages learners to interrogate their own lived experiences and determine how these correlate with their social realities (Da Matta, Richards, & Hemphill, 2015). Such consciousness-raising activities can bring about increasing awareness of the socio-cultural and socio-political environments and how they may, positively or negatively, affect peoples' lives (Ardovini, 2015; Stromquist, 2014;).

student admission, as well as in faculty and administrator recruitments in the ACEs under study. The adoption of such an affirmative-action approach would have furthered achievement of the goal of gender parity in the student admission and staff recruitment processes. New gender-equality policies and procedures such as gender-equitable curricula and improved teaching practices will help to train a critical mass of teachers and researchers. These new teachers and researchers will serve as role models and mentors for young girls and women aspiring to pursue careers in S&T while encouraging inclusive access and equal opportunities for both boys and girls. Hence, gender mainstreaming will bring about changes in deep-rooted values and relationships that are fostered by patriarchal power and privilege. As mentioned in Chapter 3, various aspects of inequality and power configuration generate domination and subordination within the social fabric. Despite the implementation of various initiatives to curtail the phenomenon, gender inequality is still very pertinent in Ghanaian S&T higher education. It is evident that gender policies are not necessarily producing required changes to support gender equality efforts. Consequently, a more proactive action such as gender mainstreaming necessitating the involvement of various stakeholders is needed to promote and intervene to produce transformation. This in turn will lead to gender equality. As stated in Chapter 3, the culmination of gender equity efforts is gender equality because equity provides people with tools they need to achieve gender equality.

Individuals can reflect upon and try to modify social practices experienced in daily routines, and their knowledge of these practices is evident both in the interpretation they make about their actions known as discursive consciousness and in the actions they take to bring about change termed as practical consciousness (Da Silva, 2015; Giddens, 1984). In fact, social structures influence people's consciousness and behaviours because people perpetually respond to and resist social systems and institutions through their agency (Wheeler-Brooks, 2009).

5.2 Theoretical Framework

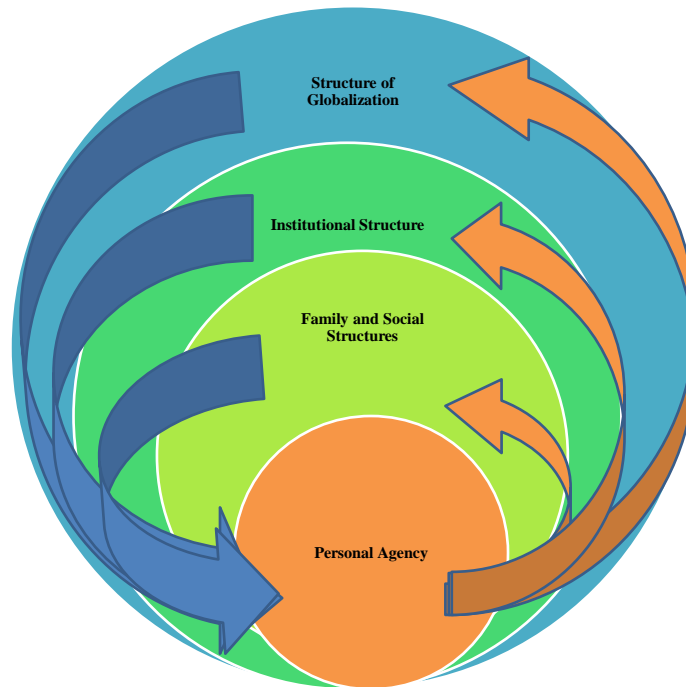


Figure 5.2. Key interfaces of structure and agency

In this study, as noted above, the conceptual framework which involves three typologies of gender-related policies including consciousness-raising on gender issues, affirmative action and gender mainstreaming is used to analyse policy data. On the other hand, structuration theory (the theoretical framework) is used to explain how the study subjects managed to overcome the obstacles they may have faced in their successful participation in graduate S&T programs as students, instructors and/or administrators. The aim has been to produce a body of knowledge that reveals ‘concealed structures’ of inequality and offers insights regarding repressive interactions while promoting gender equality. Figure 5.2 (above) represents the key interfaces of structure and agency for examining the processes by which women participate and succeed in S&T programs. This framework illustrates the multiple layers of structures such as social and family structures, institutional structures and the structure of globalization that impact the life and personal agency of women. Personal agency on the other hand refers to the capacity to act. The arrows connecting social, family, institutional, and global structures to personal agency

represent the influences that these structures have on the participant's personal agency. At the end of the education cycle when the female participants (mostly students) complete their S&T graduate education and occupy decision-making positions, their personal agency can in turn impact social, institutional and eventually global structures. Consequently, the arrows moving from the personal agency to social structures, institutional structures and structures of globalization represent the impact that is expected on structures bringing about changes required for gender equality in S&T higher education and careers.

5.2.1 The Concept of Agency

Agency refers to the ability of individuals who have opportunities and choices as well as the autonomy to be able to make their own decisions to pursue and achieve the objectives they value (Boni, Lopez-Fogues & Walker, 2015; Wilson-Strydom & Walker, 2015). The notion of agency thus relates to the capacity to act, and the way people make meaning in their life-world (Wheeler-Brooks, 2009). It is the concept of having a voice, self-determination; therefore, agency is claimed through construction of self; the way individuals act, think, and speak within the dynamics of discursively demarcated spaces and time (van Stapele, 2014). In addition, action, rationality, and emotions of individuals are the defining factors of social phenomena which are related to agency (Mboyo, 2014). Indeed, every human being has a personal agency and knowledge. People make their choices regarding the type of relationship they want to entertain including oppressive ones too. These actions could either be simultaneously oppressive and emancipating. In addition, agency is a conscious behaviour notably with empowerment (Huijg, 2012) and involves power, the capacity to act and be an agent of change. As Wheeler-Brooks (2009) has argued, individuals “possessing critical consciousness and believing themselves to be agents of change have the ability to influence their own lives and the very structure of society” (p. 132). Moreover, agency is the aptitude of an individual to act upon conscious or unconscious decision making processes. Having critical consciousness implies that people are fully aware of their agencies that inform their social practices (Wheeler-Brooks, 2009).

Nonetheless, limited global, institutional, and social actions in favour of gender transformation leads women—the oppressed group itself—to assume agency to address major problems, especially within the context of education. As Johnson (2014) has argued, agency and

education are key mechanisms that enable women to gain a sense of accomplishment in careers and leadership positions in sub-Saharan Africa. Education often allows women to assert agency in their career choices. Indeed, a woman's agency often allows her to overcome social norms or structures (Johnson, 2014). How are agency and structure interrelated?

5.2.2 The Concept of Structure

Structures are rules, regulations, norms and resources that alternately emerge from social systems and shape the actions of individuals. Rules are made up of a wealth of knowledge constructed by individuals at particular times and locations while resources include material things (money, properties) and/or social relations (Da Silva, 2015). A set of beliefs about femininity and masculinity deep-rooted in social structures and affecting individual and collective agency for centuries or millennia cannot be transformed overnight. Further, gender identities are not so much choices women and men accept of their free will. On the contrary, these identities are imposed upon them by social, institutional and global structures, and are difficult to refute or disown (Stromquist, 2015). It is hence necessary to undo gender on a daily basis, primarily through individual behaviours that challenge notions of masculinity and femininity. Yet, as valuable as this exercise might be, it belittles the power of structural forces in shaping identity and agency (Stromquist, 2015).

People's abilities to transform endowed resources into esteemed behaviours do not only depend on individual characteristics but also on the multi-layered structures of a physical, attitudinal, social, economic or political nature they confront (Hvinden & Halvorsen, 2018). These structures can constrain or facilitate peoples' achievements of effective freedom and actual well-being but also the extent of their active agency, including the capacity to modify initial structures. Social structures are believed to create context for and set limits upon the meaning people create in the world (Wheeler-Brooks, 2009, p. 124). It is apparent that power, and structures of power, influence the exercise of agency in every aspect of our lives, particularly in selecting education and career paths from the micro to macro (Baily & Holmarsdottir, 2015).

Individuals can reflect upon and try to modify social practices experienced in daily routines, and their knowledge of these practices is evident both in the interpretation they make about their actions known as discursive consciousness and in the actions they take to bring about change termed as practical consciousness (Da Silva, 2015; Giddens, 1984). In fact, social

structures influence people's consciousness and behaviours because people perpetually respond to and resist social systems and institutions through their agency (Wheeler-Brooks, 2009). At the same time, "rules and resources that structure social practices across time and space, as happens in the context of institutions, influence human agency, understood as the power to do or transform things" (p. 4). Resources are the routine mechanisms that enable people to act. Allocative resources give people transformative capacity through their use of material objects and goods; and authoritative resources, through their command over other people (Stein, 2011, p. 366). Giddens (1984) argues that structures as rules and resources are enacted by actors who produce and reproduce actions through their practices. "While structures are the outcomes of action, so in turn human action is bounded by historical and institutional conditionalities and by unintended consequences" (Maclure & Denov, 2006, p. 132).

Social structures are generally categorized on macro, meso and micro scales phenomena. At the macro level, social realities are reinforced by policy, institutional, and economic structures (DaSilva, 2015). For example, "class-structures of socio-economic stratification ... represent a macro scale social reality that may be reinforced by macro-level policy, institutional, and economic biases" (p. 14). The meso structural level reflects the social relationships between individuals and organizations, as well as the legal and other community scale regulations that can constrict or enable the actions of individuals while micro scale structures comprise family and community dynamics, and the value systems that shape the behaviour of people within society (DaSilva, 2015). Indeed, the micro structure relates to practices aiming to overcome obstacles at individual, family, and small group levels while macro structures are designed to bring about transformation and changes in society at large. From a sociological perspective, both macro- and micro-level societal forces—often labelled structure and agency, respectively—shape social change (Wheeler-Brooks, 2009). Wheeler-Brooks further argues that overall, gender beliefs result in a power asymmetry to the disadvantage of women. Moreover, the most important demarcation has been the distinction between micro and macro practice perspectives.

5.2.3 Structuration Theory

Both agency and structure are understood as distinct ways of conceptualizing complex social processes (Ahmed, Kloot & Collier-Reed, 2015). Agency and structure are thus crucial for the understanding of human interaction within a society and many scholars have used the

structuration theory to shed light on social phenomena. Structuration stems from Anthony Giddens' work, going back to the early 1970s. Structuration dismisses the notion of a dichotomy between structure and agency and instead highlights the connection between these two concepts as a tool for analyzing human behaviours in particular times and locations (Maclure & Denov, 2006).

Structuration examines the recurrent practices that construct and re-construct the social world while emphasizing that society and its structures are both conditions and outcomes of the actions of human beings (Wheeler-Brooks, 2009). It is the process of framing social relations, usually called social practices. Structuration theory conceptualizes human agency, or the power or capability to act, as situated within larger social structures and practices. The structuration theory explains the mutuality of individual agency and structuring of social roles and practices in the shaping of both family and professional life of individuals (Wheeler-Brooks, 2009). "Structuration sees society as being recursively created through its members' social practices, and oppression as being but one of these social practices" (p. 123). In the context of education, this process is doubly structured, since structuration occurs between both individuals and educational institutions and between individuals and society at large. Within institutions, the interplay among people's experiences, interests, and motivations and the broader institutional conditions, such as intentions, norms, knowledge, strategies and resources (including time, money and skills), shape individual's power to act (Orlowski, 1991).

Giddens (1984) posits a duality of structure in which human agents both influence and are influenced by the structural properties of the social practices and systems they help to create and maintain. Structuration allows people to be aware of their social contexts by relying on one or both of what Giddens calls discursive and practical consciousness (DaSilva, 2015). The notion of structuration implies that there are a variety of understandings of consciousness-raising that can positively impact empowerment practice. According to Wheeler-Brooks (2009), Anthony Giddens' structuration theory provides concepts that can be used to think differently about oppression and consciousness-raising.

The agency/structure debate in the field of sociology has been a long standing discourse that has led to much disagreement about the best way to explain human behaviour. The main debate has been that human actors always respond to or resist social systems and institutions, and sociologists' focus of study is how social life and awareness are influenced by these institutions

(Giddens, 1987; Kondrat, 2002; Ritzer, 1992). This difference reflects a similar disagreement in social work theory and practice. While those theorizing agency, such as Garfinkel (1967) and Weber (1962) have typically been preoccupied with issues related to the capacity to act, and the way people make meaning in their life-world, structural theorists, on the other hand, are concerned with how social structures impact human consciousness and behaviour (Durkheim, 1893/1947; Marx, 1964). Additionally, there has been this long standing issue linked to the divide between micro and macro practice perspectives. To contribute to the structuration debate, Rob Stones conceptualized his own version of structuration theory known as *strong structuration theory*. Stones criticized Giddens for using the term social position as a replicate of identity, while specific institutional roles are a subset of social positions (Jack & Kholeif, 2007). Stones (2005) argues that Giddens failed to explain how these institutional roles are fully reproduced in the duality of structure (Jack & Kholeif, 2007). Meanwhile Stones' strong structuration theory has only been an attempt to provide a strengthened theory while he also floundered to solve the duality-dualism divide or the issue of the critics of the structuration theory (Jack & Kholeif, 2007). Another promising development in overcoming this duality has been the emergence of empowerment as a widely recognized practice modality. Empowerment acquired through consciousness-raising has contributed greatly toward bringing these perspectives together (Bricker-Jenkins & Hooyman, 1986; Gutierrez, 1990; Paulo Freire, 1970; Solomon, 1976; Wheeler-Brooks, 2009).

The intersection of structuration theory and women in professional fields and formal educational sectors most often focuses on either the institutions such as higher education and workplace most closely related to the lived experiences of women. Rutten and Gelius (2011) study of the interplay between structure and agency in health promotion by integrating a concept of structural change and the policy dimension is noteworthy. In addition, aspects of structuration have been used to study education issues (Mboyo, 2016; Stromquist, 2015); environmental issues (Stein, 2011); entrepreneurship theory (Sarason et al., 2006); and family communication (Brathwaite & Baxter, 2006), among others. However, the work of Afouini and Karam (2014), in which they use structuration theory to examine the notion of career success from a process-oriented perspective through the lived experiences of female academics in the Arab Middle East, is most appealing.

Afouini and Karam's (2014) study addresses the complexities of the multilevel and powerful nature of gender-related forces that shape women's roles and responsibilities and eventually their respective behavioural patterns as working professionals. Drawing from the work of institutional and structuration theorists (e.g. Giddens, 1984; Scott, 2004), the authors examined agency-structure interaction within the lives of professional women over time based on a *Career Success Framework* (Afouini & Karam, (2014). The Career Success Framework highlights three key grounding processes: a) the experience of tensions due to the misalignment of mandated macro structures (social and institutional); b) the emergence of agency and agentic processes to dissipate the experienced tensions; and c) the modification of structures through the emergence of idiosyncratic roles and responsibilities (i.e. basis for the conceptualization of career success).

Macro-level mandated structures are external to the individual and associated with a particular institution. Afouini and Karam (2014) defined mandated structures in terms of expected roles and responsibilities relating to social norms. For example, women are expected to forego employment opportunities in favour of familial and community obligations as traditional gender roles. In fact, a breach of these social norms is often met with social sanctions. For instance, employed women are characterized as deviant or bad mothers, because they defy the natural connection between motherhood and staying at home, while men are sanctioned when they can no longer earn a family wage (Dillaway and Paré, 2008; Karam, Afouini, & Nasr, 2013). Mandated structures are especially powerful because they can totally influence people's sense of self and of success. For instance, the young girl learns in childhood that the cultural norms and women's gender roles for femininity includes caregiving and childrearing, internalized since childhood prompting girls and women to adjust their behaviours and aspirations in consequence. The Career Success Framework reflects that women are faced with the mandated structures of academia as well as the mandated structures of gender ideology. Sometimes these multiple mandated structures are congruent, and at other times, they are misaligned (Afouini & Karam, 2014). According to the authors, when misalignment between the variant mandated structures is experienced, a sense of tension arises along with a desire and/or need to dissipate that tension. Indeed, this desire/need is manifested in a sense of agency and the subsequent agentic processes that help navigate the conflicting demands of gender roles and academic responsibilities.

In the higher education context, it is important to analyse the interplay between individual participants' agency and the layers of structures that enable or constrain opportunities for the women. In this dissertation, structuration theory serves as the framework for examining the lived experience of cohort of African women in S&T program in Ghana as graduate students, instructors or administrators and their educational and career trajectories. Structuration theory, therefore, offers a theoretical framework that allows for the discussion of both agency and social structure that influence the freedom of the women. The structuration theory, has been used to illuminate the multiple layers of structures such as social and family structures, institutional structures and the structures of globalization that impact the life and personal agency of the women. Structuration in this context provides a lens for the analysis and discussion of the constitution of the women participants in the ACE program. Structural constraints facing the women intersected with their agency as both structure and agency are often interwoven with factors combining to impact the course of action taken.

While, the study adopts the approach used by Afiouni and Karam (2014), unlike the authors limiting the structures to the macro level, my approach includes all the three aspects of structures described above (macro, meso and micro). In addition, the components used for the analysis of women's interview data include: social and institutional structures of gender ideology; the evidence of misalignment and subjective experience of tension; and the agentic processes backed by supportive global, institutional and social structures. In sum, structuration theory provides an appropriate lens for studying the interaction between structure and agency. As described in the first part of the conceptual framework, the policies and procedures such as affirmative action and gender mainstreaming are part of the institutional structures that shape people's consciousness and behaviours. In addition to producing a body of knowledge that reveals 'concealed structures' of inequality and possibly offering insights to change repressive interactions, structuration theory has been useful in highlighting structures and oppressive practices as well as supportive structures. Gender inequality in formal education in sub-Saharan Africa in general, and in Ghana in particular, was created by elaborate interconnected sets of ingrained factors that requires a multitude of approaches to address it.

CHAPTER 6: METHODOLOGY-MULTIPLE QUALITATIVE CASE STUDY APPROACH

To examine the manifestations and interconnection of women agency and structural change happening in Ghanaian society, this study uses a qualitative methodology. Ordinarily, qualitative research includes a variety of approaches such as narratives, ethnography, phenomenology, grounded theory, and case studies (Creswell, 2013; Koro-Ljungberg, Yendol-Hoppey, Smith, & Hayes, 2009). It allows researchers to probe into the real-life experiences of the participants. It can also be a way of giving voice to the voiceless or the marginalized by allowing them to tell their stories in the way they perceive them. Qualitative research attempts to attain an in-depth understanding of meaning and implications. It is rooted in social relationships, contexts, phenomena, and structures, while recognizing the role of the researcher in the interpretation and representation of the research (Denzin & Lincoln, 2011; Seidman, 2006). The interpretive character of the narrative takes the reader beyond reportage and recording of data (Yardley, 2008).

Case study research may have a qualitative or quantitative study design. The case study may not be a methodological decision, but a selection of what to investigate using any relevant research method (Mills & Gray, 2016). As noted by Stake (2006), a case study provides insight into a particular issue that can potentially lead to generalizations or the building of a theory. A case study can comprise a single case or multiple cases. However, the number of multiple studies must be limited to four to allow enough time for a deep investigation of all the relevant aspects of the cases (Mills & Gray, 2016; Stake, 2006; Yin, 2009). In multiple case study approach, designs and procedures are generally replicated for each case (Yin, 2009, Creswell, 2013).

This study specifically adopts a multiple case study approach (Stake, 2006), targeting three ACEs in scientific research in two universities in Ghana, to examine the relationships between gender and power and the women's experiences in S&T programs. Each of the ACEs represents a case. A case study approach is appropriate for this study for the following reasons:

- (a) a case study is an approach to examining a phenomenon centred on a unit of study (Mills & Gray, 2016; Stake, 2006);
- (b) a case study is unique because it produces knowledge that is specific to a case that may not be similar to any other case (Mills & Gray, 2016);

- (c) in a case study the researcher attempts to get a broader understanding of the case that may be related to issues (political, social, historical, cultural, and sometimes personal) likely to be unique and sophisticated in their specific context (Mills & Gray, 2016);
- (d) a case study facilitates understanding that can be used as evidence for policy debates (Stake, 2006); and
- (e) using a multiple case study approach facilitates the understanding of commonalities and contrasts across two or more similar yet different contexts to understand how a phenomenon operates and manifests itself in various situations (Yin, 2006).

The final written report of a qualitative case study comprises the “voices of the participants, the reflexivity of the researcher, a complex description and interpretation of the problem and its contribution to literature or a call for change” (Creswell, 2013, p. 44), while presenting a holistic and complex picture of the problem.

6.1 Study Sites – Africa Centres of Excellence

The current World Bank ACE initiative supported by the Government of Ghana (GoG) is one of the government’s efforts to increase student participation in S&T programs, especially of women. The dual goals of the four-year ACE project, launched in 2014, are to develop and strengthen the capabilities of S&T graduate-level programs while simultaneously augmenting female enrolment in S&T fields and reinforcing the contribution and status of female researchers and graduate students in these programs. Ghana has three S&T centres that are the West Africa Centre for Crop Improvement, the West African Centre for Cell Biology and Infectious Pathogens, and the Regional Water and Environmental Sanitation Centre.

The ACE program is a donor-driven program, and one requirement of international donors is that gender equality be a policy imperative, which surely explains why the ACEs seem to be unique in this regard. The more women that the ACEs admit, the more funds they receive. The ACE project uses a results-based financing approach, which means that the ACEs obtain renewable funding only after evidence-based milestones and planned activities have been accomplished. This means that ACEs do not receive their funding unless they show evidence that milestones have been reached or planned activities accomplished. The World Bank also uses

disbursement-linked indicators (DLIs)²² to monitor project performance—before the disbursement of funds. Furthermore, the more female students admitted into the program the more funding the ACEs receive: for each Ghanaian male student recruited, the centre receives US\$ 10,000 per year compared to US\$ 12,500 for each Ghanaian female candidate. The monetary incentives are higher for regional students (from other West and Central African countries). The ACE program also requires the use of innovative teaching practices, development of new curricula, and periodic publications, by faculty, student and faculty exchange programs among other conditions. In general, the program, based on international training and research capacity standards, includes gender-responsive elements (World Bank, 2014).

6.1.1 West Africa Centre for Crop Improvement

The West Africa Centre for Crop Improvement (WACCI) was originally established at the University of Ghana, Legon, to train plant breeders, at the PhD level only, to improve the indigenous crops of the sub-region under the sponsorship of the Alliance for Green Revolution in Africa (AGRA). Under the World Bank project sponsorship, it was later expanded to include a master's program. WACCI currently admits and trains doctoral students in plant breeding and master's students in seed science and technology, aiming to address the apparent shortage of plant breeders in West and Central Africa. Plant breeding is widely regarded on the African continent as a means by which agricultural productivity can be enhanced through the genetic improvement of crops. The ACE works with 20 national agricultural-research institutions and other advanced research institutions globally as well as the private sector and farmers (WACCI, 2014). Figure 6.1 presents the gender-disaggregated distribution of student enrolment from 2014–2015 to 2016–2017 at WACCI (WACCI, 2014). According to Figure 6.1, female student enrolment has increased from 35% in 2014-2015 to 40% the following two years (2015-2016 to 2016-2017). However, the distribution of female staff at WACCI as shown in Figure 6.2 was only 20% in the academic 2016-2017. Female staff distribution was just half of the female students' participation in the academic year 2015-2016 at WACCI.

²² The project rewards the delivery of predefined results (DLIs) with monetary incentives, upon verification that the agreed-upon results have actually been delivered. Each DLI is linked to objectives and activities that must be implemented to qualify for the release of funds. Each activity is linked to an amount of money, and each DLI has a specific achievement level and timeline linked to it.

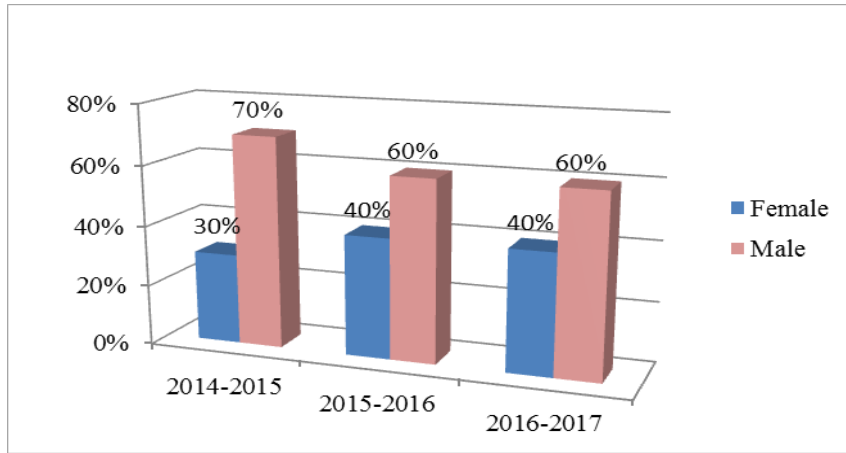


Figure 6.1. Gender distribution of students at WACCI: from 2014-2015 to 2016-2017. Chart generated from students’ records (WACCI, 2017).

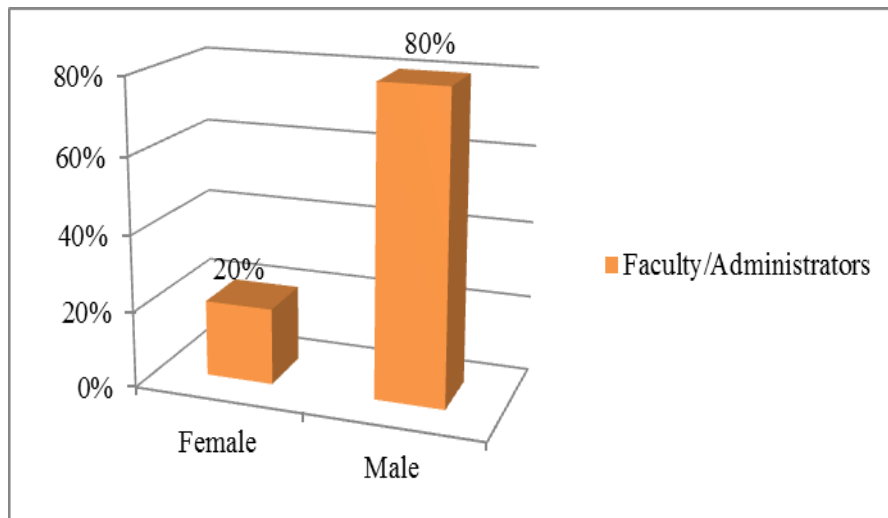


Figure 6.2. Gender distribution of faculty and administrators WACCI: 2016-2017. Chart generated from the list of instructors and administrators (WACCI, 2017).

Figure 6.3 below represents the seventh batch of WACCI graduates, the 2018 cohort of 14 PhD graduates. The graduate cohort is made up of eight females and six males from eight countries: Ghana, Burkina Faso, Mali, Niger, Nigeria, Sierra Leone, Senegal, and Uganda. In fact, this cohort had 57.2% female representation compared to the previous one, which was 33.3% female. The graduates researched seven staple crops (cassava, cowpeas, groundnuts, maize, pearl millet rice, and sorghum) to address farmers’ production constraints in their home

countries. This demonstrates that women can participate in graduate S&T education if they are given equal opportunities as their male counterparts.



Figure 6.3. PhD in agricultural science, WACCI: the 2018 graduating class.

Source: Retrieved on September 9, 2018 from <http://www.wacci.edu.gh/>

6.1.2 West African Centre for Cell Biology of Infectious Pathogens

The West African Centre for Cell Biology of Infectious Pathogens (WACCBIP), also at the University of Ghana, Legon, offers advanced-level training and research (master's degrees and PhDs) on the cell and molecular biology of infectious pathogens with the goal of improving diagnosis, prevention, and control of infectious diseases in sub-Saharan Africa. WACCBIP was created in response to the World Bank's ACE initiative. Figure 6.4 presents gender-disaggregated data on faculty at WACCBIP while Figure 6.5 presents similar data for students admitted into the program within three years, 2014-2015 to 2016-2017 (WACCBIP, 2014).

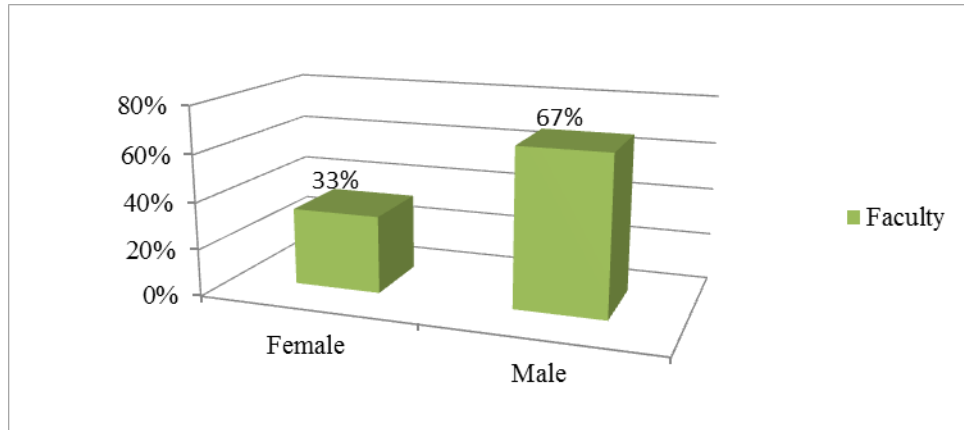


Figure 6.4. Gender distribution of faculty and administrators at WACCBIP: 2017. Chart generated from the admissions records (WACCBIP, 2017).

At WACCBIP the female staff distribution was 33% in 2016-2017 as shown in Figure 6.4. Similar to WACCI, the student population of WACCBIP has also increased from 30% in the academic year 2014-2015 to 40% the following two years (Figure 6.5). The analyses of the policy documents and administrators interviews will shed more light on the procedures and practices that explain the surge of female participants in S&T graduate programs at WACCBIP.

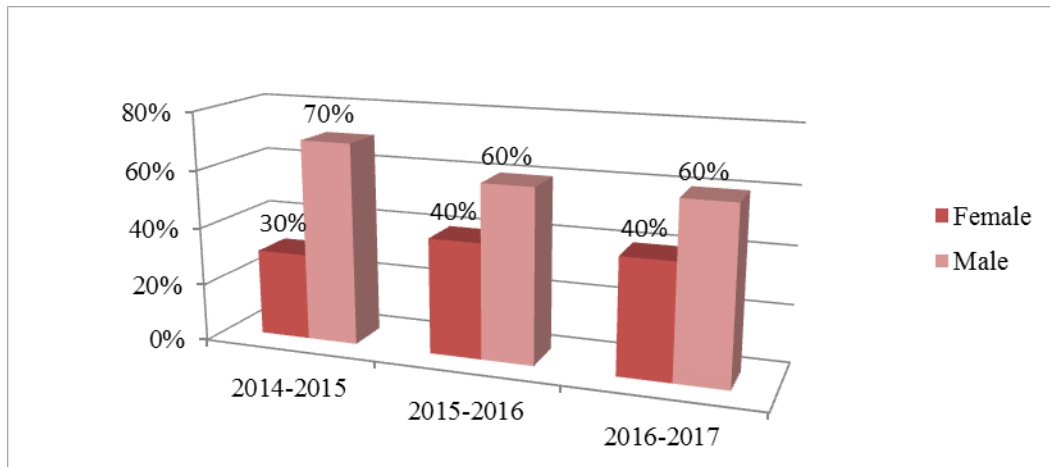


Figure 6.5. Gender distribution of students at WACCBIP: from 2014-2015 to 2016-2017. Chart generated from WACCBIP admissions records (WACCBIP, 2017).

Figure 6.6 depicts one of the female administrators at WACCBIP during a presentation at the WACCBIP Third Annual Conference in August 2018 in Accra. In addition, Figure 6.7 shows the picture of another female attendant at a WACCBIP Conference. As we can see from the picture (Figure 6.7), this woman is still performing her academic duties even though she is

pregnant. This is clear evidence that women can take part in S&T graduate programs and be equally productive as men if given the opportunity.



Figure 6.6. Head of department, biochemistry, cell and molecular biology: WACCIBP

Retrieved from <https://www.ug.edu.gh/news/waccbip-holds-third-annual-research-conference>



Figure 6.7. Participant at the Third Annual Conference in Accra: WACCIBP

Retrieved from <https://www.ug.edu.gh/news/waccbip-holds-third-annual-research-conference>

After describing the centres at the University of Ghana (Legon), I now present the centre at the Kwame Nkrumah University of Science and Technology in Kumasi.

6.1.3 Regional Water and Environmental Sanitation Centre in Kumasi

KNUST is host to the Regional Water and Environmental Sanitation Centre in Kumasi (RWESCK). RWESCK is a centre of excellence for graduate studies and research in water and environmental sanitation. The ACE trains master's and doctoral students in science, technology, engineering and mathematics (STEM) to build high-quality human-resource capacity in Ghana and the West African sub-region to address developmental challenges, specifically, those associated with water and the environment, on the continent. Its specific objectives are to (a) build a state-of-the-art laboratory and lecture facility for post graduate education in water, environment and sanitation; (b) develop new postgraduate programs (masters/doctoral) in relevant thematic areas; (c) develop and build capacity for research and development at a doctoral level, and (d) build strategic partnerships for outreach through students/faculty exchange, knowledge sharing, and dissemination. While Figure 6.8 below presents gender-disaggregated data about enrolment in doctoral programs for the academic years 2015–2016 and 2016–2017, Figure 6.9 below represents RWESK graduate students taking part in a field work. Again the female student distribution at RWESCK has also increased from 25% in the academic year 2015-2016 to 40% in the academic year 2016-2017 (see Figure 6.8). Overall, the student enrolment at the three centres has improved over the years to pick at 40%.

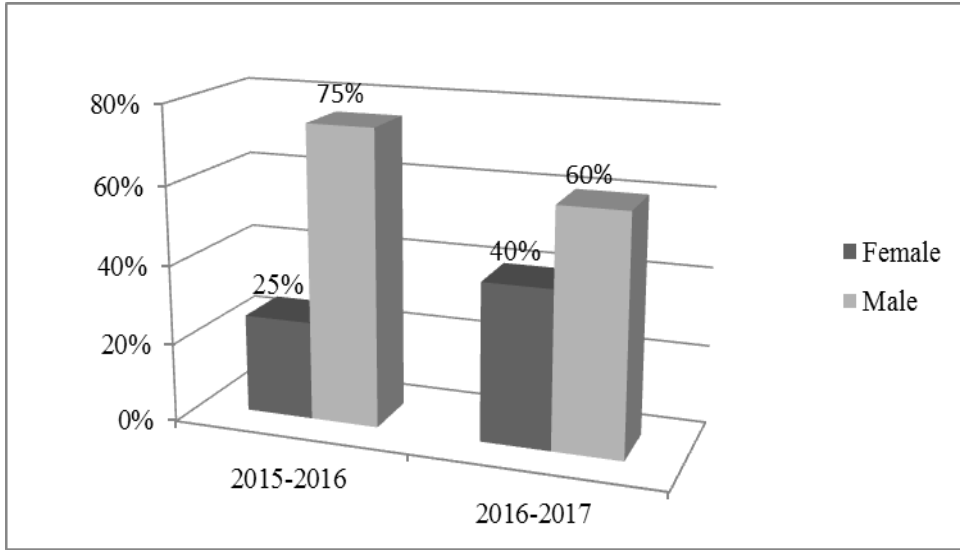


Figure 6.8. Gender distribution of PhD students at RWESCK: from 2015-2016 to 2016-2017. Generated from workshop presentation data (May 2017). Retrieved from <https://ace.aau.org/workshop-presentations-documents/>



Figure 6.9. Graduate Students Practical Field work: RWESCK Retrieved from <http://www.rwesck.org/>

Figure 6.9 depicts practical activities at RWESCK, indicating that students are not only acquiring theoretical knowledge but are also taking part in hands-on activities reflecting real life situation.

This is evidence that female and male students are working together as a team despite the fact that the female representation is slightly lower than males as has always been the case in most S&T education programs, particularly, in STEM. Again, the analysis of the administrators and instructors interview data will help shed light on the situation at RWESCK

6.2 Research Participants (University Administrators, Instructors, and Students)

6.2.1 Ethical Considerations

A researcher trying to investigate the experiences of people at a particular site must obtain approval to collect data. According to Seidman (2006), getting access to the individuals who are responsible for the operation of the site is imperative. To obtain approval letters to proceed with data collection (see Appendices 10, 11, and 12) from the research sites, I sent formal letters (see Appendix 1) to the directors of WACCI, WACCBIP, and RWESCK, requesting approval to conduct my study in their ACEs.

To gain ethical approval, I provided all required information to the university's Research Ethics Board for examination to make sure that all the required ethical principles for research involving humans were followed. Following receipt of the approval letters from the three ACEs, I applied for and obtained ethical approval from the University of Ottawa, as shown in the Ethics Certificate (Appendix 13). I also applied and was awarded a Student Mobility Bursary, which defrayed my travel costs to Ghana for data collection.

According to Glesne (2016), three main ethical principles—respect, beneficence, and justice—govern research with humans. Participation must be voluntary, and research participants must have detailed information about the study and provide their consent before data collection (Glesne, 2016). Consequently, I explained to each participant the objectives of the study and how data would be used prior to the interviews. For this study, I developed three interview protocols (one each for students, instructors, and administrators) and submitted them to the University of Ottawa Research Ethics Board for review together with the Ethics Certificate application during the winter of 2016 (see Appendices 17, 18, and 19).

Given the fact that this study was about the lived experiences of women, I made every effort to protect participants' rights and anonymity by using pseudonyms in the transcript report. The audio recordings have been stored in a secure manner and transcripts saved on a password-

protected computer. Hard copies of the transcripts are kept in a locked filing cabinet. The data will be destroyed after five years.

6.2.2 Recruitment of Research Participants

After receiving the approval letters from the ACE directors and the Ethics Certificate from the University of Ottawa, I travelled to Ghana in the spring of 2017 and started the data collection process immediately. I had preliminary and brief meetings with representatives of the directors of each ACE to inform them about my study and seek permission to proceed. The representatives of the ACEs in Legon were very supportive and immediately provided me with the needed information. RWESCK, however, reluctantly provided limited information after several follow-up requests. Nonetheless, I managed to collect some policy data from KNUST (the host institution) and from the university website to facilitate data comparison and data-source triangulation.

The privacy requirement of the Ethics Committee at the University of Ottawa—which would have required providing letters to the ACEs for the recruitment of candidates—was rejected by the directors, who explained that this procedure was impractical given the way the ACEs are set up within the universities. Therefore, the lists of all female students, instructors, and administrators in the S&T programs were provided to me, with the instruction to contact participants directly by sending the invitation letter, a copy of my Ethics Certificate, and the approval letters from the ACEs (Appendices 10, 11, 12, and 13).

Invitation letters were sent by email to all female masters and doctoral students as well as female instructors and administrators on the lists obtained from the three ACEs. A total of 121 invitation letters were sent to 9 female administrators, 12 female instructors, 56 female doctoral students, and 44 female master's students. The goal was to gain maximum participation because the number of female candidates in the three ACEs was limited. All the candidates who responded to the invitation, a total of 26 participants (25 females and one male), were interviewed. A male student received the invitation to participate in error; however, he showed a keen interest in the study and was therefore interviewed. One of the recorded interviews could not be transcribed because it was inaudible.

Many students responded to the invitation to participate in the study. However, only two female administrators and one female instructor responded and took part in the study (all three

from WACCBIP). I then invited four male administrators and/or instructors (two from WACCI, one from WACCBIP and one from KNUST) who agreed and participated in one-on-one semi-structured interviews. The timing of recruitment for data collection for this study was not particularly favourable because students were in the midst of taking their final exams, and instructors and administrators were busy with end-of-year commitments. Indeed, many students had left campus as soon as the academic year was over: the ACE program is a regional program which trains students from the Central and West African regions, and most of the regional students had already returned to their home countries.

6.2.3 Profile of the Participants

As stated earlier, only three of the female participants were administrators and/or instructors. To receive a balanced viewpoint on gender-policy issues, I asked available male administrators from the three ACEs for interviews. Three administrators from WACCI and WACCBIP agreed to be interviewed, but the two male administrators from RWESCK were unavailable. However, I managed to interview one administrator at KNUST, the host institution. This administrator provided information on the student admission process and on gender-equality procedures at KNUST. Altogether, I interviewed 30 participants (25 females and five males), which yields a response rate of 23% of the 121 invitation letters sent out. In contrast to the small number of female instructors and administrators, the number of student interviews (25) conducted for this study was generally adequate.

Overall, the total numbers of participants by centre were:

- 12 from WACCI (two administrators, two master's students, eight doctoral students);
- nine from WACCBIP (two lecturers, two administrators, one master's and four doctoral students); and
- eight from RWESCK (four master's and four doctoral students) and one from KNUST (one administrator).

Altogether, among the students who participated were seven master's students and 17 doctoral students at various stages of their studies (three doctoral students had already graduated from WACCI and were working in research institutions in their home countries). The participants have been subdivided into two main categories given the fact that I conducted two sets of interviews. The first set of interviews involved female students, administrators and

instructors and one male student, and the second set of interviews were with male administrators and instructors. Tables 6.1 and 6.2 provide detailed information on the participants.

Table 6.1 *List and profile of participants: students/instructors/administrators*

| No | Pseudonym | Institution | ACE | Position | Program | Gender | Nationality |
|----|-----------|-------------|---------|-----------------------------|----------------|--------|-------------|
| 1 | Marietta | Legon | WACCI | Master's Student | Plant Breeding | Female | Ghana |
| 2 | Gloria | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Nigeria |
| 3 | Helen | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Ghana |
| 4 | Iris* | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Cameroon |
| 5 | Jane | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Ghana |
| 6 | Karl | Legon | WACCI | Administrator | WACCI | Male | Ghana |
| 7 | Michael | Legon | WACCI | Lecturer/Deputy Director | Plant Breeding | Male | Ghana |
| 8 | Richard* | Legon | WACCI | Ph.D. Student | Plant Breeding | Male | Ghana |
| 9 | Olivia | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Ghana |
| 10 | Lynda | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Ghana |
| 11 | Janet | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Ghana |
| 12 | Margaret | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Ghana |
| 13 | Patience* | Legon | WACCI | Ph.D. Student | Plant Breeding | Female | Cameroon |
| 14 | Joana | Legon | WACCBIP | Lecturer | Department of | Female | Ghana |

| No | Pseudonym | Institution | ACE | Position | Program | Gender | Nationality |
|----|-----------|-------------|---------|------------------------------|---|--------|-------------|
| | | | | | Biochemistry, Cell & Molecular Biology | | |
| 15 | Georgiana | Legon | WACCBIP | Instructor/ Administrator | Department of Biochemistry, Cell & Molecular Biology | Female | Ghana |
| 16 | Edith | Legon | WACCBIP | Ph.D. Student | Department of Biochemistry, Cell & Molecular Biology | Female | Ghana |
| 17 | Esther | Legon | WACCBIP | Master's Student | Department of Biochemistry, Cell & Molecular Biology | Female | Ghana |
| 18 | Doris | Legon | WACCBIP | Master's Student | Department of Biochemistry, Cell & Molecular Biology | Female | Ghana |
| 19 | Golda | Legon | WACCBIP | Administrator | Department of Biochemistry, Cell & Molecular Biology | Female | Ghana |
| 20 | Joseph | Legon | WACCBIP | Administrator | WACCBIP | Male | Ghana |

| No | Pseudonym | Institution | ACE | Position | Program | Gender | Nationality |
|----|-----------|-------------|--------|---------------------|---|--------|-------------|
| 21 | Gladys | KNUST | RWESCK | Master's Student | Water Resources Engineering & Management | Female | Ghana |
| 22 | Sylvia | KNUST | RWESCK | Ph.D. Student | Water Resources Engineering & Management | Female | Ghana |
| 23 | Delphi | KNUST | RWESCK | Ph.D. Student | Environmental Sanitation & Waste Management | Female | Ghana |
| 24 | Zara | KNUST | RWESCK | Master's Student | Water Supply & Environmental Sanitation | Female | Ghana |
| 25 | Jill | KNUST | RWESCK | Ph.D. Student | Water Resources Engineering | Female | Ghana |
| 26 | Gilberta | KNUST | RWESCK | Master's Student | Water Supply & Environmental Sanitation | Female | Ghana |
| 27 | Deborah | KNUST | RWESCK | Master's Student | Water Resources Engineering & | Female | Ghana |

| No | Pseudonym | Institution | ACE | Position | Program | Gender | Nationality |
|----|-----------|-------------|--------|------------------------------|---|--------|-------------|
| | | | | | Management | | |
| 28 | Zoe | KNUST | RWESCK | Ph.D. Student | Environmental Sanitation & Waste Management | Female | Ghana |
| 29 | Don | KNUST | N/A | Administrator/ Researcher | Quality Assurance Unit | Male | Ghana |

Note. Study participants who had already graduated from the program and were working in scientific research institutions in their respective countries have an asterisk (*) next to their name.

Table 6.2 *List and profile of participants: administrators/instructors*

| No | Pseudonym | Institution | ACE | Position | Program | Gender | Nationality |
|----|-----------|-------------|---------|-----------------------------------|---|--------|-------------|
| 1 | Georgiana | Legon | WACCBIP | Lecturer/ Administrator | Department of Biochemistry, Cell & Molecular Biology | Female | Ghana |
| 2 | Joseph | Legon | WACCBIP | Centre Director | WACCBIP | Male | Ghana |
| 3 | Golda | Legon | WACCBIP | Resource & Development Officer | Department of Biochemistry, Cell & Molecular Biology | Female | Ghana |
| 4 | Karl | Legon | WACCI | Centre Leader | WACCI | Male | Ghana |
| 5 | Michael | Legon | WACCI | Lecturer/ Deputy Director | Plant Breeding | Male | Ghana |
| 6 | Don | KNUST | N/A | Administrator/ Researcher | Quality Assurance Unit | Male | Ghana |

6.3 Data Collection Process

A transformative methodological approach like that espoused in Morley (2010) implies the use of qualitative data collection techniques to learn about the subjects of study and begin to establish trusting relationships. I used self-reflexivity as an analytical tool for examining the research participant's agency, a resolute and/or conscious behaviour notably with empowerment and change (Huijg, 2012). To examine gender-based affirmative-action policies and gender mainstreaming in graduate-level S&T education at the three selected ACEs, I conducted culturally sensitive qualitative research. The most common type of qualitative interview is the individual face-to-face, in-depth interview that seeks to understand participants' experiences and perspectives on specific issues (DiCicco-Bloom & Crabtree, 2006). The field research followed a multiple case study approach conducted in two phases.

The purpose of the first phase of data collection was to identify the policies and procedures put in place by the selected institutions and ACEs to address gender-disparity issues and to assess their effectiveness and efficacy. This phase consisted of (a) the collection and analysis of policies-and-procedures documents related to gender and (b) interviews with administrators to corroborate document analyses. The documents were collected from relevant websites, such as those of the selected universities, the Permanent Mission of Ghana to the United Nations; the Ministry of Environment, Science, and Technology; the Ministry of Education; the Ministry of Gender, Child and Social Protection; and the National Council for Tertiary Education. A few documents were collected from the offices of the three ACEs. (See Appendix 2 for the list of policies and procedures analysed). Interviews with ACE administrators and/or instructors provided more detailed information on these policies, procedures, and strategies. Hence, some data came from primary sources (interviews with administrators), while other data were from secondary sources (policies and procedures documents).

The purpose of the second phase of data collection was to investigate how the academic and professional experiences of women in graduate S&T programs had been affected by gendered policies and procedures, and by broader factors of culture and social class. It consisted of a multiple qualitative case inquiry into the experiences and perceptions of women who had achieved entry into graduate-level S&T programs as students, instructors, and administrators.

Semi-structured in-depth interviews are widely used in qualitative research and are organized around a set of predetermined open-ended questions, with other questions emerging as dialogue between the interviewer and the interviewee proceeds (Creswell, 2013). I chose the semi-structured interview method to enrich conversations between participants and myself to yield reliable and comparable data. This kind of interview method allowed me to concentrate on planned items that were related to the research questions.

Following the preliminary analysis of the policy documents, I conducted one-on-one semi-structured interviews with 25 female participants comprising master's students, doctoral students, instructors, and administrators. Each interview lasted approximately 45 minutes. These interviews enabled me to delve into the female participants' experiences in three main areas: (a) the gendered affirmative-action and other supportive gender-equitable policies and procedures, discussed in chapter 5, put in place to overcome gender disparity in S&T education in Ghana; (b) the participants' experiences of gaining access to and participating in these programs; and (c) the participants' perceptions of the status of girls and young-women vis à vis S&T education in general.

The interviews were scheduled for dates and locations that were convenient for the participants. Most of the interviews were face to face. Since some of the student participants had already left campus for summer vacation, a few interviews were conducted by phone. As indicated on the Ethics Certificate, a copy of the consent form (see Appendix 4) was sent to each participant before the interview. Most of the participants sent their signed consent forms back to me via email before the phone interviews or brought them to the face-to-face interviews. Four of the participants who took part in the phone interviews failed to send their signed consent forms online. Nonetheless, those participants agreed verbally to participate in the study and decided whether they wanted their names associated with the interview data collected or preferred to remain anonymous.

During the interviews, I made sure that I established rapport with the participants at the beginning of every interview, which made the interviewees very relaxed and the interviews conversational. DiCicco-Bloom and Crabtree (2006) suggest that it is necessary for the interviewer to rapidly develop a positive relationship since the process of establishing rapport is an essential component of the interview. Having a good rapport involves trust and respect for the participant and the information to be shared (DiCicco-Bloom & Crabtree, 2006). To achieve rapport, I

discussed the goal of the interview with each participant and assured them that they were free to refuse to answer any question they felt uncomfortable with and could stop the interview anytime they chose to do so.

One of the outcomes I had expected from the semi-structured interviews was the collection of some policy information. However, few female administrators or instructors responded to my invitation. Indeed, only one female participant was an instructor/administrator. Even though I expected that each interviewee would have had unique experiences to recount and an individual story to tell, I followed the interview protocol with every participant in their respective category (student, instructor, or administrator) to make sure that all the participants responded to very similar questions. My field notes were not lengthy, just minor points jotted down for one reason or another.

Each interview was recorded on three different devices at the same time: a laptop, an iPad, and a cellular phone. After the interviews, I listened to the recordings before beginning transcription. The transcription was facilitated by Nvivo software, which I found extremely useful for this purpose. I completed 80% of the transcripts and used a professional transcriber for the rest. Following transcription of the first two interviews—I considered these interviews as pilot interviews—I revised my interview protocol because two questions elicited the same response. Once each transcript was completed, a copy was sent to each participant for feedback. This was done to ensure that the transcripts accurately reflected the participants' perspectives on the issues discussed. Indeed, the topic of the study has been of interest to many students who saw it as an opportunity to share their accomplishments and voice their concerns, with hopes of effecting change. Altogether, data collection took place in Ghana, specifically in Accra and Kumasi, over a period of approximately four months, from May to August 2017 (see Appendix 8 for the dissertation timetable).

6.4 Data Analysis: Identification of Different Elements of Relevant Data

Following preliminary analysis of the policy documentation, the qualitative data coding (see Appendix 9 for details) and analysis drew upon the Maxwell (2013) thematic analysis method, facilitated by the use of Nvivo. The Maxwell approach to qualitative research asserts that classifying analysis starts with the identification of the different elements of relevant data.

Maxwell further added that this identification can be based on prior ideas of what is important or

on an inductive attempt to capture new insights. The latter strategy is called *open coding* and involves reading the data and developing coding classifications based on what seems most important.

Even though Nvivo software had been very helpful in the transcription process, it was not very useful for data analysis. As noted by DiCicco-Bloom and Crabtree (2006), Nvivo requires a lot of background knowledge to be able to use it effectively to analyse interview data. Indeed, it was very complicated and required inordinate amounts of time to learn how to use it for coding. Therefore, I used a combination of Nvivo and manual coding, relying on pen and paper to categorize the data. Overall, approximately 350 pages of transcripts were coded. Nvivo software was not very effective in the data analysis phase; however, it has been useful for data management, like storing the data collected.

The analysis entailed triangulation of evidence collected and collated through fieldwork in the three ACEs as well as the policy data analysis and the literature review. For data-source triangulation, as suggested by Stake (1995), I tried to find out if the phenomenon or case remained the same at other times, in other locations, or when people collaborated differently. After reading and re-reading the interview transcripts, I imported the transcripts from MS Word back into Nvivo. I then proceeded with multiple readings of the transcripts. I then ran word-search queries as well as text-search queries in Nvivo to help me visualize the results, which allowed me to develop categories for conversion into themes. After isolating relevant statements and phrases, data were coded and categorized into themes.

To counter validity and credibility issues related qualitative research, I asked all participants to review the transcript of their interview to make sure that it was a true reflection of their views and perspectives on the various issues discussed. I interviewed many students who provided important information related to their experiences and perspectives. In fact, collecting policy data was more challenging than recruiting and interviewing the participants. Sometimes, cooperation with formal gatekeepers—or people who control access to the sites and candidates—may be inadequate. As a sole researcher, I established a good working relationship with the program leaders, and they were instrumental in my acquiring the lists of potential candidates to whom I sent letters inviting participation in the study.

6.5 Limitations of the Study

There were several limitations of my field study. The primary limitation of the study is one that is found in all qualitative research: the results are applicable only to the group under study. The findings are not generalizable so it is difficult to determine whether the same results would emerge in other universities in Ghana or in other ACEs throughout West and Central Africa. In addition, the pool of female instructors and administrators in the three institutions examined was limited because women are underrepresented in S&T at the graduate level in Ghana. Even though I set out to investigate the perspectives and experiences of female students, instructors, and administrators in S&T fields, there were few women in administrative or faculty position in the ACEs requiring the inclusion of male instructors and administrators.

A further challenge was that data collection was undertaken during the period of final exams and the summer breaks, both times that are not favourable for students and instructors in particular and hence was likely a reason why the response rate from female instructors was very limited. The timing also made it impossible to have face-to-face interviews with all the participants. Because the ACE program is a regional program, most students from outside Ghana had returned to their home countries at the end of the academic year. Phone interviews were particularly challenging where connections were not clear. This was the case with out-of-country participants resulting in some poor recordings that made transcription extremely difficult. Moreover, the policy data collection was much more challenging than the recruitment and interviewing of female participants.

Yet another limitation of the study is the women interviewed seemed to have been a homogeneous group despite the fact that some of them came from other regional countries (Nigeria and Cameroon). They were all able-bodied women and therefore did not have the challenges that are presented to those who are living with disabilities. In addition, there were just three participants who came from low socio-economic background, mainly the Northern region. There again, all the participants except one were awarded scholarships that had helped defray the cost of their studies. I would have liked to have interviewed a more evenly distributed group of peoples based on nationality, locale of upbringing, socio-economic status, among others, to be able to analyse how these social identities interact and intersect with gender.

The initial intention was to use feminist intersectionality theory as a guide to interviews and interview analysis. However, due to limitations of fieldwork, such as restricted cohort of interviewees, lack of in-depth life histories and personal data, restricted number of female instructors and administrators in the S&T centres and their relatively common backgrounds like supportive families, teachers, high achievers in school, etc., intersectionality theory was not especially appropriate as a framework of analysis. Further research in the area of reducing gender inequality in S&T, in higher education, in general, and graduate level in particular, with a broader cross-section of women (different socio-economic status, religion, ethnicity, rural versus urban, nationality, North versus South, etc.) will therefore be more amenable to analysis in relation to feminist intersectionality theory.

6.6 Summary

Gender inequality in formal education in sub-Saharan Africa in general, and in Ghana in particular, was created by elaborate interconnected sets of ingrained factors. A multiple case study methodology helped gather data on the policies and procedures at the selected study sites (Phase 1) and the lived experiences and perceptions of the female participants (Phase 2). This chapter has covered detailed information on the goals and expected outcomes of the case study. Recruitment procedures and the profile of the candidates, as well as data collection and analysis have been discussed. Nvivo software has been useful in data collection and management, but has been less effective in data analysis.

CHAPTER 7: GENDER-EQUALITY POLICIES AND STRATEGIES IN GHANA: CONSCIOUSNESS RAISING, AFFIRMATIVE ACTION, AND/OR GENDER MAINSTREAMING?

Education policy consists of the guidelines and regulations that govern the operation of educational systems. The policy environment of Ghana's educational system has been shaped by the *Constitution of the Republic of Ghana* (Government of Ghana, 1992), *Vision 2020*²³ (Chakravarty, 2016), as well as the sector-wide strategic plans of the Ministry of Education (MoE, 2012), the National Council for Tertiary Education (NCTE) and other government entities. This policy environment is designed to direct all educational practices and procedures. This includes policies and strategies that have been put in place to overcome gender disparity in S&T education in Ghana. In this chapter, I will assess these various policies and strategies, and the extent to which they have been successfully implemented. This assessment will be guided by the conceptual framework outlined in the previous chapter which encompasses three policy approaches: consciousness raising, affirmative action, and gender mainstreaming.

The chapter will examine the following national policy documents: the *National Gender Policy* (NGP, 2015); the *National Science and Technology Policy* (2010); the *Education Strategic Plan 2010–2020*; the *Science Mathematics and Technology Education* (STME) initiative (1987), and gendered-affirmative-action initiatives. This will be followed by a review of a number of university policies and strategic initiatives:

The University of Ghana:

- the Centre for Gender Studies and Advocacy (CEGENSA) initiative;
- the *Anti-Sexual Harassment Policy* (University of Ghana, 2010);
- the *Strategic Plan 2014–2024*;
- the *University of Ghana (UG) Gender Policy* (yet to be approved).

Kwame Nkrumah University of Science and Technology (KNUST):

- the *Sexual Harassment Policy*;
- the *Equality and Diversity Policy*;
- the *Ethics Policy*, and the *Corporate Strategic Plan 2016–2025*.

²³ In 1995, the National Democratic Congress administration launched the *Vision 2020* document, which was prepared by the National Development Planning Commission as Ghana's blueprint for sustainable socio-economic development (Frimpong-Boateng, 2011).

Complementing the review and discussion of these policy and strategic plan documents in relation to the conceptual framework of the dissertation will be insights elicited from interviews conducted with ACE instructors and administrators, and with an administrator from KNUST. The chapter concludes with a synthesis and comparative analyses of the gender policies of the three centres studied. .

7.1 National Policies and Procedures Supporting Gender-Equality Environments

The government of Ghana has introduced various initiatives and policies to overcome gender inequality in Ghanaian society and to mitigate the adverse effects of gender inequality on the country's socio-economic development efforts. As early as 1970, the National Council on Women and Development (NCWD) was created which over the years has initiated policies and strategies designed to promote gender equality in diverse sectors, but especially in education, including in S&T fields. Many of these policies have been guided by UN resolutions to which Ghana is a signatory. For example, the government has endorsed the goal of meeting the basic learning needs of every child, and to pay particular heed to girls' schooling (UNESCO, 2014). The Convention on the Rights of the Child has likewise served as a beacon for educational declarations and initiatives (McGrath, 2010). What follows is a synopsis of the principal state policies related to education and gender in Ghana.

7.1.1 National Approach to Mainstreaming Gender into Development Efforts

Historically, at independence in 1957 in appreciation of the role played by women activists during the battle for autonomy, 10 women were proposed and appointed to the legislature²⁴ (Ministry of Gender, Children and Social Protection – MoGCSP, 2015). These appointments led to consciousness-raising among Ghanaian society, bringing to the fore gender-equality and women's empowerment issues. In addition, following the first United Nations Conference on Women in 1975, Ghana established the National Council on Women and Development, currently known as the Department of Gender, as the national mechanism to support government-wide efforts in the empowerment of women through income generation, social mobilization, and social development (MoGCSP, 2015).

²⁴ Ten women were appointed to the legislature that had 104 seats after the 1956 (MoGCSP, 2015).

The government of Ghana's goals towards achieving gender-equality targets are guided by its commitment to international mechanisms as well as the 1992 Constitution and national development frameworks. Specifically, articles 17(1) and (2) of the 1992 constitution stated clearly that all individuals are equal before the law and free from all forms of discrimination.²⁵ In 2001, the government created a Ministry of Women and Children's Affairs with a minister of state having cabinet status through an Executive Instrument (EI 8)²⁶ (MoGCSP, 2015). The mandate of the ministry was further expanded in January 2013, when it was renamed the Ministry of Gender, Children and Social Protection (MoGCSP). Additionally, social protection and welfare issues along with the gender equality and women's empowerment issues highlighted in the NGP enacted in May 2015 have become part of governmental policy directions (MoGCSP, 2015).

The guiding principles of the NGP are (a) "women's rights are human rights"; (b) diversity issues have become very important; and (c) it is widely accepted that gender equality is not only a women's issue but is rather a sustainable development issue (MoGCSP, 2015). Building positive gender relations requires that women and men co-exist. The government seems to be committed to promoting accountability through women's leadership, women's voices, women's visibility and effective participation in decision-making, politics towards good governance peace and security (MoGCSP, 2015). The policy document claims that there is enough political will from the government and all players at all levels, in the economy, mainly officials from the executive, legislature, judiciary, civil society, the media, private sector, youth and faith based organizations to make gender a nationwide issue (MoGCSP, 2015).

The main objective of the NGP is to integrate concerns about gender equality and women's empowerment into the national development process in order to improve the social, legal, civic, political, economic, educational and cultural conditions of the people of Ghana; in an appreciable manner and as required by national and international frameworks. Gender mainstreaming in Ghana's development process has been a policy goal since the early 1990s (MoGCSP, 2015). Specific objectives of this policy are based on the overarching goal, the

²⁵ (1) All persons shall be equal before the law; (2) a person shall not be discriminated against on grounds of gender, race, colour, ethnic origin, religion, creed or social or economic status (Constitution of Ghana, 1992).

²⁶ The Ministry of Women and Children's Affairs was established by the New Patriotic Party administration in January 2001. It was given legal status by Executive Instrument (EI 18) of October 26, 2001 Civil Service (Ministries) Instrument. The National Council on Women and Development (Department of Women) and the Ghana National Commission on Children (Department of Children) are part of this ministry (MoGCSP, 2015).

guiding principles, lessons from achievements, and challenges faced by women and men, boys and girls (as demonstrated earlier in this study). The specific objectives of the NGP are to accelerate efforts and commitments of the government in empowering women to have a safe and secure livelihood; promote gender equality and women's empowerment nationwide by adopting the rights-based approaches²⁷ focusing on *social justice*; support the enactment and implementation of an *Affirmative Action Law*, with transformative measures to allow women and men to participate equally or in achieving at least the 40% women representation in politics, on boards, and all levels of decision making; enhance women's economic opportunities; and change inequitable gender relations to improve women's status relative to that of men (MoGCSP, 2015, p. 21).

The NGP implementation plan calls for universities and research organizations to identify information sources and contribute to the MoGCSP's gender-research agenda by (a) soliciting and evaluating research proposals on designated areas of interest; (b) supporting evaluation and production of technical papers for the MoGCSP; (c) collaborating with mandated agencies to gather sex-disaggregated data to aid in gender planning and analysis; (d) designing training and educational programs on gender and women's empowerment; and (e) being accountable for training (pre-service and in-service) on gender in Ghana (MoE, 2012a).

Various institutions have been assigned key roles in the implementation of the gender policy related to education. At the national level, the MoE is responsible for the implementation, monitoring, and evaluation of the NGP in educational institutions from primary to tertiary-education levels. The Ghana Education Service (GES) is specifically tasked with implementation of the NGP at the primary and secondary levels, while the National Council for Tertiary Education (NCTE) is responsible for the higher-education level. Tertiary-education policies developed by the ministries are implemented by educational institutions; therefore, universities are tasked with adapting the NGP to their institutional gender policies, plans, and procedures (MoGCSP, 2015).

²⁷ "A human rights-based approach is a conceptual framework for the process of human development that is normatively based on international human rights standards and operationally directed to promoting and protecting human rights" (UNDG, 2003).

7.1.2 National Science, Technology and Innovation Policy (2010)

After previous failed attempts since independence to integrate science, technology, and innovation (STI) into its development plans, the government of Ghana has revived its commitment to utilizing STI to help meet its economic, social, and environmental challenges and to foster inclusive and sustainable growth and development while promoting the S&T education of girls and women. To that effect, a new *National Science, Technology, and Innovation Policy* (MEST, 2010) was initiated in March 2010 under the leadership of the Ministry of Environment, Science, and Technology (MEST). Subsequently, the ministry has developed an information, communication and technology (ICT) policy and has launched various initiatives aimed at deploying ICT in various communities and partnering with the private sector and international organizations. However, implementation has faced significant challenges, particularly regarding meeting the significant funding requirements, equipment maintenance, and cost of Internet access (UNCTAD, 2011).

A revised policy framework has been designed to facilitate the sustainability, adaptability, and continuity of ICT in education in Ghana into the future through concrete guidelines, objectives, and strategies (MoE, 2015). Ghana has adopted the policy of attaining a 60:40 science-to-arts ratio at the tertiary level. The government has also put in place necessary measures to develop national S&T capabilities of both male and female students to enable the nation to achieve significant productivity and efficiency and to attain self-reliance in trained skills and technical expertise.

7.1.3 Gender Equality in Education: Policies, Initiatives, and Plans

7.1.3.1 Overview

Ghana's education policy is based on equal opportunity of access to education: it aims to tackle inequalities in access at all levels. The tertiary-education sub-sector includes several specialized agencies that support the ministry, such as the National Accreditation Board (NAB), the Ghana Academy of Arts and Sciences, the Ghana National Service Scheme, the Student Loan Trust Fund, as well as the NCTE, which plays the key role of coordinating higher-education activities (Bailey, 2014). This study focuses mainly on the work of the NCTE.

As described in Chapter 4, the NCTE “was established in 1993 as a semi-independent statutory body to oversee all public tertiary-education institutions of both university and non-university status” (Bailey, 2014, p. 6). Since its mission is to provide leadership in the direction, functions, role, and relevance of tertiary education in Ghana (NCTE, 2012), the MoE and the NCTE work in close collaboration. Both are responsible for developing strategies such as affirmative-action initiatives, gender mainstreaming and other relevant gender-equality supportive procedures to deal with existing and future challenges of gender in education (NCTE, 2012). It is necessary to examine the current strategic plan for education (MoE, 2012a) to obtain in-depth information on what the government intends to achieve within a specific timeframe, particularly in regard to gender equality.

7.1.3.2 Education Strategic Plan: 2010 to 2020

The fifth *Education Strategic Plan* (ESP) (MoE, 2012a) covering the period 2010 to 2020, is built upon its predecessors and takes into consideration acts, policies, reviews, and papers of national and regional importance (MoE, 2010). It was guided by policy initiatives that appeared in the years following the publication of the previous strategic plan in May 2003. Additionally, there have been several noteworthy sub-sector policy reforms. In 2009, the succeeding government instituted various education-sector policy initiatives that are essential policy drivers for the current ESP (MoE, 2015). The main objectives of the 2010–2020 ESP related to women in higher education, and particularly S&T higher education, are to (a) enhance equitable access to and participation in quality education at all levels, (b) decrease the gender gap in access to education at all levels, and (c) mainstream gender, human rights, and environment in the education curricula at all levels (MoE, 2012a).

According to the ESP, the following target activities are necessary to

- Ensure equal tertiary education opportunities for all academically eligible students;
- Encourage females into hitherto traditionally male dominated faculties/departments;
- Eliminate gender stereotyping in coursework, skills development and materials;
- Define and institutionalize a multi-level career path with a clearly defined promotion policy based on equality and merit with appropriate incentives and rewards to those who add value to the tertiary sector;

- Positively discriminate in the supply of tertiary grants to female applicants [affirmative action];
- Eliminate gender stereotyping in courses and in teaching approaches, skills development and training materials;
- Develop and implement equitable resource allocation systems that are available to public scrutiny;
- Institute girl-friendly guidance and counselling system and procedures implemented with non-gender biased ICT and elimination of inequitable subsidies (MoE, 2012b).

The performance indicators include (a) the implementation of information, education and communication (IEC) programs to raise awareness of the importance of tertiary education for females; (b) at least 40% of cohort entering tertiary education (all kinds) is female by 2015; (c) ensure that appropriate skills are provided for personal development and work; (d) strengthen capacity within tertiary institutions including the NTCE to conduct relevant research by enhancing the capacity of the research unit of statistics, research, information management and public relations; (e) gender-appropriate information communication and technology and skills development opportunities within second cycle curricula by 2012 (reviewed periodically throughout the ESP period; (f) upgrade the planning, budgeting, monitoring and evaluation division; (g) the annual national girls education reports including relevant indicators completed/published; and (h) develop a mutual-accountability scheme for students' institutions, academic staff and NCTE. (MoE, 2012b)

To monitor the implementation of ESP in tertiary education, the government proposes to introduce a client report system that enables students to make independent institutional assessments that may be sent directly to NCTE - operative by 2012. The Ministry of Education uses a results-oriented approach to monitoring and evaluation (M&E) to assess outcomes, to identify operational and funding gaps, and to introduce improvements that will enhance the quality of education service delivery throughout the country. M&E is therefore a central component of the ESP. The M&E framework is based on an annual cycle that involves: monitoring at all levels of the sector, information gathering and publication, detailed analysis of sector performance, evaluation against indicators and other devices, and reporting on a periodic basis. The agency responsible for the coordination of this tertiary education strategic plan

including gender equality program at the tertiary education level, is the NCTE. Consequently, the funding to NCTE is said to be tied to the achievement of clear and realistic targets that were set by December 2010 following the audits and reviews mentioned above. The goal is to make sure that the relevant evaluations reports are available each year. The timeframe for the implementation of the activities mentioned-above is supposed to be ongoing starting from 2010 (MoE, 2012b).

7.1.3.3 Science, Mathematics, and Technology Education (STME)

One of the most significant interventions initiated by the MoE and the Ghana Education Service (GES) in collaboration with the MEST to promote girls science and technology education was the introduction of *STME clinics* (MEST, 2010), implemented with the support of UNESCO (UNESCO, 2002). Launched in 1987, a clinic comprised an annual two-week-long program that enabled selected girls in secondary schools to interact with female scientists and technologists and to receive career guidance on job opportunities (Andam et al., 2013). The ultimate goal of the STME clinics was to achieve a target of 30% of female students at the tertiary level pursuing a career in science, technology and mathematics fields. To help sustain the process, the MoE created an office for the coordination of the STME. Subsequently, the clinics were decentralized into zonal levels, where students from two or three regions were clustered for each clinic. By 1999, the clinics had been extended to include girls from junior high schools and been organized in all 10 regions of Ghana. A total of 40,908 girls attended clinics and camps from 1986 to 2010 (MEST, 2010). The program and other initiatives managed to increase girls' participation from 12% to 25% within 25 years; thus, this intervention led to increased enrolment of female students in S&T programs in the universities and polytechnics in Ghana (MEST, 2010).

7.1.3.4 Gendered Affirmative Action Initiatives

Affirmative-action policies in university admissions were initiated in the mid-1990s to remedy the persistent gender-based disparity, particularly, in S&T higher-education programs (Atuahene & Owusu-Ansah, 2013). Universities introduced quota systems for the admission of female students into university S&T programs, and some went further, lowering the admission cut-off points for female students (MEST, 2010). Oftentimes, there are no specific figures for

female admission for the quotas change from year to year. As noted by Yusif & Ofori-Abebrese (2017) “the irregular nature of the yearly admission figures might be explained by the fact that admissions into KNUST are determined predominantly by the yearly quotas that the Academic Board approves to guide general admissions.” (para. 12). The admitted students were given the opportunity to take part in remedial science programs to bring their science skills up to date. Similarly, efforts were made to recruit students from deprived schools (Atuahene & Owusu-Ansah, 2013).

At the turn of the century, the School of Medical Sciences at the University of Ghana stipulated that 20% of persons admitted would be women (Sutherland-Addy, 2002). Later, universities in Ghana strove to enrol at least 10% of their student population in tertiary educational institutions and increase women’s participation in graduate programs (NCTE, 2012). The social-consciousness-raising efforts earlier on, right after the independence of Ghana in the late 1950s, brought about progress in gender normalization. According to the NGP, the MoGCSP was well resourced and positioned with the capabilities to mainstream gender equality and women’s empowerment into all aspects of sound and accountable-governance practices of the country (MoGCSP, 2015).

7.2 Description of Universities’ Policies and Procedures

The description of universities’ policies and procedures that follows consists of a combination of information pertaining to gender attained through the collection of policies-and-procedures documents. The analyses of these documents are complemented by the interpretation of administrators and instructors perspectives during one-on-one semi-structured interviews. These interviews were related to the implementation of gender policies and procedures in the three ACEs studied (WACCI, WACCBIP, and RWESCK). It is important to note that even though the ACEs are semi-autonomous, they did not formulate their own policies and procedures. Instead, they adapted their respective host institution’s policies and procedures to their systems of operation. The policy-implementation processes at WACCI, WACCBIP, and RWESCK are also discussed.

7.2.1 University of Ghana

7.2.1.1 Centre for Gender Studies and Advocacy (CEGENSA)

The university's vision is to become a "World Class research intensive University" within a decade (University of Ghana, n.d.). Its mission is to create an empowering environment that will make the University of Ghana pertinent for national, regional, and global development. The creation of CEGENSA represented a significant impetus to the early efforts to institutionalize gender in the university's culture.

CEGENSA was established by the University Council in 2006 to (a) institutionalize gender issues as a university priority; (b) promote research on gender-related issues; (c) prepare and publicize gender-related research; (d) provide resources and facilitate female staff' and students' unique gender-information needs; and (e) support advocacy and lead the gender-policy development process by providing gender-related services to key stakeholders in government and non-governmental organizations (University of Ghana, n.d.). The mission of CEGENSA is hence to establish an interdisciplinary platform while leading in key areas of the university's gender-policy making, curriculum development, and service provision. Its mandate is to formulate policies on gender within the university, to review existing policy documents and the operation of the university boards and committees, and obtain consensus among university administrators, staff, and students regarding gender issues (CEGENSA, n.d.).

According to its website, through advocacy, CEGENSA develops and organizes student outreach programs on gender issues specifically related to the unique situation of young female students in the academic environment. It also promotes networking and collaboration with government ministries, departments and agencies while encouraging them to share knowledge and work together on issues of common interest (CEGENSA, 2013). CEGENSA is also involved in curriculum development, including the development of short courses, such as "Gender and Development and Gender Culture", in *the Institute of African Studies*. It also provides mentoring programs that aim to empower faculty and students while advocating for change. The major accomplishments of CEGENSA include the university's anti sexual-harassment policy, the draft gender policy, and the 2014–2024 strategic plan (CEGENSA, 2013).

7.2.1.2 Sexual Harassment Policy

The “Anti-Sexual Harassment Policy” was enacted in 2009 (CEGENSA, n.d.). According to the policy document, the University of Ghana is devoted to creating and maintaining an environment that allows all participants in university programs and activities to be free from intimidation, exploitation, and abuse. The university defines sexual harassment as an interaction between individuals of the same or opposite sex that is depicted as unwelcome sexual advances, unwelcome requests for sexual favours, and other verbal or physical conduct or behaviour of a sexual nature. The anti-sexual-harassment policy aims to provide an atmosphere for work and study where everyone is treated with respect and dignity. The objectives of the policy are to (a) be proactive in the prevention of sexual harassment and sexual abuse, (b) respond quickly and effectively to sexual harassment and sexual abuse cases, and (c) impose suitable disciplinary actions should a violation be proved (CEGENSA, 2013, personal communication, August 15, 2017).

7.2.1.3 University Gender Policy (Awaiting University Council’s Approval)

The *University Gender Policy* (A. Darkwah, personal communication, September 12, 2017) aims to ensure gender parity and a gender-equitable environment that is inclusive and supportive of both males and females while providing equal opportunity to all its current and prospective employees, students, interns, and teaching assistants regardless of gender. The guiding principles include (a) freedom from gender discrimination, (b) equal opportunity, (c) gender sensibility, (d) gender mainstreaming, and (e) gender parity and gender balance in all university student population, academic and non-academic staff. Based on the draft policy document, gender balance will be achieved when there are approximately equal numbers of men and women present or participating in all areas of the university life. The draft policy specifically aims to enable optimal productivity; engage both males and females in decision-making; harness women and men’s diverse skills, perspectives and knowledge; and value diverse perspectives. According to the University Draft Gender Policy,

The University is committed to the promotion of equal opportunity for male and female employees and students. At the level of employees this will be reflected in recruitments, appointments and promotions and the University will institute special measures to ensure gender parity at all employee levels. With regard to the students,

existing special measures (affirmative action policy) put in place in the 1980s will be continued and expanded to increase the number of female students until parity is achieved in the number of male and female students in both sciences and humanities at both undergraduate and post-graduate levels. The University will pursue a strategy of mainstreaming a gender perspective by assessing the implications for males and females of any planned action, including policies or programs, in any area and at all levels (University of Ghana, n.d.).

The University Council has the overall responsibility for policy compliance and enforcement, while CEGENSA facilitates and supports the Equal Opportunity Board in the implementation of the gender policy. Audits of the policy and its monitoring and evaluation have been assigned to the Equal Opportunity Board supported by CEGENSA.

7.2.1.4 University of Ghana Strategic Plan: 2014–2024

The university 2014–2024 strategic plan includes the vision, mission and core values, and strategic priorities for the university. The development and implementation of relevant policies and procedures to facilitate the smooth operation and development of the university are crucial for the achievement of its core strategic objectives. The main goals are to (a) develop public engagement that is aligned with the university research plan; (b) promote stronger collaboration between the university and its key stakeholders (government, tertiary associates and industry); (c) strengthen collaboration with top-tier international research universities; and (d) develop an effective system of assessing, and publicizing the impact of the university programs on the entire community. Nine key strategic priorities are identified, including gender and diversity, which is number four among the nine. This priority seeks to create the best environment for equal opportunity for both women and men (University of Ghana, 2013, personal communication, June 16, 2017).

7.2.2 Kwame Nkrumah University of Science and Technology

The key policies and procedures that have been put in place by KNUST to achieve its vision, mission and core values²⁸ include a *Sexual Harassment Policy*, *Equality and Diversity Policy*²⁹, *Ethics Policy*, and *Corporate Strategic Plan 2016-2025*.

7.2.2.1 KNUST Draft Sexual Harassment Policy

There were few policy documents on the university website besides the university's 2016–2025 strategic plan. Most of the policy documents were collected at the Office of Quality Control Unit and were all in draft form. Below is a quotation of the Sexual Harassment Policy.

KNUST adheres to the principles and traditions of academic freedom, and recognizes that these freedoms must be in balance with the rights of others, including the right of individuals not to be sexually harassed. It is understood that the principles of academic freedom permit topics of all types, including those with sexual content, to be part of courses, lectures, and other academic pursuits...

Sexual Harassment need not be intentional. Under KNUST sexual harassment policies, the intent of the person who is alleged to have behaved improperly is not relevant to determining whether a violation of KNUST's policy has occurred. The relevant determination is whether a reasonable person could have interpreted the alleged behaviour to be sexual. The University seeks to create a peaceful and cordial atmosphere devoid of sexual harassment of any form. Sanctions will be applied where appropriate when the complaint or allegation of sexual harassment is established³⁰ (KNUST Ethics Policy Document, p. 6, personal communication, September 17, 2017).

7.2.2.2 Draft Equality and Diversity Policy

KNUST is committed to promoting and implementing equality of opportunity in its learning, teaching, research and working environments. The university developed an equality and diversity policy based on the following objectives:

²⁸ Most of the documents collected were still in draft form and had not been finalized.

²⁹ The policies on equality and diversity and on sexual harassment were embedded in the ethics policy but not approved.

³⁰ The policy documents were collected from the Office of Quality Assurance Unit, KNUST.

- The university aims to ensure that all members of its community are treated with fairness, dignity and respect.
- The university aims to apply this policy in compliance with and in the spirit of the relevant legislation.
- The university will not discriminate on grounds of age, disability, pregnancy and maternity, race, religion, belief, or sex in any decisions concerning student admissions, progression, or support provision.
- The university will not discriminate on grounds of any protected characteristic, in decisions concerning staff recruitment and selection, career development, promotion, staff development opportunities, pay and remuneration, or reward and recognition.
- The university will not discriminate against any person on grounds of age, disability, pregnancy and maternity, race, religion, belief or sex in the provision of facilities or services, or in the exercise of public functions (Draft Equality and Diversity Policy, p. 2)³¹.

7.2.2.3 Ethics Policy (Awaiting Approval)

KNUST has operated as an institution with principles that have been enacted in various documents in the form of ‘Recorders’. The Ethics Policy document ³²was developed to serve as the main guideline for ethical issues taking into consideration the university’s vision to advance knowledge in S&T for sustainable development in Africa. KNUST acknowledges that it has an obligation to all its stakeholders to observe and maintain high ethical standards in all transactions through leadership in innovation and technology, a culture of excellence, diversity and equal opportunity for all, and integrity and stewardship of resources.

³¹ draft equality and diversity policy During my visit to the Quality Assurance Unit, I was informed that the university’s ethics policy has been finalized and was awaiting approval of the Management Council (Quality Assurance Unit, personal communication, May 15, 2017).

³² The ethics document was collected from the Quality Assurance Unit.

7.2.2.4 KNUST Corporate Strategic Plan: 2016–2025

KNUST's 2014–2024 strategic plan (KNUST, n.d.) features a situational assessment (strengths, weaknesses, opportunities, threats, and challenges) and projections, strategic focus, and strategic objectives, implementation, monitoring, and evaluation, plan implementation framework. The seven main thematic areas and objectives are (a) institutional governance and leadership; (b) development of human resources; (c) training, research and innovation; (d) development of infrastructure and ICT facilities; (e) financial sustainability; (f) environment and development; and (g) visibility. While its corporate strategic plan is silent on the subject of gender equity and equality, through its policy of Diversity and Equal Opportunity for All, KNUST ensures an environment of understanding and respect for cultural diversity and equal opportunity for students and staff (Quality Assurance Unit, personal communication, September 17, 2017). The university upholds academic freedom in its quest to advance the frontiers of S&T education in Ghana (KNUST, 2016).

7.3 Discussion of National, University, and ACE Policies and Procedures

Among the numerous challenges faced by tertiary education in Ghana —facilities maintenance and upgrading, a growing demand for admissions, maintaining standards of staff, addressing the quality of education and the skills requirement of employers— is growing concern about gender disparity, particularly in S&T programs. The increased demand and the limited capacity of Ghanaian universities to admit all applicants who meet the admission requirements has been a major hindrance to university education and S&T higher education. In addition, the introduction of fee-paying programs in public universities has made it difficult for students from low-income families, particularly females, to gain access. As argued by Atuahene and Owusu-Appiah (2013), “in the public universities, the enrolment growth rate has not reflected the proportionate expansion in academic facilities to ensure equity and inclusion of all social groups” (p. 2). The inequitable access of males and females has prevented women from gaining access (Kilu & Sanda, 2016). More competitive entry requirements favouring students from wealthier regions and schools and higher socio-economic status (Arthur & Arthur, 2016) also contributed to the increase in the gender gap that was observed between the 2012–2013 and 2015–2016 academic years at the University of Ghana: it rose from a ratio of 43:57 to 29:71 in

favour of males (see Figure 4.4 in Chapter 4), meaning that many more male students were gaining access at the expense of females.

The government continues to push for an increase in women's participation in S&T higher-education programs. Consequently, some initiatives have been adopted, and a few of the policies currently in place have helped to improve the situation. Tertiary-education policies and initiatives in Ghana have focused on improving and bridging the gender gap in access to education and promoting S&T quality education at all levels. As discussed in Chapter 4, affirmative action and gender mainstreaming are claimed to have been the policies of choice at the national and institutional levels. However, this stance contrasts with Oppong's (2017) comments about the gap between gender-policy development and implementation in Ghana. Oppong noted that lack of funding, the absence of a clear mandate for inter-ministerial coordination regarding gender capacity, and a shortage of data present challenges to policy implementation processes, thus contributing to the gap between policy and practice. Oppong further noted that less than 1% of the national budget was allocated to the MoGCSP. Appiah and Baah (2017) corroborate Oppong's observation. The question is, "would the Minister for Gender, Children, and Social Protection have the cooperation of other Ministers for the amendment of their laws to include gender equality" (Appiah, 2015, p. 279)? It is evident that policies take a long time to draft, approve, and actually enact. As Sutherland-Addy (2002, p. 74) noted "affirmative action where practiced in the area of admission into science-based disciplines, for example, was done informally and was not part of the institutional culture".

In addition, the STME program in secondary schools had not reached the 30% enrolment objective before the focus was shifted towards building the capacity of both girls and boys under the name of Science, Technology and Innovation Education camps for both male and female students (MEST, 2010). According to a statement made by Honourable Juliana Azumah-Mensah, former Minister for Women and Children's Affairs (UN, 2011), the STME program in secondary school had been so successful that it was replaced by a new program catering for both girls and boys despite the fact that the goal of 30% female participation had not been reached. Contrary to the government's claim of success, Boateng (2015) argued that "it appears that some of these governmental initiatives are losing steam, probably because of funding issues, lack of capacity, or indifference by governmental agencies both at the national and district levels" (p. 164).

Thirty-one years after the initiation of the STME, the gender gap between girls and boys persists in S&T programs in Ghana. It is apparent that more needs to be done to bridge the gender gap. Andam et al. (2013) concurred that further initiatives are necessary to encourage more girls to enter S&T fields.

7.3.1 National Gender-Equality Policies Analyses

While some policies have been successful, a few of them have not achieved the outcomes expected, either from lack of appropriate funding, poor physical facilities, the gap between policy development and implementation, or lack of political will and commitment (Effah, 2011). Moreover, the limited capacity of the universities in Ghana severely impedes the access of women to tertiary education (Atuahene & Owusu-Ansah, 2013). If limited capacity means that female applicants have to compete with male candidates, who seem to be favoured in higher education and who have all the privileges, then it is evident that women's access and participation is very restricted (Arthur & Arthur, 2016). Notwithstanding various campaigns for gender equity through affirmative-action programs, there remains the challenge of bridging the gender gap in education, especially at the tertiary level in S&T programs.

Affirmative-action policies were introduced into university admission procedures in the mid-nineties as a corrective measure for the long-standing gender-based disparities. Universities have adopted various quota systems such as lowering the admission cut-off points by one point for female students in various programs (Atuahene & Owusu-Ansah, 2013). This has been the case at KNUST, as indicated by Don. However, it is difficult to assess how this strategy has been used in other institutions and if it has been applied selectively or across the board. There seems to be no standard for the implementation of this affirmative-action initiative particularly in S&T. Additionally, there is no mechanism in place to allow for the immediate follow-up and verification of the implementation of such quotas during the admission processes. The proportional distribution of gender is available only after all admissions have been granted (Sinha and Nayak, 2008). As Abagre and Bukari (2013) pointed out in regard to affirmative-action approaches, "while held to be widely practiced at the tertiary-education level, particularly with respect to admissions to science-based courses, it is not clear whether all the institutions do so as a matter of discretion or in pursuance of a well-defined or state policy" (p. 22). Moreover,

very little assessment has been done of gender-sensitive strategies in Ghanaian educational institutions beyond quota allocations in enrolment (Sinha & Nayak, 2008).

It is not surprising that the implementation and assessment of results of affirmative-action policies seem to be laden with issues. A study undertaken by Appiah (2015) revealed that despite the development of a broad national framework in the Draft Affirmative Action Bill aiming to achieve gender balance in recruitment and appointment of public officials, the bill was yet to be enacted into law, and full implementation, due to lack of cooperation from the various ministries and government agencies. One reason for the delay is that the Minister for Gender, Children, and Social Protection cannot have the cooperation of other Ministers for the amendment of their laws to include gender equality. In Ghana “public life is based, not purely on a system of advancement by merit, but on patriarchal notions of gender and gender roles” (Appiah, 2015, p. 275). The draft bill meets the requirements for gender equality; however, the challenge lies in its enactment and implementation (Appiah, 2015). In fact, Djaba³³ (2018) noted that successive governments had, over the years, tried to put in place mechanisms to enhance the participation of women in all aspects of decision-making in Ghana but these mechanisms had not achieved the intended outcomes. Indeed, on March 8, 2018, the National Commission for Civic Education in Ghana marked the International Women's Day with a call on “government and parliament to expedite the passage of the Affirmative Action Bill”(NCCE, 2018).

Similarly, mainstreaming gender in Ghana’s development plans has been the policy goal since the early 1980s. However, according to critics, Ghana has a reputation for having excellent policies on paper but failing to deliver expected outcomes, suggesting the rhetoric is far from the reality (Ackyeampong, 2009; Nguyen & Wodon, 2013; Nordensvard, 2014). Many scholars have asserted that policy commitments related to gender have a propensity to evaporate during implementation (Goetz 1997; Longwe, 1995; Morley, 2010; Tsikata, 2009). To determine how far policy is from real implementation practice, Nordensvard (2014) investigated how the NGP had been implemented in agricultural and natural resources management. The findings suggest that sensitization programs on gender issues have been successful in raising awareness to a certain extent. However, the formulation of gender-equitable policies and programs does not necessarily lead to the implementation of projects and activities that actually increase women’s access to resources or participation in influential public and political decision-making positions.

³³ Madam Otiko Afisah Djaba is the current Minister for Gender, Children and Social Protection.

The shortage of financial resources is the main challenge for the educational policy implementation gap (Nordensvard, 2014). Another challenge has been the inability of the NTCE to conduct research that is clearly needed for evidence-based policy-making. NTCE blamed its poor research capacity on lack of financial resources, claiming that resources were not available to upgrade staff's competence to conduct research (Bailey, 2014). In fact, the findings of Nordensvard's study (2014) confirm the observation made by Bailey (2014) that there was no single comprehensive gender policy for tertiary education in Ghana. The claim made by the government that the MoGCSP is well resourced is not borne out. It shows a clear lack of understanding of the nature of the problem and the magnitude of resources necessary to effectively address gender inequality issues.

Moreover, the government of Ghana has claimed that "education is the right of every child; still, the education policy has been informed by an economic discourse rather than a citizenship discourse" (Nordensvard, 2014, p. 279). The World Bank and the International Monetary Fund (IMF) have often influenced the discourses around education (Nordensvard, 2014). In addition, fundamental education reforms have been built on a dominant economic factor, suggesting that education is considered as an investment and Ghana's educational reforms have been mainly donor-driven. Moreover, the continued failure to design and rightfully target policies and interventions which address the needs of rural peoples, in Africa in general and Ghana in particular, suggests that policy-makers seem to misunderstand the way of life of these people (Nordensvard, 2014).

Despite an elaborate logical framework for monitoring and evaluation of the NGP, the MoE's 2016 performance report provided only the female enrolment statistics in tertiary education. This implies that the MoE was equating gender equality to gender parity: there was no discussion of the specific actions (consciousness raising, affirmative action, and gender mainstreaming) taken to increase female participation, retention, and success in education programs (MoE, 2016). The 2016 report did mention awareness-raising at the secondary school level.

Participatory Approach to Student Success (PASS) Scholarship program is to increase the enrolment, retention, completion and performance of girls at Junior High School (JHS) level in the 75 deprived districts of Ghana. PASS will achieve this by providing a full access, needs-based material support package comprising items

necessary for a girl to attend JHS, paying school and BECE [Basic Education Certificate Examination] examination fees, raising awareness and promoting girls education, and enhancing the capacity of the Girls Education Unit (GEU) Head Office and District and Regional Officers (MoE, 2016, p. 25).

However, awareness-raising related to gender has not been mentioned in the report at the tertiary level. Additionally, the MoE has developed a policy implementation plan for tertiary education including a timeframe for the accomplishment of the various activities that tended to be very useful milestones for the achievement of the various activities and gender policy monitoring and evaluation. However, seven years into the suggested timeframe in the Plan 2010–2020, all activities are ongoing from 2010 and none has been finalized. There seems to be no urgency in accomplishing the strategic plan's activities related to gender. The NCTE is responsible for implementing these activities with the collaboration of the tertiary-education institutions. Yet, there was no mention of gender on the NCTE website. It is apparent that priority has not been assigned to gender issues at the tertiary level.

The MoE and the MoGCSP developed the NGP with no detailed information on implementation and no specific timeframe. It was not surprising, therefore, that there was no progress report. According to the NGP, the various tertiary-education institutions were required to provide annual reports to the NCTE, which in turn was expected to provide reports to the MoE. The MoE was to work closely with the MoGCSP to prepare reports to the President. None of these evaluation reports was available. The 2016 annual report of the MoGCSP itself was scanty and mostly discussed social issues (raising women's awareness and empowerment through workshops) and finance. The only information related to education was about building classrooms for elementary school children, donating computers to some libraries, and elementary-school feeding programs.

Notwithstanding the Ghanaian government's numerous initiatives to increase inclusivity and equality and to normalize gender, the underrepresentation of women in higher education persists. Moreover, traditional practices entrenched in masculine organizational cultures continue to hamper the effectiveness of existing legislation and gender policies (Atuahene & Owusu-Ansah, 2013; Mabokela & Mlambo, 2015). Gender has been the most widespread and persistent socio-cultural, socio-economic, and institutional factor impacting access to education in Ghana

(Assie-Lumumba, 2006; Mabokela & Mlambo, 2015; Nordensvard, 2014). Lack of commitment and political will is widening the gap between policy development and policy implementation. Women continue to face discrimination in access to education; hence the call for more action towards gender equality to bridge the gender gap in the Ghanaian formal education, particularly in S&T higher education.

While effective gender-policy development requires countless debates with stakeholders, including women and consideration of all gendered issues with various solutions and perceptible outcomes, little analysis of the strengths, weaknesses, opportunities, and threats in the Ghanaian educational context occurred during the policy development process (Nordensvard, 2014). Furthermore, inconsistency between policy and implementation practices suggested a lack of political will and real effort to eradicate gender disparity in the Ghanaian society in general and in educational institutions in particular (Appiah, 2015; Arthur & Arthur, 2016). The same view was expressed by Don (KNUST) when he spoke of lack of commitment and political will. As Don noted there is this general consensus that KNUST is doing well. There are not very many competitors in Ghana. Therefore, KNUST does not see the need to change the status quo.

Gender mainstreaming necessitates the integration of women into gendered development efforts because gender equality cannot be attained until institutional and organizational changes occur. In most cases, the focus is on women—reinforcing the concept of women as victims and ignoring the fact that both men and women are influenced by societal gender constructs (Chauraya, 2014)—rather than on gender. This often leads to minimal institutional transformations that do not create any significant impact. Nonetheless, Sinha and Nayak (2008) acknowledged efforts made by the government of Ghana in adopting a sector-wide approach—reflecting the real essence of gender mainstreaming—in its NGP. As mentioned in the conceptual framework of this study, effective gender mainstreaming promotes gender equality within institutions if implemented effectively, thus enhancing social justice.

7.3.2 Gender-Policy Implementation at the University of Ghana (WACCI and WACCBIP)

CEGENSA has contributed greatly to raising consciousness regarding gender issues at the University of Ghana and has been instrumental in bringing gender issues to the forefront of debate and discussion within the university system. The draft gender policy refers to the use of

an affirmative-action policy that was apparently instituted in the 1980s to implement the university's commitment to promoting equal opportunity for male and female employees and students. However, during my numerous visits to many university offices, (CEGENSA, the Registrar's Office, the Student's Affairs Office, the Institutional Research and Planning Office as well as the University's Office of the Legal Counsel), I was not able to collect the Affirmative Action Policy document. Part of CEGENSA's mandate is to review existing policy documents and the operation of boards and committees and obtain consensus among administrators, staff and students regarding gender issues. Could this delay in the policy approval be interpreted as a failure on the part of CEGENSA to achieve consensus among stakeholders? Or was it simply lack of political will? This sluggish process of approving the gender-equality policy at the University of Ghana may have been the replication of what is happening at the national level (as discussed above). Affirmative action can work and improve gender equality in women representation and ultimately improve development outcomes only if there is full commitment to its goals and measures.

It is worth noting that even though the formal gender policy is not available, the sexual-harassment policy is readily available on the university website. The sexual-harassment policy document was reported to have been made available to students and employees as a handout at orientation sessions. The fact that this policy is in place at the University of Ghana could be interpreted as sexual harassment being an issue of grave concern to the university community. This notion was confirmed by one of the professors at the University of Cape Coast, Ghana in the following statement. "Yes, indeed, there are serious problems of sexual harassment in Ghanaian universities that we continue to grapple with" (B. A. Opokua, personal communication, May 12, 2017). Morley (2010) concurred that some students and staff in Ghana have raised the issue of sexual harassment as a significant impediment to gender equality. Tanye (2008) argued that sexual harassment, among other obstacles such as poor educational background among women, school environment, type of school, school location, and inadequate learning materials, affect women's participation in higher learning adversely.

7.3.3 Gender-Policy Implementation at KNUST (RWESCK)

The KNUST is an acclaimed institution devoted to training students in S&T: it admits 'the cream of the crop' into its S&T programs (IRR, 2017). Even though the March 2017

University Self-Assessment Report claimed that the “College shares the four core values of Leadership in Innovation and Technology, Culture of Excellence; *Diversity and Equal Opportunity for All*, and Integrity and Stewardship of Resources”, it would seem that the University does not really consider gender issues as relevant to its day-to-day activities or as a performance indicator to measure success. The current 2016–2025 strategic plan does not mention gender and the focus is on student achievement with no consideration to who is being left behind.

The lack of gender-policy documents is clear evidence that gender is not an issue of concern. In fact, most of the policy documents described earlier were in draft forms. Access to information at RWESCK was a challenging undertaking and involved many follow-ups and reminders. For example, it took more than six weeks to receive the list of students, instructors, and administrators involved in the study. Furthermore, in the IRR (2017), the only gender-related procedure mentioned that KNUST was the lowering of the admission grades for female applicants by one cut-off point. Indeed, the only information on gender in the KNUST self-evaluation report 2017 — a one-hundred and sixty-four-page document — was scattered over 10 lines (IRR, 2017). As indicated by the Officer in Charge of policies at the Quality Assurance Unit during my interviews, KNUST is just in the process of developing a gender policy.

This absence of a gender policy was reflected in the study conducted by Acheampong (2014) at the KNUST. This study revealed that “there are no policies governing females’ participation in STEM because most institutions believe that having a gender policy in STEM fields will instead discriminate against male students” (p. 50). In fact, one of the female registrars interviewed by Acheampong indicated that the idea of aiming for increased female participation in the S&T program was new to her. She also confirmed that no gender policy had been formulated since the establishment of the institution (Acheampong, 2014). Boateng (2015) corroborated this finding: “policy frameworks are in dissonance with gender concerns” in Ghana (p. 54).

The lack of policy related to gender and the absence of political will contribute to this enormous gender inequality in university admissions. For example, over the period between 2011 and 2015, female admissions into engineering programs at the KNUST were less than 17% of total admissions (IRR, 2017). Interestingly, the Faculty of Medicine at KNUST had a higher enrolment rate for women than the University of Ghana: according to the *Baraka Policy Institute*

Research Report (2016) from the 2010–2011 to 2014–2015 academic years, the average student enrolment rate was gender-equal. As noted by Berggren (2011), women are interested in medicine and social science fields while men ordinarily opt for technology fields such as engineering, architecture, and computer science. Since KNUST is an S&T institution, it is not surprising that many more women enrolled in medicine than engineering and other S&T fields.

7.4 Analysis of Gender-Policy Implementation at WACCI, WACCBIP and RWESCK

To respond to the first research question related to the policy and plans formulated to address the gender inequality issue and to support the policy documents discussed above, it was necessary to interview administrators and instructors at the respective ACEs. According to Figure 5.2 in Chapter 5, WACCI female student population increased from 35% of the total in the academic year 2014–2015 to 40% in the academic years 2015–2016 and 2016–2017. WACCBIP saw their proportion of female students increase from 30% to 40% (Figure 5.6) in the same time period, while RWESCK's female student admission increased from 29% to 40% between 2015–2016 and 2016–2017 (Figure 5.9).

The administrators of the respective ACEs were interviewed to gain insight into the factors that contributed to the increase in admission rates: two male administrators from WACCI (Karl and Michael), one male administrator and two females (one administrator and one faculty member) from WACCBIP (Joseph, Georgiana, and Golda), and one male administrator from KNUST (Don). Administrators from RWESCK were not available for an interview.) (See Table 5.1 in Chapter 5 above for detailed information on the research participants.)

7.4.1 Consciousness of Gender Issues

I now describe the policies and procedures at the various ACEs and examine the extent to which these have been effectively implemented. A total of six administrators and/or instructors took part in one-on-one semi-structured interviews of approximately 30 minutes per participant. Each participant was asked questions related to the policy implementation process at their respective ACE. All the participants were asked the same questions as detailed in the administrators' interview protocol. The administrators' perspectives on gender issues and the various solutions each ACE has brought to the issue of gender disparity follow.

When I asked interviewees if they were aware of gender issues most of the administrators seemed to have some knowledge of gender issues and noted that gender could sometimes have a negative impact on the success of women in S&T programs:

They [researchers] recently said that gender is an attribute of society. For example, in some societies women are not allowed to drive. It is society that differentiates between men and women and assigns specific roles based on gender (Michael, WACCI).

I think, historically, women have not been given the opportunity to study sciences. However, now, there is a deliberate effort to try to involve them and give them a chance. Those days where they thought that science is for guys are over, and things are changing now (Joseph, WACCBIP).

I think it has been this individual consciousness. After the Beijing Conference on Women, people became aware of the issue, and so, individually, people began to talk about the issue. These days, people are conscious. Well, let me say there is an improvement (Don, KNUST).

Administrators at the three centres confirmed that neither university has a written gender policy. Meanwhile, all participants (administrators and instructors) claimed that they had been using their institution's gender policy. Given the fact that there was no written gender policy, it was apparent that they were referring to informal policies that had not been prepared in any coherent form. When asked about the existence of a gender policy, Michael (WACCI) responded, "You know, this gender balance issue is a new thing basically. Maybe people have not thought about it. In all those established institutions, many people are now becoming aware of the issue. So, policies are being developed." Georgiana (WACCBIP) stated that she did not believe the university had a policy, but that at WACCBIP, the ACE had made it a point to give women the same opportunity as men; interestingly, there were more female applicants than men. Don (KNUST) claimed, "As a Quality Assurance and Planning Unit, we implement the KNUST policy as reflected in the strategic plan 2016–2025. However, we are working on the actual gender policy."

7.4.2 Affirmative-Action Approach

Three types of affirmative-action approaches (quota systems, preferential treatment, and outreach programs) were discussed in Chapter 3. To obtain information on the types of affirmative-action approaches that are being used in the ACEs, the administrators and instructors were explicitly asked about student and staff recruitment processes:

The university has an [informal] gender policy, and that is what we would like to go by.... What we are trying to do is...We are trying to focus on quality... Nonetheless, I don't think that anyone should put in place a policy which disadvantages one sex over the other. I mean it is about excellence. You have to meet the minimum requirements for admission. We have to show that female candidates have special requirements. When they come in, they are treated well, and they are given conditions which are conducive to their progress. I think that is the main issue. (Karl, WACCI).

We work within the framework of the university. Generally, we follow the [informal] university policies. We do not go directly against the university policies. We just try to make things more efficient. We do things faster but not do anything that is illegal. No, that one [affirmative action] has not been written. That is something that we have adopted ourselves... Generally, what the university says is that we should be giving them [women] a chance; but how? They have not outlined how to give them a chance. (Joseph, WACCBIP).

Next couple of weeks we are going to be discussing the gender policy. So, I have started documenting. We have started advocating now for gender issues. But now, we are trying to put everything together... There is no policy, so it is difficult to evaluate it. (Don, KNUST)

From the interviews, it was evident that there was no specific standard for affirmative action in university recruitment processes. For student admissions, each ACE used its own interpretation of the informal affirmative-action policy. WACCI based its gender affirmative action on age during the admission process, while WACCBIP ranked both male and female

applicants and admitted 50% of the top candidates between the male and female applicants. KNUST required a lower admission grade for female applicants according to the interviewees.

We have said that we may be able to increase the bar for admissions for females; so, while we stop male admissions at 40, we can allow females to come in around 45 [years of age].... This is not the university policy. The University of Ghana does not assemble females and give them special admission. I mean no one would go to Cambridge and say that you are female, so come for this lecture. No, I doubt that is the case of the University of Ghana. So, we also do not do that. You know, we are talking about PhD. No, I mean it is rubbish. (Karl, WACCI)

You have a pool of candidates, all of them are qualified. Then you ranked them males and females, and you take the best; best of the males and the best of the females, 50/50... Moreover, by the way, that works for master's and PhDs but not so much for postdocs because, sometimes, we do not have enough female candidates. (Joseph, WACCBIP)

Starting from last academic year...one of his [the vice chancellor's] strategic visions...we lowered the cut-off point for females who applied to go for science and technology programs to increase the enrolment of females. So, that is one affirmation-action program that we have instituted. (Don, KNUST)

Affirmative-action approaches are being used to increase female student participation, but the administrators indicated that the ACEs did not recruit their staff directly because they had to use the pool of staff available at their universities. Joseph noted that the ACEs had more control over what happened to the students but had limited control over staff recruitment. Georgiana corroborated Joseph's statements, stating that WACCBIP had no control over staff recruitment while Don (KNUST) mentioned that his institution had a policy of non-discrimination.

In fact, faculty-wise, it is just because we did not have that many women as lecturers or so... Well, for the students, we have the gender balance, but not for the faculty; just because the faculty members are, first and foremost, employed by the University (Georgiana, WACCBIP).

For staff entry, we make sure we don't discriminate because culturally in Ghana, in science and technology...like computer engineering and others, the policy [Draft Ethics Policy] states that once you qualify, once you have what it takes to pursue your degree, you should be considered (Don, KNUST).

7.4.3 Gender Mainstreaming

Similarly, all the administrators claimed that they had instituted procedures and plans to help increase participation of female students, instructors, and administrators in their respective programs. The gender-mainstreaming policy at WACCI was summarized in this management perspective on gender:

To be admitted, you must be all rounded, you must have the ability to undertake the PhD degree, and so, gender-wise, I do not see that as a challenge at all. It is when an individual has special needs then we take care of her. For example, a woman carrying along a child, a woman pregnant, then we...those are special needs. I do not see them as a challenge at all. They are special needs, so we can take care of those (Karl, WACCI).

The participant from WACCBIP referred to procedures that had been adopted to help mainstream gender:

Generally, our training is meant to use a combination of approaches that would allow everybody to find whichever way would optimize their potential. So, some of the programs... I mean some of the positive inputs are to encourage them [students] to work in groups and present... We are lucky the university has been quite open to innovations. So, most of the things we have tried to do by way of training the students, we have been allowed to do so (Joseph, WACCBIP).

As for KNUST, the gender conversation started a long time ago, but it seemed to have stalled in recent years. There have not been follow-ups on the progress made earlier due to lack of political will. For example, Don (KNUST) voiced his concern by stating:

I know the issue. It's just like...I know all the work that Dr. Rudith King has done on gender-policy documents has not been recognized...We cannot say now that the women do not have the aptitude. The more you are bringing the women down, the same way you are bringing society down and yourself in the process... Oh, it's all about lack of commitment. Yes, the issue is there is this general view that we are doing well. If what we are doing is working, why change it? There is no policy, so it is difficult to evaluate it.

The findings of administrators and faculty interviews at the ACEs corroborate the description of the gender-policy environments of both the University of Ghana and KNUST. It was evident that none of the institutions had a formal written and approved gender policy. Nonetheless, informal gender policies used on an ad hoc basis limit the effectiveness of program implementation as no specific standard is applied to everyone. As mentioned in the University of Ghana draft gender-policy document, “the formal and informal policies and practices of the University have differential impact on men and women” (p. 1).

7.4.4 Comparison of the Policy Environments of the Three Centres

7.4.4.1 Similarities between the Three Centres

The three ACEs (WACCI, WACCBIP, and RWESCK) under study are hosted by various departments of the University of Ghana, Legon and the KNUST and therefore implemented policies that had been formulated by their respective host institutions. Figures 5.2, 5.6, and 5.9 above show that all three ACEs managed to reach a 40:60 female-to-male ratio within two years, the ratio set out in the *National Science and Technology Policy* (MEST, 2010). This contrasts sharply with regular enrolment figures in the two host institutions (University of Ghana and KNUST). In fact, the average undergraduate female admissions at the Faculty of Medicine at the University of Ghana and the Faculty of Engineering at the KNUST in the academic years 2010–2011 to 2014–2015 were respectively 35.86 % and 13.06 %. Apart from the KNUST Faculty of Medicine ratio of 1:1, engineering and other S&T statistics provide clear evidence that the NGP goals are far from being reached.

However, the gender gap between female and male instructors and administrators

requires urgent action. There is need to bring female participation to at least 40% for faculty and administrators just as for students. In 2016, only 20% of instructors at WACCI were women. The figures for WACCBIP were slightly higher (33%) but still below the gender-policy target of 40%. These figures reflect the underrepresentation of women academics and staff in general. The lack of concrete action in the enforcement of the NGP at the national level seems to be replicated at the university levels. Neither the University of Ghana nor KNUST have formal and endorsed gender policies requiring implementation and assessment. Consequently, the policies are implemented on an ad hoc basis with differential impact on students, instructors, and administrators in all three ACEs.

7.4.4.2 Differences between the Three Centres

As discussed earlier in the study, there are many different conceptions of gender, and gender policy does not necessarily mean the same thing to all people. To date (November 2018), no gender-policy information is visible on the University of Ghana website. Therefore, it is safe to assume that the gender policy document has not been approved yet. Even though the administrators interviewed seemed to be aware of the gender issue to some extent, it was not clear if the University management team as a whole was equally knowledgeable.

For example, Karl (WACCI) stated at the beginning of the interview that WACCI did not care about gender: “I mean it is about excellence.” As the interview with Karl progressed, I noticed a gradual change of position from not being concerned about gender issues to talking about improving female representation. Towards the end of the interview when I asked Karl whether he had any suggestions on how we could address gender inequality in the S&T graduate program, he replied:

I think when you look at data you find that females are not well represented in certain areas. So, you want to change that because we are beginning to become aware that the females have an impact in a special way. The main problem we have with the world is that we do not find people who are leading properly. That is the serious problem—that leadership is so corrupt—so how do you get a leadership which is impactful in ways that would make institutions flourish? And I think that women have an important role to play because of, in the majority, the special touch they have in the way they do things. They are patient, and they think critically and

carefully. They do not act when they are not convinced that it is good for the majority. (Karl, WACCI)

Overall, the University of Ghana seemed to be improving its perspectives and procedures related to gender. The statistics from 2014 to 2017 for female student enrolments for WACCI and WACCBIP were an average of 38% and 37% respectively compared to 35% for RWESCK, which reflects a minimal gap. However, there was a big gender gap between faculty and administrators for WACCI and WACCBIP at Legon compared to students. In fact, 33% of WACCBIP's recruitment is female and an average of 22% at WACCI, compared to 40% female student participation in the whole University of Ghana, Legon. In contrast, with the exception of assistant lecturers (42% female), an average of only 21.33% of instructors (associate professors, senior lecturer and lecturer) were female in 2012–2013 at the University of Ghana. As Karl (WACCI) and Joseph (WACCBIP) stated, the ACEs do not recruit their staff directly but among university staff. This explains the very low participation of female instructors and administrators at the ACEs, particularly at WACCI, which had 20% female academics (see Figure 5.3). No data was available on staff at RWESCK (KNUST). Overall, the University of Ghana seems to have given more priority to gender issues than KNUST because it has created a Centre for Gender Studies and Advocacy to coordinate gender issues. However, KNUST seems to be far behind Legon in how to move the gender debate forward.

There does not seem to be any urgency on the part of the government of Ghana and the universities in addressing gender issues. To date, the Affirmative Action Bill has not passed, and thus there is no law to direct the implementation and enforcement of affirmative-action policy in the country. Policies take a long time to draft, approve, and actually enact. There is a need for behavioural change and organization transformation to bring about the effective formal implementation of an affirmative-action approach in student admissions and staff recruitment.

7.5 Conclusion: Consciousness-raising, Affirmative Action, & Gender Mainstreaming in S&T in Ghana

In this chapter, I have discussed various policies and procedures put in place at the national and university levels to overcome the challenges of gender disparity in higher education, particularly in graduate S&T education. The government seemed to be keenly aware of the

negative impact of gender discrimination on the socio-economic development of the country. The social consciousness raising efforts earlier on has seen some progress in tackling gender issues in a limited way. There is a need for consciousness-raising in the Ghanaian society in general. The government's attempts to create an enabling policy environment for female education at the national level have been complemented by a growing number of interventions. Notwithstanding various campaigns for gender equity through affirmative-action programs, there remains the challenge of bridging the gender gap in education, especially at the tertiary level. In particular, gender inequality in university enrolment and faculty/administrators recruitment remain a problem. Ghana has a reputation for having an exemplary education policy on paper but failing to deliver expected outcomes.

The University of Ghana and the Kwame Nkrumah University of Science and Technology, like many African universities, have been marked by structural inequality with respect to region (rural versus urban), ethnicity and race, social class, and gender. The analysis of policy documents revealed that a whole lot more needs to be done to create awareness about gender issues at the management levels among university, staff and faculty as well as the stakeholders. The findings described above are consistent with Rummana, Ferdaus, Rashid, and Chowdhury's (2011) observation that low representation of women in S&T fields is an alarming global phenomenon, for "the leaking pipeline" still exists. The analysis of policy documents revealed that incoherent, unclear, and informal gender policy documents exist in the institutions studied. The findings of the interviews with administrators confirmed what was found in the review and analyses of policy documents. The analysis of the administrators' interview data helped corroborate the information in the policy documents examined in the first phase of this chapter.

One of the performance indicators of the University of Ghana's Strategic Plan 2014–2024 is the approval of the gender policy (University of Ghana, n.d.). The presence of this indicator may suggest that even though gender equality is listed as a key priority of the university, delayed action on approving the policy undermines the perception that the university is genuinely committed to gender issues. The low level of commitment and accountability may have resulted from the inability of the government to demand adherence to their policies and to carry out the necessary monitoring and evaluation that are likely to bring to the fore the underlying issues:

those that prevent institutions from adopting the required gender policy and bridging the gender gap in higher education in general and S&T education in particular.

The main focus of both the University of Ghana and KNUST is on education and research. The inattention of these institutions to the exclusion or marginalization of half of the population (women) whose talents are not being tapped adequately is evident in their inability to approve their draft gender policies and implement them in a consistent manner. While policy provides a supportive environment, it is clear that without resources and effective accountability mechanisms the pace of change will remain slow. The collection and reporting of statistics need to be supported by active steering mechanisms, access to resources, focused interventions, and leadership from positions of power. The accountability of the individual managers should also be stressed: achieving equality should be a key performance requirement for all heads of departments given the strong evidence of endemic gender disparity in both institutions. In order to bring about change, there is a need for awareness and training in how to initiate gender mainstreaming in these and other higher-education institutions in Ghana. While the administrators' interview data offer evidence that some types of affirmative-action initiatives have been implemented at the ACEs, there is no clear indication that these programs function as key factors in facilitating women's access to post-secondary science education and are effective. There is a need for behavioural change and organization transformation to bring about the effective formal implementation of an affirmative-action approach in student admissions and staff recruitment.

Despite the fact that affirmative action will help bridge the gender gap in formal education, particularly at the higher level, gender equality cannot be attained until institutional and organizational changes occur. Tackling gender inequalities and regional imbalances in access to higher education particularly in S&T graduate education requires consistency in the formulation and implementation processes and transformation of institutions at the higher level. Thus, gender mainstreaming is imperative for keeping gender perspective in policies, programs and plans. The government created an enabling policy environment for female education such as the STME program and the ACE initiative at the national level. These initiatives have helped improve the situation to a limited extent. I will elaborate on the preceding short explanatory discussion of policies and procedures following the presentation of the results of interviews with

female participants in Chapter 8. I will elaborate further on the gap between policy development and policy implementation in the concluding chapter.

CHAPTER 8: WOMEN'S EXPERIENCES AND PERSPECTIVES

This chapter presents results of interviews with female students, instructors, and administrators from the West Africa Centre for Crop Improvement (WACCI) and the West African Centre for Cell Biology and Infectious Pathogens (WACCBIP), both at the University of Ghana, and the Regional Water and Environmental Sanitation Centre in Kumasi (RWESCK) at KNUST. A total of 24 women participated in in-depth, semi-structured, one-on-one interviews conducted either face to face or by telephone. To protect participants' identities, pseudonyms and the ACEs names are used in this chapter. The chapter presents analyses of participants' experiences leading up to their enrolment or work in S&T, and their perceptions concerning the relative impact of university and ACE policies and strategies on these experiences as well as the women's perspectives on the status of girls vis-à-vis science and technology education.

I examine the intersection of gender, socio-cultural factors, and organizational culture and the extent to which these have affected the professional experiences of women academics at the selected ACEs. I also explore the obstacles faced by women in the pursuit of higher education and careers in S&T fields and the strategies they have adopted to navigate socio-cultural, educational, and professional contexts that are not always supportive. Structuration theory has been used as a lens to illustrate the multiple layers of structures such as social and family structures, institutional structures and the structure of globalization that impact the life and personal agency of the women.

For ease of interpretation, the results are organized into three distinct parts according to the theoretical framework. Part 1 provides information on the challenges and obstacles that the participants have experienced and what they regard as typical hindrances to other women's participation in S&T disciplines at the ACEs. These represent the structures of gender ideology and the institutional structures that negatively influence women's successful participation in S&T programs, particularly, at the graduate level. Part 2 covers evidence of misalignment between the social expectations and institutional responsibilities and experience of tension. Part 3 highlights agentic processes and factors such as affirmative-action approaches and gender-supportive-practices and procedures that may have helped the participants overcome these challenges and enabled them to gain access to, and succeed in, graduate S&T programs at the three study sites. At the end of each section, a final discussion focuses on the central issues

raised by the participants alluding to the conceptual and theoretical frameworks described in Chapter 5. The findings are classified under three main themes and thirteen sub-themes.

The first theme, challenges and obstacles experienced and/or perceived by the participants, is subdivided into three main sub-themes: a) socio-cultural views of girls and women's place in society regarding graduate education in S&T; b) stereotypical views of girls and women regarding education in S&T and c) institutional constraints. The second theme, misalignment of social structures and academic responsibilities subdivided into: a) women's reproductive role versus their professional responsibilities; b) challenges of scheduling home versus academic requirements; c) workplace politics and environments; d) lack of childcare; e) conservatism of female supervisors; and f) sexual harassment and lack of trust in the system. The third theme, agentic processes, fostered by supportive factors, includes four main subthemes: a) personal agency; b) supportive factors; c) supportive gender equality practices and procedures; and d) the participants' perceptions of the status of girls vis-à-vis girls S&T education.

8.1 Social and Institutional Structures: Challenges of and Obstacles to Pursuing Graduate Education and Careers in S&T

Most of the participants admitted having faced some challenges or obstacles in their pursuit of graduate education in S&T disciplines. In general, there was lack of encouragement when the women decided to pursue graduate degrees in an S&T field. As early as 2000, it was acceptable for females to study all the way to a bachelor's degree. However, consistent with socio-cultural and traditional views of girls and women in Ghanaian society and the stereotypical view of girls and women in S&T, the pursuit of a graduate degree has been frowned upon because that is precisely the time when these women are expected to get married and have children (Awumbila, 2007).

8.1.1 Socio-Cultural Views of the Place of Girls and Women in Society

8.1.1.1 Pressure to Marry Early and Have Children (Foregoing Education)

The female participants faced societal pressure to marry early and bear children. The participants indicated that they often felt pressured by family members to follow cultural and societal norms and felt discouraged from pursuing higher education, especially at the graduate level, alleging that no man would marry them when they were a lot older. There is an erroneous

perception that well-educated women are opinionated and tend to abandon their main gender roles of home-keeping and child-bearing. Indeed, graduate education is widely perceived as unnecessary for females because fulfilling traditional gender roles of marriage and child-bearing does not require higher education. Esther (WACCBIP) recollected the remarks made by her peers when she told them she was planning to pursue graduate studies.

I often get comments like, okay, so you went to Wesley Girls High School. You have obtained a degree, and you are now aiming for a PhD. Do you not know that if you do not marry before then, you may not find anyone to marry you?

Socio-cultural expectations place pressure primarily on ambitious women; this invariably creates implicit boundaries for every woman. Most of the participants referred to such barriers, and felt that generally marriage created a barrier to the pursuit of higher education.

Marriage is a significant impediment to women trying to pursue a graduate degree in science and technology programs. Women have a lot of roles and responsibilities that tend to compete with graduate-education requirements. (Helen, WACCI)

In Ghana here, marriage is regarded as very important and often related to age. If you are after a particular age, they [family and society] feel, maybe, time is flying because you need to get someone to marry. If not, you will end up settling for anyone that comes your way, just because the pressure from family and society is fierce. (Deborah, RWESCK)

In rural areas especially, marriage and higher education are regarded as mutually exclusive for women because by default they cannot make good wives or mothers, two requisites of women's traditional role in life, while simultaneously pursuing higher education and academic careers. In fact, as most participants suggested, women in higher education are often seen as undermining women's socially assigned roles. Consequently, in relative isolated areas in Ghana, particularly in the Northern and Upper regions, marrying off young girls is common practice. Early marriage of daughters, not higher education, will guarantee family prestige while providing a valuable dowry³⁴. In these contexts there is substantial pressure for girls to drop out

³⁴ "The dowry system, the monetary value of a daughter's marriage" (Tanye, 2008, p. 169)

of school in order to be married. This is exacerbated by the fact that polygamous marriages are commonly practised in rural and predominantly Muslim area of the Northern and Upper regions.

Most of the girls from this part of Ghana [Northern region] will drop out at an early age and go into marriage. Most of the marriages are somehow polygamous. For instance, my father had four wives. As a woman living in that society, you will be responsible for bringing up your children. (Lynda, WACCI)

Similarly, Olivia (WACCI) argued that girls in rural areas are silenced and are not expected to have any opinions because life decisions are made for them by their parents and society:

Most of the women in rural Northern Ghana, especially the Muslim women, do not have a voice. They are at the mercy of their parents and society at large. Of course, society has created these roles, meaning the man should be in the office and the woman should be in the kitchen and take care of the home. (Olivia, WACCI)

These cultural beliefs [are] consistently followed to the point where in meetings, as a woman, you dare not speak. I recall we were having a community-based program and I happened to have been the group leader. However, because I was a woman, I was told not to speak, and I had to respect the culture. So, I also kept mute. Therefore, I had to elect a man to speak on our behalf. (Gladys, RWESCK)

The expectations from our deprived villages are very high, and the gender roles must be adhered to. Women are expected to do housework. This is the biggest challenge in the pursuit of higher education; particularly, women from the rural areas do not have running water in their homes. They have to go fetch water from far away on a daily basis, which is not an easy job. (Helen, WACCI)

Gender status not only provides different interpretations of social and personal aspirations for young women but also instills in them the sense of the boundaries not to cross and the potential penalties for crossing them. Quite often, parents advise their daughters to forego their education in order to get married:

When I completed my master's degree, my mom personally told me not to pursue further education. She said that the master's level was enough because I was not married and, therefore, I should consider getting married instead of pursuing further education. (Delphi, RWESCK)

People were like... 'Don't you want to get married first? Well, it is better for you to get married than go for a master's degree. (Joana, WACCBIP)

Not only are women encouraged to get married at an early age, but they are also expected to start having children immediately. Even though Ghanaian society seems to have accepted the discourse concerning the importance of girls' education, the concept of graduate education for women is still not readily condoned in most households (particularly in rural areas), especially when the parents are not well-educated. As Doris (WACCBIP) indicated:

Science is generally seen as very demanding, and girls growing up in traditional homes are often told that if they study science they will be too "educationally inclined" and therefore will not fulfill their expected family roles as grown women.

8.1.1.2 Stereotypical Views of Girls and Women Regarding Education in S&T

The women whom I interviewed were unanimous in their critique of the gender stereotyping that occurs in school curricula and academic programs. They all agreed that this applied to S&T disciplines which are widely seen as masculine areas of study and professional work. This is often related to the common refrain that because S&T careers tend to be financially rewarding, they are suited for men since they are the ones who are expected to be family breadwinners. From early childhood, the participants were frequently told that applied sciences are for men while social sciences and humanities are suitable for women. Some parents paid less attention to female students' grades in S&T classes because less was expected of the girls. As indicated by Joana (WACCBIP).

Some parents would tell their daughters that it was okay if they failed a science course...you are just a girl...they would say. I recall when I told my friends that I was going to do a master's degree in science, my friends interjected: a Master's

degree in science? Cos, some sciences like a medical doctor, that was hands-on experience ... you are going to work at the hospital and that was acceptable. But to do courses like Botany, Zoology, Biochemistry etc. is frowned upon

The observations of Janet (WACCI) and Marietta (WACCI) typified these accounts. Both commented on how their friends were baffled on finding out that they were pursuing doctoral degrees in S&T fields. In fact, both these graduate students progressed straight from undergraduate studies to doctoral programs without taking time away from their studies, despite sensing pressure from friends that they ought to get married.

A further challenge facing many of the participants is that many people are not familiar with the range of S&T fields or the job opportunities associated with them. Besides disciplines such as medicine, engineering, pharmacy, and nursing, few people are aware of S&T careers in areas such as molecular sciences, agricultural sciences, or biology.

When I started talking about graduate education, they were like ... a master's degree in science? What are you going to do with it? Are you going to teach? Even then, a bachelor's degree is enough. (Joana, WACCBIP)

I know some of them still think that a woman's place is neither in the classroom, nor in the workplace ... it is at home fetching water and doing house chores. Yes, so generally, society is biased towards women. (Zara, RWESCK)

8.1.2 Institutional Constraints

8.1.2.1 Inadequate Teaching Practices and Digital Divide between Rural and Urban

Areas

Ordinarily, graduate S&T studies require a lot of time conducting experiments in laboratories which is not the case in social sciences and humanities programs. In addition, students have other expenditures related to laboratory coats, reagents, bench fees or overhead costs associated with the use of science and technology laboratories and other equipment that students in non-scientific fields may not need. This was reflected in the observation made by Marietta (WACCI).

It was a bit challenging to study mathematics compared to the reading programs, or

social sciences and humanities. It meant that you have to put in extra efforts in the maths, the physics, chemistry compared to the other ones that involve reading. So, I have to put in more efforts.

It is obvious that women have to overcome many obstacles in the pursuit of S&T programs at the graduate level. Poor teaching practices in schools can exacerbate their situations. While the lack of gender sensitive teaching methods has discouraging effects on both male and female students, the adverse impact on girls and young women is greater because from an early age women are obliged to take on responsibilities at home and sometimes out of the home. The RWESCK program is challenging, especially for female participants who are grappling with family and professional responsibilities. Almost all the female participants from RWESCK complained about the poor science teaching they had received and that this had sometimes threatened to impede their progress in S&T learning. At REWSCK the inflexible STEM module system of teaching was packed with so much information and this proved to be very time consuming, with classes running from 8 a.m. to 5 p.m. and only occasionally an hour's break for lunch. For the RWESCK participants, this was extremely stressful and challenging because they found it difficult to combine learning with their daily family responsibilities.

The difficulty we have is mostly related to the modules. The other thing is organization. There are ... miscommunications [and] sometimes, we don't even follow the set structure. (Gilberta, RWESCK)

Our program is a bit inflexible for women, making it impossible sometimes to catch up. This is particularly true for nursing mothers who have to skip some classes because of their children. (Deborah, RWESCK)

In the view of the RWESCK participants, there was a need for more program flexibility to help mitigate the stress of female students. By contrast, the women at the WACCI and WACCBIP's programs who also use the module system did not complain about their programs.

8.1.2.2 Shortage of Formal Professional Mentors and Role Models

Because the ACEs do not always provide mentorship to their students, they tend to rely on their supervisors for academic advice and guidance. However, the number of female

academics who can provide advice to students on issues unrelated to school is limited. The shortage of mentors and role models has been an obstacle for female students as it has made it difficult for many of them to adjust to the working environment. As noted by Olivia (WACCI) Esther and Sylvia respectively: “mentoring was one of the things that would have been helpful for student success”.

I honestly did not know what I was stepping into, and I think I had not mentally dealt with the fact that I did not get into medical school as planned ... So somewhere, I think when biochemistry got a bit tough, now, everything just started coming back, and it kind of crushed me a bit. (Esther, WACCBIP)

Science is a very broad field. You can go into engineering; you can go into medicine; you can be this ... you can be that, and then you can also do a PhD. Because like some of us, we really thought that doing science, you just have to become a medical doctor. We ended up in engineering. (Sylvia, RWESCK)

Female teaching staff registered similar difficulties about having to fend for themselves with no support from senior staff members. Some participants complained about the shortage of professional role models in their respective programs, which limited their ability to make informed decisions about career choices and career progression. As Georgiana observed,

I personally think there should be some kinds of mentoring system; if the more experienced staff members in the system can help the new recruits, it will be very helpful (Georgiana, WACCBIP).

Moreover, there is a digital divide between the rural and urban areas making it challenging to students, particularly girls and women, who graduated from rural areas, before moving the urban areas for further education. They found it difficult to catch up with their urban counterparts. This was reflected in the narration made by Deborah (RWESK) who stated:

From the undergraduate level, I wasn't much exposed growing up. I wasn't privileged to have access to those technologies and stuff like that. I had to stow my way out to go to the Cafe whiles I was sent on an errand, and even then, maybe just

30 minutes... When I was growing up, my father never allowed me to go out and to associate with people. So, I go from school, straight to the house ... within my environment, I had little or no time to even interact with anyone outside...or to have access to a computer.

The participants faced several challenges related to socio-cultural expectations and family pressures to get married and raise a family at the expense of their graduate education, particularly the pursuit of a doctoral degree in S&T which is considered as being destined for men. In contrast, female pursuit of graduate studies in social science and humanities is somewhat accepted and not regarded with such antipathy.

8.1.3 Summary of Challenges and Obstacles

Participants perceived and/or faced numerous socio-cultural and institutional obstacles that militate against women trying to pursue higher education or have careers. However, the stereotypical views of girls and women regarding higher education in S&T makes it more problematic for the women to be active participation in S&T disciplines as students, instructors, and administrators. Not only did they face obstacles trying to obtain higher education credentials, they faced more challenges if their areas of study were not the socially accepted fields for women. The participants felt constantly under pressure to marry early, forego graduate education, and start a family, perceptions that are consistent with findings in the literature (Abramson, Rippeyoung, & Price, 2015; Cherkowski and Bosetti, 2014; Clark and Hill; 2010; Moloney, 2015). These socio-cultural norms, values, and roles deeply implanted in the fabric of African society generally guide tertiary-education practices.

The institutional challenges are also worth noting. The teaching practices adopted by RWESCK seem to have been very challenging, especially for female students trying to adjust to graduate studies. Similarly, Assuah and Ayebo (2015) suggested that the highly theoretical teaching methods of some lecturers in undergraduate mathematics programs in selected universities in Ghana made it difficult for students to connect their everyday life experiences to their classroom activities. Instructors' pedagogic skills need to be enhanced to include more modern teaching practices focusing on student-centred approaches, and that this training be coupled with mathematics curriculum development. The findings of Buabeng-Andoh and Issifu (2015) have likewise revealed that urban school students use ICT in their learning more than

semi-urban and rural school students as has been the case in this study. Indeed, as discussed in this section, some participants experienced many challenges in the pursuit of graduate S&T programs and careers, source of structural misalignments.

8.2 The Evidence of Misalignment and Subjective Experience of Tension

The misalignment between the variant mandated structures was experienced with a sense of tension that arose along with a desire and/or need to dissipate that tension. Many participants elaborated on their perceived obstacles rather than their personal challenges.

8.2.1 Women's Reproductive Role Versus their Professional Responsibilities

From the common traditional perspective, a woman's reproductive role takes precedence over her educational aspirations, particularly when it relates to graduate studies in S&T. Among many households in Ghana, and in most African countries, families exert considerable pressure on their daughters to start families once they are in their early twenties. This of course is the age that young people apply to attend graduate school. Consequently, while a childless married woman could conceivably attend graduate school with limited other responsibilities, family members generally press the married daughter to bear children before they apply to, or enter, graduate programs. In Ghanaian society, married women are expected to become mothers.

Being African and with our culture and everything, it is a bit difficult because for now, people expect that you will be thinking about marriage and then children. On my birthday last month, they [family and friends] were like, oh, so we just hope that after your master's, you will get married, and then some even said, "Oh, you are done with school." (Esther, WACCBIP)

After my bachelor's degree, a friend asked me about the next big thing in my life and she was disappointed I didn't say marriage ... and she was like, 'are you crazy? 'Obaa dee wode sukuul bebirebe yi ko he' [...] Okay, that was Twi³⁵ and it just means that as a woman what are you going to do with a lot of education? So, I don't talk to many people about my career aspirations anymore (Zara, RWESCK)

³⁵ Twi is one of the local languages spoken in Ghana.

The predominance of the reproductive role of women over their education and career achievements is stressed in the story narrated by Helen (WACCI) when she recounted her decision to pursue her PhD studies in agricultural science.

After my master's degree, I got married, and after that, I had some miscarriages. So, two years later, I was offered a scholarship to study for a PhD degree in plant breeding. However, when I informed my brother-in-law, he suggested that I waited and gave birth before I pursued the doctoral degree.

According to the interviewees, those aspiring to pursue a graduate degree completed their undergraduate programs in their twenties. They were then faced with a dilemma: should they pursue their career goals or start having children in compliance with family and societal expectations. This was especially difficult for these women since S&T programs are traditionally considered male-dominated fields and not suitable for women. Early into their careers in male-dominated S&T fields, this was a dilemma that many participants faced which was a source of tension linked to the misalignment of the traditional gender roles and the professional responsibilities.

Several participants indicated that male professors on occasion openly expressed doubt regarding the suitability of S&T as a career path for women, and some expressed dislike about having to teach women whom they thought would never practice as scientists or engineers, but would instead leave the profession once they were married (Helen, WACCI; Esther RWESCK). Some male bosses are also very stern with their female employees regarding pregnancy. When I got pregnant for the second time, my former was very annoyed, and shouted "again!" Iris (WACCI).

8.2.2 Challenges of Scheduling Home Versus Academic Requirements

Almost all the participants, particularly women with young children who were already burdened by household duties, reported that it was challenging to balance studies and work with child care, household chores, and other family responsibilities. This was especially the case with a graduate S&T program in which scheduling and professional demands (long hours in the laboratories and even sometimes overnight experiments) often conflict with home responsibilities. Because they felt overloaded, several participants felt that this situation affected

their performance and productivity. Since it was virtually impossible for them to decide that academic and professional responsibilities should outweigh family ones, the participants all agreed that women in S&T fields have to carry out both duties concurrently.

It is tough to carry out your research work when you are living at home. Imagine, for example, during the weekend, you are planning to do some work, and suddenly your family and mother-in-law decide to visit you. You cannot tell them you are busy with your PhD for fear of being chastised. Iris (WACCI)

One of the factors I would say could be challenging for graduate S&T education was the domestic work or having to take care of our children and stay back for the men to advance their careers. In most cases, there have been impediments created by men. (Jane, WACCI).

I remember I was talking to one of the male employers, and he said that he wouldn't want to work with women because they are always on maternity leave. In fact, in Ghana here, they even made an attempt to make a maternity leave six months instead of the three months and so many male bosses were against it. (Deborah, RWESCK)

In an attempt to manage these competing alternatives, the interviewees indicated that women often put their careers on hold or give priority to their family over their professional life. "Your career has to be on hold just to raise a family" Golda (WACCBIP). If both husband and wife are career professionals and the man is transferred to a different city, then the wife is expected to move with the family. This practice does not help the career advancement of women. However, a husband is not expected to follow his wife in the event that she is transferred to another locale. In some instances, the women are expected to spend more time on family affairs at the expense of their professional responsibilities. Joana, Zoe, Esther, and Iris respectively spoke of such situations.

I was in a different town from my husband, and we had to decide who would move. I looked at the situation, and I thought it was better for me to move with our child. The drawback was that if I had stayed in my former institution, I could have been a

senior manager by now. But, coming down here, I had to start over again. (Joana, WACCBIP)

I am married and have children. So, I am combining...professional and family roles. Yeah, it is terrible ... Moreover, this is typically an engineering field, and the work environment is even more stressful. Sometimes, they can even do 24-hour shifts. (Zoe, RWESCK)

People sometimes think women like to give excuses when they are raising genuine concerns about balancing home life with academics. But then, it is honestly very stressful. I mean I am not parenting, and I have not been a parent before. I am just saying it from what I see, and it is not very encouraging. (Esther, WACCBIP)

When you are in the graduate program, you know, it is not easy to take care of the family and study. But, if you are not pursuing your degree abroad, you have no other choice than to deal with family issues. (Iris, WACCI)

The study participants had all been socialized to accept these often-conflicting reproductive and professional responsibilities: traditional family responsibilities such as child-rearing and housework continue to be a woman's responsibility. This is the widely accepted norm, often readily accepted, that professional women perform these multiple responsibilities.

Yet despite their complaints about this demanding load of combining professional and family responsibilities, several women indicated that they were loath to ask their spouses for assistance with household chores for fear that they would not be able to carry out the housekeeping or child-rearing responsibilities adequately. Instead they tended to rely on their mothers or other female siblings or relatives. Edith and Joana claimed respectively that:

Men can help with the housework occasionally, but, when it comes to child-rearing, only women can do it because children are often closer to their mothers than fathers. (Edith, WACCBIP)

I have to plan experiments when the children are on vacation, so they can be with my mother, or my mother can come and be with them because my husband cannot

handle it. So, for me, they need to be safe and okay, and then I have peace of mind to do my work. (Joana, WACCBIP)

Traditional social characteristics of women include being feminine not only through nurturing, caring, and housework, but also by accepting a status inferior to men through obedience and respect:

It is inconceivable to marry and tell your husband to go wash dishes. You [a woman] may see it as part of your job. So, maybe, you will have to explain it to your husband. If he decides to understand you and support you, that is fine. But, in Ghana here, women are made to know that the household chores are their responsibilities. (Deborah, RWESCK)

Several of the participants indicated that because of pervasive gender-role stereotypes and societal pressures they sometimes felt torn between career and family responsibilities. This was especially true for those who had small children. Women with young children tended to sacrifice their career advancement on the altar of family life.

When I had to decide to study for a doctoral degree or try to have a baby as suggested by my in-law, I reflected on the following questions for many days. Do I need to wait till I give birth? This is an opportunity I have been given. So, why don't I use the opportunity that was given to me? What if I waited and nothing came? (Helen, WACCI)

As for me, to pursue a graduate program, it was another tug of war. Some members of the family wanted me to continue with my PhD; others said no. So, I was faced with a dilemma to either pursue the PhD or try to get a job and start a family. (Doris, WACCBIP)

When you become a mother, it becomes so difficult to manage the two [family and career]. At some point, you have to choose one and concentrate on one, and later on you go back and develop the other. Maybe, for me, that is how I see it... (Zoe, RWESCK)

8.2.3 Workplace Politics and Environments

8.2.3.1 *Traditional Preference for Hiring and Promoting Men*

Education is not the only challenging situation for career women. Politics in the work environment also creates impediments for career women. As several participants observed, male professors sometimes make sarcastic remarks about the capability of women working in S&T fields, claiming that they are not reliable or serious about S&T careers because inevitably they will get married early and abandon their S&T careers. Several interviewees also explained that they had been discouraged from pursuing S&T disciplines because they would have to compete with men for limited job opportunities in male dominated fields. They were likewise led to believe that when women do manage to graduate with higher-education degrees and are offered employment, they are likely to be victimized by men in the workplace. With neither support nor policies or procedures in place to protect them from harassment, employment in S&T fields would be unpleasant and at time risky.

They tell us that when you study the sciences, getting jobs is difficult, and sometimes you have to compete with the male counterparts for securing jobs. I had personally experienced it when I was about to join my current research institution. After my National Service³⁶, I met the then director to seek job opportunities, and he told me that I had a pretty face. Therefore, I should rather join the banks because they were looking for people like me. (Olivia, WACCI)

Some supervisors who have their own grants prefer taking male students because they think that female students would either get married or not be as committed to the program once they get married, or they would have children and would have to take some time off for maternity leave. (Golda, WACCBIP)

³⁶The Ghanaian students who graduated from accredited tertiary institutions are required under law to do a one-year national service to the country. The National Service program is designed to enable every Ghanaian, male or female to have an opportunity to deploy their energies by offering some service to organizations and communities in any part of the country. The Scheme derives its mandate from Act 426 of 1980 of the Government of Ghana. The National Service Scheme was instituted in 1973 by the Government of Ghana to provide newly qualified Ghanaian graduates the opportunity to gain practical exposure on the job, both in the public and private sectors, as part of their civic responsibility to the state. (GoG, 1973)

Workplace discrimination is not only in other fields of employment, but it is also in the teaching career... Some heads of departments prefer men to the women. They will tell you that the woman will go on maternity leave. So, they will not pick a woman. They prefer hiring a man instead of a woman. (Zoe, RWESCK)

Overall the study participants all concurred that women face discrimination in obtaining employment, particularly in S&T, and this can prevent them from reaching their professional aspirations. This is related to the socio-cultural views of gender discussed earlier in this chapter. Some participants believed that as young female graduates, the chances of getting a job without any prejudice were slim because most decision-makers were men, and in their view, preference for hiring and promoting men in S&T fields is the norm. This was one of the reasons that Georgiana (WACCBIP) gave in explaining why she had not been able to get into a post-doctoral program. Delphi confirmed this view:

When I decided to pursue my PhD, my salary has been stopped for over nine months now, and nobody is helping me. It is not because the policy was against me going to school, but it is because my workplace is more of a male-dominated environment and the men felt that they were entitled to that position but did not get it. (Delphi, RWESCK)

Indeed, the internal working realities in the workplace, particularly in the higher education environment reveal that stratification – in multiple forms is the campus norm – where women felt isolated, marginalized and stigmatized.

8.2.3.2 Lack of Childcare

In addition to the challenges associated with the shortage of role models and formal mentors as discussed earlier, most of the participants had to deal with childcare issues. The lack of daycare centres and inadequate provision of nursery services was very stressful and challenging for the participants. When Ghanaian women reach a certain age, society expects them to be having a family and raising children. The ACE program is training female adults who, for the most part, are married women who have children. Consequently, there is a need for childcare services. The availability of efficient daycare centres would have been a source of relief for these women as they pursued their degrees or careers in S&T. While the University of

Ghana at Legon has daycare facilities for students and staff, daycare fees for some of the study participants were too high, and the centres do not offer care for infants. Joana (WACCBIP) who was caring for a small baby indicated that while a crèche at Legon was available, it closed at 2:00 pm and she often had to work on campus until late afternoon. Others had similar experiences.

I delivered, and two weeks later, I started my exams. I could not find a daycare that would take my baby. My aunty had to leave her work to come to stay with me and the two-week-old baby. (Olivia, WACCI)

If you drop your kid off at the daycare, at the university, you need to pick the child up at a specific time, which is not convenient for my class schedule". (Esther, WACCBIP)

Both WACCI and WACCBIP (Legon) have daycare facilities but they were not fulfilling the childcare needs of the participants. At the time of the interviews KNUST had no daycare facility at all. This made it very difficult for the women to manage their professional and family responsibilities. Zoe (RWESCK) voiced her concerns by stating:

You are admitted into your program. You know, they expect that within three years or four years you are supposed to graduate. But they forget that for the ladies, once you get married you can get pregnant. You will have to give birth [and] you have to take care of the baby. And you know there is no daycare facility at KNUST.

While a number of students admitted into the ACE program at the various centres grappled with the issue of daycare in their respective institutions, others argued that women were stigmatized and marginalized in the workplace due to male biases and stereotyping of women. One female participant reported that some male colleagues believed that women should be at home taking care of their children (Zoe, RWESCK). Other participants claimed that some male colleagues would not agree to work with females because it was presumed that women would always be on maternity leave. The assumption was that women often received professional training, when the opportunity became available for them to put their learning into practice, they would sooner or later be on maternity leave.

8.2.3.3 Conservatism of Female Supervisors

As mentioned above, the study participants indicated that some male supervisors are not very supportive of women's professional endeavours. Yet ironically, many participants also complained about the conservative nature of female leaders who often seem to display unwelcoming behaviour towards female subordinates. Women supervisors were labelled as being "mean" and overly demanding, insensitive to the needs and plights of female supervisees. The common assumption among numerous participants was that these perceptions were probably based on gender stereotypes wherein women are expected to be quiet, docile, and respectful. As a way of countering such stereotypes, there was a belief that women who obtain decision-making positions consider that they need to be firm and assertive for fear of not being taken seriously. Hence, in the view of several participants, the patriarchal work environment leads some female Ghanaian supervisors to become highly assertive. This was confirmed by a female ACE administrator who stated that if she was not firm, people would not respect her:

Especially if you are talking to the male faculty members, they think that you should not tell them what to do. I had a problem with one of the professors because of that. (Golda, WACCBIP)

Ordinarily in Ghana's patriarchal social context, men would not respect women in decision-making positions. Yet in this study it was female participants who complained about women supervisors whom they presumed ought to have had sympathetic appreciation of women's issues and the obstacles female students and young professionals would have to overcome to manage careers and family life. In fact, some participants noted that women were their own worst enemies and were worse than the male bosses.

My current female boss is no different. For example, she claimed that pregnancy is not sickness. Therefore, female employees should not come to tell her that they are sick and request time off when they are pregnant. (Olivia, WACCI)

I have seen some women professors who do not encourage fellow women...Yeah, because you have a woman supervisor whom you expect to understand the pressures of being a woman, but then you realize that sometimes they are worse than the men. (Esther, WACCBIP)

8.2.3.4 Sexual Harassment and Lack of Trust in the System

Besides the perceived negative attributes of certain female supervisors, all study participants referred to risks of sexual harassment in their work environment. In this study, however, only one participant recounted a specific case in an ACE.

I think my former roommate was telling me about how she thought she failed one of her courses because the lecturer had asked her out earlier on and she said no. She was not supposed to have failed considering her class grades and her performance during the exams. She was able to write everything, but she failed the class and had to re-sit the course. However, she has not reported the purported incident. (Esther, WACCBIP)

The fact that this assumed incident was not investigated and reported could have been due to fear, or to lack of awareness concerning grievance procedures which are available on the University of Ghana's website. Esther explained that her colleague had not reported the incident because she did not want to prolong the issue. She re-sat the course because she felt she did not have any proof and doubted that she would be believed over the male professor.

I think it has not been explained to students in a way that they will actually trust that process. So, what if the lecturer's friend is the one who is going to be on the committee? How sure are you that they are going to take your word, especially if the person is a professor? (Esther, WACCBIP).

For society, especially for people who have been sexually abused as younger children it is difficult for them to trust systems, most especially because probably at that time, nobody believed them.

8.2.4 Summary of the evidence of misalignment and subjective experience of tension

The challenges of juggling conflicting family and career demands are also evident. Indeed, Clark and Hill (2010) have argued that "women in tenure-track positions in science disciplines at research-intensive institutions are more likely to gain tenure if they are unmarried and/or are childless than their married colleagues with children" (p. 1). The perceived dilemma for many women academics of child-bearing age is to choose between having a family and

having a successful career (Abramson, Rippeyoung, & Price, 2015). As Cherkowski and Bosetti (2014) have summarized, women may feel anxious, confused, or incompetent as they negotiate the contradictions in their personal and professional lives dealing with issues of power, resistance, and the challenging demands of their academic world. It is apparent that there is misalignment between social expectations and S&T professional responsibilities, a source of subjective experience of tension in the daily lives of the career women.

Study participants' perceptions of discrimination in the workplace are nothing new. The same view is reflected in many studies that have concluded that women working in a male-dominated environment are subject to different treatment and gender-specific hindrances that prevent them from reaching their professional aspirations (Case & Richley, 2013; Rosser & Taylor, 2009; Wentling & Thomas, 2009). As argued by Busatto and Marry (2009), "the metaphor of the glass ceiling helps one to focus on the often invisible barriers qualified women have to deal with in order to gain access to the highest professional positions" (p. 170). For example, women faculty members are less likely to be elected to high-powered committees that approve or deny tenure and promotion applications (Abramson, Rippeyoung, & Price, 2015).

The participants' perception of female supervisors is interesting: the majority saw them as unsupportive and unwelcoming. This creates a confusing and difficult question. How then can these female supervisors become role models for women who are aspiring to enter S&T careers? It would seem that women in S&T fields who are acting out their gender as "women" in a male-dominated environment are inclined to "do gender" in professionally expected ways, and this increasingly requires a rejection of "femaleness" (Mejiuni, 2013). This is a great example where a gender analysis (drawing on masculinities and femininities where men are supposed to be authoritative, strong, while women are expected to be humble and caring) is revealed. Women leaders and mentors often adopt masculine attributes in order to be taken seriously; then those same attributes make it difficult for women students and supervisees to get the support they need, mostly, from fellow women.

As argued by Moloney (2015), "the cultural tendency is to think of the masculine as normative of collective groups" (p. 109). The transgression of gender norms for women in positions of leadership or power is an important framework of analysis that helps us understand why sex (being a woman or being a man) is not what is so important but rather the socially-constructed attributes of masculine or feminine adopted in positions of power and authority. 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 S&T.

There is also a culture of secrecy and mistrust in the institutions. The institutions have a hard time to share information and disseminating policies, plans, and procedures. For example, this incident of the female student who believed that she failed a class because she declined advances from one of her male lecturers was the reflection of the mistrust that set in the educational system. This particular incident could have been reported and investigated had the student known the procedures to follow to file a claim or had perceived the system of operation to be trustworthy. However, the Sexual Harassment Policy has been the only policy document that was readily available at the University of Ghana’s Website. It would seem that this particular student might have been oblivious to the policy and was not able to use it to her advantage given the fact that policies are supposed to be legal binding documents. In fact, one of the administrators said: “For sexual harassment, I think there is a University of Ghana policy. Actually, it is there [on the University website]; but, nobody knows about it.” (Golda, WACCBIP).

Despite the experienced and/or perceived obstacles, all participants managed to overcome the challenges associated with their graduate S&T programs at the selected ACEs, WACCI, WACCBIP, and RWESCK. Certain fundamental factors have helped and encouraged study participants to want to stay in the programs despite the numerous obstacles they have had to negotiate. I will now discuss the motivating and favourable processes and factors behind the participation, retention, and achievement of women in graduate S&T disciplines at the study sites. The following section sheds light on the strategies these women have employed to navigate professional environments that are not always supportive.

8.3 Agentic processes fostered by supportive global, institutional and social structures

8.3.1 Personal Agency

Interviewees reported that personal agency played a major role in their in S&T graduate programs. Not only did the participants choose to pursue careers in S&T, but they were all prepared mentally to overcome the challenges that came their way. While other actors played a significant role in their educational and career paths, these women would not have succeeded in

the absence of personal agency. It is one thing to encourage and influence someone, but the decision to take action to actually pursue a program of study or career depends on the individual student. These women all exuded the attributes of people who exert personal agency such as hard work, diligence, and competence. This has been the case for the 24 women interviewed in this study. They seem to be patient, persistent, and determined to succeed in their career choices. In addition, in light of the challenges they all faced, these women were all clearly resilient, and consequently were able to withstand and even rise to the challenges that confronted them.

Almost all participants had demonstrated a predisposition towards S&T prior to any encouragement and/or influence exerted by parents, teachers, or other third parties. Many reported that pursuing a graduate degree in an S&T program also stemmed from the passion for the field and the determination to succeed that they had developed at the undergraduate level. Though some of them faced many challenges along the way, their personal determination, resilience, and motivation helped them to overcome the obstacles they encountered. Others did not really face the challenges that are commonly associated with pursuing a graduate degree in S&T. This is particularly true for participants who came from homes where their parents' socio-economic status put them in a privileged position. When asked how they negotiated the potential obstacles, Marietta, Golda, and Deborah responded, respectively:

In my family, nobody has reached this level of education, and it cannot continue to be like that. At least someone has to break through so that at least the young ones coming up will have someone to look up to. (Marietta, WACCI)

Mine was a choice. I chose to go to the sciences. And then, I got admission to Legon to study biological sciences for the first two years. And, because of my GPA [grade point average], I was selected to do biochemistry. (Golda, WACCBIP)

When my friends tried to discourage me, telling me that I might not be able to find a man who would be willing to get close to such an educated woman like me and let alone get married to me, I wasn't bothered by all those comments. (Deborah, RWESCK)

Some participants noted that they loved to challenge themselves. They believed that they could do anything they set their minds on, regardless of whether they have been involved in it

before or not. As more and more women have come to know their rights, and since they realize that they can do equally well what men do, growing numbers of women are less inclined to let such opportunities pass them by. Instead they take advantage of them.

So, in my primary school days and my junior high school days, I have studied with women who excelled in class. I went to a girls' secondary school, and the people in the class were brilliant, and at the university, I still met smart women. (Zara, RWESCK)

Some of the participants stated that their parents were scientists and they wanted to follow their parents' footsteps or they had been influenced by a few role models. Children usually try to imitate their parents who then tend to have a big influence on them. Those students whose parents were scientists or highly educated did not really feel any pressure not to consider graduate school and get married. They rather felt pressured to excel, not to lag. Also, seeing other students striving to attend universities gave them the incentive to want to go further. Often times, the female students had interest in the sciences to start with, and this interest was then fuelled by, teachers, parents and sometimes friends. Occasionally, some were influenced by the achievements of other ladies in S&T programs. Gilberta (RWESCK) noted that she had been inspired by a lady who received an award for the best Geotechnical student and another also had the best student in 2015 Engineering Graduating Class. As for Olivia, it was neither her parents nor her teachers that influenced her. It was rather her friend. She said:

Ah, okay...Since infancy, I have loved to do science and technology ... and from secondary school... anyway, let me go from scratch. From my primary school, I have a friend whose father used to work with the research institution, and she used to tell me so much about how agriculture is nice, so, I had the interest in agriculture. (Olivia, WACC).

In fact, some participants have had early exposure to S&T programs that motivated their interest in the field. Therefore, it was rather a very easy process for most of them. A number of the participants from the health science program at WACCBIP were lucky. After their undergraduate programs, some of them did their National Service at the Noguchi Memorial Institute for Medical Research (Legon) that prepared them for graduate school.

So, working I knew what I wanted to do research in. Now, I was doing it with a purpose. I was not just going through the motions. So, going back to grad[uate] school, I knew what I wanted and then it made the experience better for me because now I understand why I am doing what and I appreciate everything that I am taught in class. (Esther, WACCBIP).

Some of the women had also developed some kinds of resilience and found ways, referred to as agentic processes in this study, to overcome some of the socio-cultural expectations that negatively impacted their achievements and pursued their dreams and aspirations while still fulfilling their traditionally assigned gender roles. For example, Helen (WACCI) highlighted how she decided to go against the wish of her bother-in-law who suggested that she had children before pursuing a doctoral degree.

So, depending on what you want to achieve in life, probably, you might tend to wait to get children first, before starting graduate education. But for me, I was like ... If I wait and it doesn't come, then what do I do? You've just wasted your time. So, I decided to go and do it, and if you get pregnant, it is a bonus for you, and at least you have not lost anything. So, for me, marriage is one of the things that impede graduate education.

When I asked her whether her decision not to follow the advice of her in-law has affected her relationship with her in-laws, she responded: "it didn't, it didn't because I did not give them any bad answer for them to take me on or something." (Laughing) she then added:

Yeah, once he said it, I just smiled over it (laughing). But, I said to myself this is an opportunity I have. So, why don't I use the opportunity that was given to me? It depends on individuals. Some women might have withdrawn. But for me, I took a bold decision that ... no, I am going for it. So my persistence paid off. I didn't want anybody to influence my decision (Helen, WACCI).

Jane and Gladys also added:

When I decided to go for graduate school, both of my parents supported me. They are both graduates, and my father encouraged every young person he met to

pursue a degree. But from my in-law's side, one person commented that it was not necessary for me to pursue a doctoral degree ... Because he was not a direct father or mother of my husband ... he was an uncle we met at a funeral. But that is not enough to coerce me to give up my dream. And my husband is also a research scientist (Jane, WACCI).

The truth of the matter, I did not even inform them [parents] of my decision to go to graduate school. It was after I got admission and even made a payment I'm supposed to make before I told my mother that this is what I intend to do. And even till today, my father doesn't know that I am going to school. I just want it to be a surprise that...on the day of my graduation, I will call him and say...ah old man, this is it. (Gladys, RWESCK)

In addition to personal agency and resilience, participants believed that scientific training instilled discipline that they could not have got from other fields or programs. As noted by Delphi:

Science, you see the science training instills some kind of discipline in you. This you will not get from the other courses or programs. And that thing I love so much about the program. I have never regretted doing science at this level (Delphi, RWESCK).

Moreover, as argued by (Georgiana, WACCBIP)

Things have changed, and I think it is encouraging to see quite young women who are doing what you wished you could do. So, my colleague and I, we are young, and we have young families, but we are manning the fort.

The interviewees in graduate S&T programs at WACCI, WACCBIP, and RWESCK all identified numerous obstacles that they had to overcome to attain higher education and upward mobility in the workplace. A contributing factor to participants' interest and motivation to pursue S&T disciplines stemmed from supportive factors promoting women's S&T education, awareness campaigns, media, and overall exposure as well as from broad societal transformation.

8.3.2 Factors Supportive of Women in S&T Higher Education

Beside personal agency, the participants recounted numerous factors that enabled them to overcome the various challenges that hindered their S&T education and careers. Most of them benefitted significantly from strong family support. All had received at least some family support, most often from parents, and many as well had gained from the encouragement and advice of teachers and other mentors. In addition, several indicated that a growing shift in societal attitudes in favour of girls' education and policies supportive of gender equality were also helpful. These factors are elaborated as follows-s: (a) family support; (b) mentorship; and (c) awareness of broad societal change;

8.3.2.1 Socio-Economic Background: Parental Education and Occupation

For almost all the interviewees, parental support was a crucial influence on their educational and career choices. When parents regarded S&T highly and believed that their daughters could have good opportunities in S&T fields, they encouraged them to pursue the sciences in school. Most of these parents were themselves generally well educated and were able to provide the financial support for their girls' education. This was especially true in S&T study programs that are generally more costly than the humanities and the arts because of laboratory fees, equipment, and reagents. Family financial status was also significant for girls whose results on the West Africa Senior Secondary School Certificate Examination (WASSCE) prevented them from enrolling as regular non-fee paying students, but who nonetheless, met the minimum entry requirements as tuition-paying students. Students admitted on this basis usually rely on their parents to provide financial support. The occupational status of parents was likewise a critical factor in providing their daughters with the motivation and emotional support needed to succeed in S&T fields.

Obviously, the ability of parents to pay depends on several factors, including socio-economic status, level of parents' education, and the location and region of residence. For example, Janet (WACCI) noted that her dad used to be a contractor before he retired from active service and her mother was a nurse. This implies that the parents were financially in a position to support her in graduate school. The same was true of the father of Zara (RWESCK):

My dad is an electrical engineer, so I developed the interest to study engineering at an early age. I decided to choose civil engineering. (Zara, RWESCK)

My father was an engineer, in telecommunication, and my mother was a teacher. I was good in both arts and sciences. But my father wanted me to go into the sciences. So, he encouraged me to get into the sciences. (Iris, WACCI)

For me personally, growing up, my parents were scientists. My dad was a scientist, and my mom also did a little bit of science, and they encouraged me to consider an S&T career. So, getting used to the science environment was not difficult for me. (Doris, WACCBIP)

In addition to the positive impact of parental education and occupation reflected in the support provided by parents to their daughters, the locale of upbringing of the participants is equally as important.

8.3.2.2 Locale of Upbringing

While parents and other family members played essential roles in the career choices of the participants, the local context of their upbringing was also a crucial factor in participants' choice of S&T and to pursue education to the highest level. City dwellers are not only generally better off financially and are more educated than people living in rural areas. The majority of the research participants attended schools located in economically advantaged regions of the country, mostly in urban regions. Moreover, since there are few educational institutions in rural areas, all those whose parents lived in rural areas eventually left home to attend secondary schools in urban areas.

I did not really grow up in my community. I grew up in Accra. So, I did not really have that hindrance about women not going to school. I was supposed to go to school, and I went. (Doris, WACCBIP)

My parents are in Takoradi³⁷, and I am in Accra. Because I mostly am in the university community, I do not hear a lot of those arguments related to not allowing girls to go to school. (Esther, WACCBIP)

The advantage of growing up or attending secondary school in urban areas is compounded by the fact that universities in Ghana are located in urban centres.

Those in the cities have their parents who are sort of educated, and at least they can help them. They are exposed, and they know the merits of getting into some of these S&T programs. (Marietta, WACCI)

I did not have a specific problem. I was in a family of people who were educated, and from my young age, my parents took good care of me... [My father] made sure he hired a tutor at home to help me improve my science. (Iris, WACCI)

This common urban-oriented background of the women whom I interviewed in the ACE program reinforced the general pattern that in rural areas, where family budgets are very limited, the general tendency of parents is to curtail their daughters' education either during or soon after primary school so they can participate in economic activities to supplement household income.

8.3.2.2 Mentorship

Parental support or lack thereof and upbringing had either positive or negative impacts on the participants. Those who managed to get into graduate S&T programs either as students, instructors, and/or administrators reported that mentorship had been very useful for success in their chosen field of study or career.

My biggest mentor in my scientific career has been my PhD supervisor...She was really fundamental in tuning or fine-tuning my rule of science and research and how to go about getting quality data...writing quality papers to publish... Since I came to Ghana, one of our senior colleagues in this department, who was once

³⁷ The population of Sekondi-Takoradi Metropolis, according to the 2010 Population and Housing Census is 559,548 representing 23.5 percent of the region's total population. Males constitute 48.9% and females represent 51.1%. Ninety six percent of the population is urban. Takoradi is a port city in western Ghana that has timber, energy, and technology industries. The city has several secondary schools, colleges, and special schools (GSS, 2014).

upon the time, my lecturer, has really taken me as her daughter and she's helped me a lot with advice, when I started having kids, when I was having issues at home...having issues at work...she's really been a rock. (Georgiana, WACCBIP)

My former boss has been my mentor. He is the one who made me like what I am doing ...plant breeding... He was difficult at the beginning, but he has changed, after sometimes ... You know, he had a daughter with a lady who came and left the baby with him and that was when he realized that having babies is very difficult (Iris, WACCI).

8.3.2.3 Parental / Family Support and Encouragement

Over a third of the participants indicated that their parents were important role models who influenced their career choices through advice, encouragement, and financial and emotional support. The support received early in life aroused their interest and motivation in S&T fields. Some parents were role models as well as mentors. Joana (WACCBIP) stated: “my father was my mentor and role model ... and still is.... I always wanted to be a doctor.... I walked in his footsteps.” Some participants mentioned other family members, mostly their husbands, who played roles supportive of their educational endeavours. Others were very religious and relied on their faith in difficult and challenging moments. Gloria and Zoe noted, respectively:

Basically, I haven't really had many problems because my family had been very supportive. So, I don't think that I have really had any influence from outside besides my family's contribution to my choosing science. (Gloria, WACCI)

I thank God and I thank my husband so far. I prayed for support from God and then from my husband. In fact, if I did not have a supportive husband, I may not have been able to take part in a graduate degree program. (Zoe, RWESCK)

While the positive link between the education level of parents and the high achievement of the children remains, the converse is not necessarily true. Uneducated parents also encouraged their children to pursue higher education, particularly in S&T fields. Some parents, though uneducated, understood the need to educate the girl-child.

My parents saw the need for a girl-child to go to school ... from that illiterate background ... even right at junior higher school (JHS); I had a Catholic father who

was determined to send me to St. Francis Girls to do general science. (Lynda, WACCI)

Where support from family members as mentors and role models was absent, participants relied on the advice of teachers and mentors who were S&T professionals. Obviously, many of the participants developed a sense that they fit in with S&T and desired to pursue this career path because they had a positive view of S&T professionals, typically developed through exposure to a few role models. This exposure to role models from various S&T fields allowed them to match their career options and the relevance of each field to their own lives; they were able to see possibilities within these fields for themselves. Consequently, they increased their interest in S&T and their self-concept through their exposure to S&T activities, thereby improving their S&T identity (Olivia, WACCBIP). Some participants emulated role models as a source of motivation and inspiration and tried to follow in their footsteps. Without these role models, many participants would have had difficulty believing they could defy cultural, societal, and even family expectations of their life trajectories to pursue careers in S&T disciplines. For example, Helen (WACCI) mentioned that some role models and mentors were introduced during the STME workshops and the late Prof. Ewurama Addy was part of them so she chose her as her mentor... When she came back, she did not relent in sending letters to some of them, given the fact that she was coming from a very poor part of the country (Helen, WACCI).

During the Science, Technology, and Mathematics Education [STME] workshops, we went to Cape Coast University and Legon. Some role models and mentors were brought down, and the late Prof. Ewurama Addy was part of them, so I chose her as my mentor. (Lynda, WACCI)

I used to watch *Math and Science Quiz* as a child, I used to like watching Wesley Girls High School, which I eventually went to, and I admired Prof. Ewurama Addy so much, and I just told myself that I wanted to be a doctor. (Esther, WACCBIP)

Last week, for instance, people from NASA³⁸ came to our institute to do some training on water and storage, and there were some Black women amongst them,

³⁸ NASA: National Aeronautics and Space Administration (U.S.).

and it was encouraging. So, seeing that, I thought that it was possible for me to do it too (Sylvia, RWESCK).

A further example was demonstrated by Zara (RWESCK) who had attended single-sex primary and secondary schools and had no difficulty in adjusting to coeducational university life. As Zara argued, the advantage that students from single-sex schools have is that they tend to have many more role models and mentors than those who attend coeducational institutions. Besides parental support, some of the participants benefitted from the support of other family members, teachers or third parties. For example, Joana (WACCBIP) noted that her husband had been very supportive because she completed her PhD while she was married and had a child.

8.3.2.4 Teachers or Third Parties

Teachers played an important role in the lives of several of the participants, particularly those who came from homes where parents were not well-educated or were not very supportive of the education of their children. Some students were pushed by their teachers to pursue science because they were identified as having scientific potential.

So, when selecting the program at the secondary school, they decided to choose science for me. Those days, all the brilliant students went to do science ... So, that was how I got into sciences at the secondary level. (Zoe, RWESCK)

It's Prof. Enu-Kwesi. So, he talked to me at length and encouraged me to consider the Botany or go into biotechnology. Because it was a new area and there are not a lot of scientists in that area. So, he was my... he advised me and my options to take biotechnology field as a course. (Jane, WACCI).

For Olivia (WACCI), it was rather her friend while Edith (WACCBIP) had been inspired by a nurse.

From my primary school, I had a friend whose father used to work with a research institution, and she used to tell me so much about agriculture. So, I developed an interest for agriculture. (Olivia, WACCI)

It wasn't a teacher who inspired me; it was a nurse... Yes, her attitude and her behaviour, the way she carried herself made me want to be a nurse from the beginning. (Edith, WACCBIP)

Based on this analysis of external factors, it is evident that parents, teachers, relatives, friends, or third parties played crucial roles in influencing, supporting, and/or encouraging the participants.

8.3.2.3 Societal Changes: Institutional Modernity

In Ghana there is near-universal access to basic education. More girls than ever are moving up the educational ladder. Among the many factors that have contributed to the increase in girls and women's participation in education, one is that higher levels of education and training are becoming necessary to ensure social mobility and higher incomes. As well the global diffusion of ideas regarding gender equality has also been a significant factor. This is partly due to awareness campaigns related to the importance of educating the girl-child by broadening access and participation of boys and girls. The result of these shifting realities is that more people are coming to accept that girls and women are as capable of S&T careers as men. This was exemplified by Janet (WACCI) who indicated that she became a student in the same graduate science program as her future husband.

There is a gradual acceptance of women in positions of authority and responsibility. This, somehow, has helped to raise the confidence level of most participants in pursuing graduate S&T education. The research participants were fully aware of the gradual transformation taking place in many institutions and in various parts of the country.

I believe that more women are coming into the sciences and it's much better than, let's say, it has been in the past 10 years. I believe it is because of the awareness that has been created. (Gloria, WACCI)

Nowadays, if you are a woman in science and technology fields seeking employment, some people would give you the benefit of the doubt and employ you. I firmly believe that things are changing.... (Georgiana, WACCBIP)

With increased global consciousness of the need to educate boys and girls equally, institutions in Ghana have begun to transform their systems of operation, leading to the gradual improvement of the conditions of girls and women. Some of the student participants had had the opportunity to attend STME clinics when they were in their early teens, and these initiatives helped them to interact with a few female scientists and technologists and to spark their interest in the possibility of career opportunities in S&T. This was reinforced by university use of results from junior-secondary-school exams to identify potential students. Students who performed well in subjects like English, science, and other science-related subjects and on the subsequent West Africa Senior Secondary School Certificate Examination (WACCSE) were frequently encouraged to apply to continue their education in the sciences.

Award programs also helped to motivate young women and gave them the opportunity to get into sciences.

Awareness creation is one of the projects I was involved in here in my institute. I think some three years back, my immediate supervisor had a project being funded by the American Society of Plant or something ... and what we were doing was to create awareness for biotechnology. (Helen, WACCI).

These actions have influenced the awareness level of the Ghanaian community, which has resulted in a gradual increase in young women's participation in higher education. Media coverage and debates on the need for equal opportunity have made an impact in the world and in Ghana. These transformations are very encouraging and help to improve the situation of girls and women in higher education in general, and women in S&T fields in particular.

It wasn't as before when women were placed at the back; now we are making forefront with our academic careers... If the men are not careful, we will overtake them ...I think, for now, most institutions are aware, and they know that we are gearing towards a certain level where everybody wants equal opportunity for all. So, I think they [WACCBIP] put that into consideration when they are doing the recruitment. (Margaret, WACCBIP)

Moreover, supportive gender equality practices and procedures have also been very helpful in helping the participant succeed in S&T graduate education programs. The

following supportive initiatives also contributed to the success of the participants and their positive perspectives related to the future of girls in S&T education overall: (a) the effects of consciousness-raising efforts; b) impact of the science, technology, math, & engineering (STME) program; c) Africa Centres of Excellence Program; and d) women's perceptions of the status of girls vis-à-vis S&T education.

8.3.3 Supportive Gender-Equality Policies and Strategies

8.3.3.1 The Effects of Consciousness-Raising Efforts

The consciousness-raising efforts in past decades seem to have had an increased effect on women in S&T fields. The women were aware of the creation of the Ministry of Gender, Child, and Social Protection (MoGCSP) and the development of the NGP (2015) which provided broad policy guidelines designed to empower women through their engagement with socio-economic activities. Likewise STME clinics for girls have contributed to heightened awareness and participation of girls and women in the sciences. The current World Bank ACE initiative, with its emphasis on gender equality, has also played a role in the participation of a limited number of female students in graduate S&T education.

New procedures that have been instituted by the University of Ghana and KNUST, as well as the ACE program, have positively affected the educational and career experience of the participants. Although changes have been slow, the University of Ghana's creation of a Centre for Gender Studies and Advocacy (CEGENSA) has championed gender issues, promoted a gender-policy-development process, and supported the resolution of gender-related problems on campus. KNUST has also adopted elements of gender-supportive policies and procedures. The inclusion of gender-sensitive procedures into systems of operation, particularly at RWESCK, have contributed to an enhanced status of the study participants. An information meeting with the directors of WACCI, WACCBIP, and RWESCK revealed that an affirmative-action approach has been used mostly in student recruitment. In fact, Joana highlighted the progress that has been made to date:

I would say there has quite recently been a kind of affirmative action where they try to recruit 50% female staff and 50% males. The same procedure applies to students too. So, if there is room for 10 appointments, then automatically, five should go for

women and five should go for men. If only four women applied, there is a high probability that all the four women will be picked. (Joana, WACCBIP)

8.3.3.2 Impact of the Science, Technology, Math, & Engineering (STME) Program

The STME program instituted by the Ghanaian government has been instrumental in exposing students, particularly those from rural areas, to the advantages of pursuing a career in S&T. Even though students from low-income families do not have the same opportunities for success in education, particularly in graduate science education, some such students have benefitted from the STME program.

This phenomenon is apparent in the responses provided by the female participants about the impact of the STME clinics on their career choices, interests, and motivation to study S&T at the graduate level. The STME clinics have specifically assisted female students from rural areas and Northern Ghana, areas that were marginalized compared to urban areas. Jill was the only participant from RWESCK who took part in the STME program. She reported that she had had the opportunity to enrol in the STME clinics in Sunyani³⁹. The experience had been beneficial to her upward mobility as it gave her self-confidence and helped her succeed in her S&T career choice. Lynda and Jane corroborated Jill's comments:

I was in senior high school, and I was lucky to have been chosen as one of the females from Northern Ghana to attend a science-and-maths clinic workshop in Accra. During the early days, the selection was on a regional basis. So, I was the one selected from my secondary school. (Lynda, WACCI)

I took part in the science and math clinic program, and it has played a significant role in my further interest in science and technology program. As for me, I represented my secondary school, and so I had exposure to sciences at the early stages. I mean, it gave me the confidence that I was equally good as any other student. (Jane, WACCI)

³⁹ Sunyani municipality is one of the 27 districts in the Brong-Ahafo region. Men comprise 49.9% of the population, and females represent 50.1%. More than 80% of the population is urban (83.1%). It is the fifth largest city in Ghana, and its population is equivalent to approximately 10% of the population of Accra, the capital city of Ghana (GSS, 2010).

Nonetheless, the study participants were not aware of the policies and procedures that govern the day-to-day operation of the ACEs nor of the disparities in the implementation of policies and procedures.

8.3.3.3 Africa Centres of Excellence Program

The procedures and plans that the World Bank ACE project put in place to meet program objectives has brought about changes in the systems of operation in the institutions where the program is located. A key goal of the ACE program has been to augment needed skills at the Master's, PhD, and other postgraduate levels in the West and Central Africa while increasing women's enrolment in S&T fields and reinforcing the contribution and status of female researchers and graduate students in these programs. Accordingly, gender sensitive policies were introduced to foster of gender equality at WACCI, WACCBIP, and RWESCK. These requirements have created a real incentive for the ACEs to improve their systems of operation, and these changes led to the positive outlook and success of the female participants in this study. By encouraging female candidates to apply for graduate degrees in S&T, the ACEs have undertaken to create a critical mass of female scientists who will in turn act as role models and mentors to girls and young women aspiring to pursue careers in S&T while contributing to teaching and research:

I think if you are a female and then you apply, you have good grades, and they will consider you more than the men. If you are a female and you have the same grade as a male, the female will be picked not the male. (Edith, WACCBIP)

Most of the participants from WACCI attributed their success to these initiatives made to encourage female students to enrol in S&T graduate studies. In fact, Lynda (WACCI) pointed out how WACCI was empathetic, adjusted the program to meet the demands of her family situation, and helped her when her son was diagnosed with cancer. Others made the following comments:

There has been some kind of affirmative action where they try to recruit 50% women and men as workers and as students. Joana (WACCBIP)

We had a very cordial relationship and the interaction was awesome. I think we were all taken at the same level... No bias. Georgiana (WACCBIP)

They encourage females.... they put in procedures to make sure that more females are recruited into higher positions. Since I've been here, we had a very dynamic head of department for the last four years which has steered us all to apply for grants... to buy equipment.... So, now I would say that we are comparable to any academic institution that has equipment for biochemistry and molecular biology program in the world. Georgiana (WACCBIP)

This graduate program is better. Some labs are fully equipped. Everything is available so you just go there, you take what you need. You just ask permission that you want to use this equipment. At my undergraduate level, it was really difficult to understand some of the processes especially when it comes to the molecular aspect of the study. It was difficult because we didn't have the equipment. (Edith, WACCBIP)

It made me happy that we are learning something related to how everything here is being put up. Again, we just came back from a field trip like three weeks ago, and I was so sad, that it was the end of the year. I am enjoying the program. (Zara, RWESCK)

Funding was a major contributing factor to the participation of the women in the S&T programs. Almost all the participants reported that they might not have been able to take part in the graduate programs had there not been funding opportunities. Some students have had the opportunity to receive assistantships that allowed them to pay for their education. Others have received funding for tuition and research, which makes the program very attractive, particularly for women from rural and less privileged homes. Of the 24 participants interviewed, only one reported not having received a scholarship or some form of funding assistance. She explained that she had switched her major between her undergraduate and her master's program, which might have contributed to her not receiving a scholarship. Her bachelor's degree was in the arts.

When I decided to pursue further education, WACCI was one of the options; mainly, because there was funding for the research. I had encountered many

students ... PhD students who had been frustrated and not be able to complete their research on time because of lack of funding. (Jane, WACCI)

Graduate science and technology study programs are costly. Although we have sponsorship, it does not adequately cover what we have to do. So, it looks like we have to look for funding elsewhere to support what we are doing. (Margaret, WACCBIP)

The program I am in now had it not been because of scholarship, maybe I could not have enrolled. The cost of graduate studies is prohibitive. The award is a crucial aspect of it. (Jill, RWESCK)

The one male student whom I interviewed (Richard) reflected on how gender awareness has improved, how his own perceptions of gender have changed over the years, and what needs to be done to improve the situation of girls in rural areas.

I used to think that boys should be smarter than girls, and that applied sciences should be for boys while girls should study arts, like home economics. Once I climbed up the educational ladder, I realized that my previous assumptions were erroneous. Now, I see that women are even smarter than us and they can study any discipline [laughter]. However, my previous perspective is still relevant in rural areas today. To remedy the situation, we need to educate many more people in the rural areas where people still don't understand the role of formal education. (Richard, WACCI)

Most of the married participants commended the program for the support they had received during their pregnancy and child birth while they were studying in the program. Furthermore, many female students acknowledged the efforts that the ACE had made to include more women in the program and to develop their capacities. Nonetheless, a few at RWESCK suggested that the ACEs try to make the programs more flexible to allow female students, particularly nursing mothers, to fit in, to adjust quickly, and to be able to combine their double duties related to family and career. Also, the financial support the women received from their ACEs was instrumental in their pursuit of advanced degrees in an S&T discipline. Georgiana (WACCBIP) proposed that her ACE be a model for the others because she believed the program

had put in place all the required procedures and plans to support gender equality, particularly in their admission process.

8.3.4 Women's Perceptions of the Status of Girls Vis-à-Vis S&T Education

Female participants were asked to discuss their perspectives on the future of girls' and young women's S&T education overall and to give comments and suggestions on how to improve the situation of gender disparity in S&T programs. In general, most participants were very positive. They seemed to be happy about the improvements in policies and procedures that had been introduced to reduce the gender gap in the graduate S&T programs in the three ACEs in Ghana. Nonetheless, they made suggestions on how to improve the program to increase women's participation.

Some female participants noted that S&T education had made them more conscientious, tidier especially in the labs, and more inquisitive. They were confident about their skills and aptitudes and saw a bright future for girls and women in S&T fields. This was due to the proliferation of media, exchange programs, and the perspective that S&T fields are pertinent for global development in general and Africa's development in particular. Participants claimed that more women were taking part and standing out in S&T fields. They looked up to the few role models and decided to aim high. The fact that more and more people were gradually accepting that girls and young women should be educated was very motivating. Georgiana (WACCBIP) talked about how her husband's attitude towards her pursuing a career in S&T had changed over time.

I'm married to a typical Ashanti [an ethnic group in Ghana] man... You understand! And he works in a totally different field. He is a media PR [public relations] person. He did an MBA [Master of Business Administration]. So, we don't speak the same language. Or should I say academic language. And initially, he couldn't conceptualize me being a lecturer... He thought I just come here and I teach and when I finish I come home ... Until I had a conference and he went along with me... and I was presenting work that I did on my research... It was like a bulb... a light bulb went on in his head. He now understood... So, it really not just lecturing, and you are actually doing something... At that moment, he had his 'AHA' moment. Because, he saw the panel of people that I was presenting to... their status, their role

and for me to be imparting knowledge to such a panel, his 'Ashanti-ness' has gone down a little bit [laughter].

These women seemed to have been very cognizant of the responsibilities that came with being educated and the duty of becoming role models for young girls aspiring to follow in their footsteps. Even though most participants were struggling with and juggling family expectations and socio-cultural gender roles and responsibilities, the majority were proud of their mother-and-career-woman status. In general, participants believe that young women are good scientists:

Science used to be men's world; not anymore. Yeah, we work in groups, both men and women. There are some things that we the women can do because we understand them better. There are things that we want details on, but the men will just brush it over. But you, the woman, you want the details. Why this, why that? You understand, but sometimes they [men] just take it like the way it is. (Edith, WACCBIP)

8.3.5 Summary: Supportive Factors

The interviews provided an opportunity for the participants to express their views on gender issues and offer suggestions on how to mitigate the gender disparity in S&T while encouraging more girls and women to enter these disciplines. Study participants specifically suggested that the ACE training program be made more female-friendly by being more generous in the admission of women through additional special incentives such as affirmative-action policies. In fact, Lynda (WACCI) suggested that socio-cultural and socio-economic backgrounds of female candidates be taken into consideration during the admission process.

All the women were extremely proud of their achievements and, interestingly, most of them were not bothered by the gender gap in their programs. In fact, some of them glorified their minority status, claiming it gave them the opportunity to be visible as they were outnumbered by the men. They noted that the effort they put in was always noticed, and they hoped to move higher up the academic ladder in S&T. "You see, you are always in the minority. So, a little effort you put in is always noticed ... you are going to move higher in the academic ladder and that is one thing I like about the sciences" (Zoe, RWESCK). Being a minority can be an advantage in a way that people would want to know you and hopefully listen to you. These

women are expected to be role models for young girls and women who would aspire to follow on their footsteps. However, being a minority can also play against you. It could be a source of prejudice, bias and discrimination. The same view is shared by Thorne (2015) who noted that people are fascinated by woman working in the man's world and would want to know her; but at the same time she is judged harshly. Women working in male-dominated positions are not readily accepted and their education are often overlooked or undervalued. Thorne recounted the advice a powerful female university president received from a fellow woman in a senior academic administrative position at another major institution. This new university president has been told that it was good that she was selected, however, she should make sure that she did not make any mistake for "all the women will be watching" (p. xvi).

They succeeded in overcoming many obstacles they faced in the pursuit of graduate S&T education and careers because of the layers of family and social structures, institutional structure and the structure of globalization as well as their personal agencies that were supportive of their S&T education and careers. As argued by Johnson (2014), agency and education are key mechanisms that enable women to gain a sense of accomplishment in careers and leadership positions in sub-Saharan Africa. Education often allows women to overcome social norms and assert agency in their career choices (Johnson, 2014). In fact, some of the participants glorified their minority status, claiming it gave them the opportunity to be visible as they were outnumbered by the men. The little effort they put in was always noticed, and they hoped to move higher up the academic ladder in S&T.

8.4 Conclusion

By examining the narratives of a cohort of women in the ACE program in Ghana who overcame socio-cultural, socio-economic, institutional obstacles, I have demonstrated how the exercise of free will and the exertion of personal agency helped the participants succeed in their S&T higher education and careers. Structuration theory provided the analytical categories and distinctions necessary to investigate how policies and procedures shaped the range of factors influencing the participants' S&T higher education processes and careers. The sociological notions of structure and agency have been used to distinguish between cases in which participants had control over their decision to pursue S&T graduate education and careers and those in which participants were dominated by various structural factors. This has been helpful in

terms of deciding what actions can be taken in order to promote access, retention and success of women in the ACE program. There are structures that clearly hindered women's advancement such as family pressure to marry early and forego graduate education, the socio-cultural view of women's place in society, the stereotypical views of girls and women regarding S&T education, unfavorable workplace politics and environment. Other supportive structures that enabled them to progress in S&T can be identified as affirmative action, impacts of limited role models, STME and the ACE programs as well as support from family, friends and informal mentorship.

The interviews provided an opportunity for the participants to discuss their interests in pursuing graduate S&T degrees and their concerns about some of the programs and policies that affected their efforts to pursue a career in S&T. The experiences and the perspectives revealed by the 24 female interviewees were categorized under themes and sub-themes. The analyses of the stories recounted by the women during the interviews provided insights into the intersection of gender, socio-cultural factors, and organizational culture and how those gendered challenges impacted the professional experiences and perspectives of selected women academics at the ACEs hosted at two public universities in Ghana. The analyses also highlighted the social and institutional structures that impede women's pursuit of graduate studies in S&T as well as the misalignment between the society's assigned gender roles and the professional responsibilities of the women. Overall, the participants' personal agentic processes complemented by the gender equality supportive environment helped the successful participation of women as students, instructors and/or administrators in the ACE program.

Given the limited number of women in academic positions across many Ghanaian universities, particularly at academic ranks beyond entry level, junior lecturer, or lecturer positions, these findings provide insights into socio-cultural and institutional factors that impact S&T education, the upward mobility of study participants, and the strategies these women have employed to navigate socio-cultural and professional contexts that are not always supportive. Most often, the educational background of parents is a predictor of their economic and financial status and their ability to financially contribute toward their children's education (Adusah-Karikari, 2008). McEwen (2013) argues that children's home environments play an important role in their attitude towards learning and often their career choices. In his study, he concluded that "the women described their fathers as the most important person who had introduced them into the traditionally masculine technology world during childhood" (p. 2).

Yet the supportive factors that helped women overcome the psychological/ cognitive, socio-cultural, educational, and institutional obstacles mainly stemmed from the socio-economic background and professional status of the participants' families. These families mostly played the roles of models and mentors. According to Rosenthal et al. (2011), the availability of role models and mentors contributed to the success of a single-sex STEM program. This was noticeable in the case of Zara (RWESCK), who had attended a single-sex secondary school yet was able to navigate the challenges of undergraduate S&T education.

Women have been socialized to think that they are second-class citizens, and thus every woman must be associated with a man and be married as a sign of womanhood. Despite all the academic and professional achievements of these Ghanaian women, motherhood and marital status take precedence over their achievements as academic professionals. Women are defined by their husband to the point that their educational and professional achievements are secondary in their lives. A married woman with a doctorate will make sure that everybody knows that she is not just an academic but she is also married. For example, at the beginning of each interview I asked each female participant to state her name for the records. One participant identified herself as "Dr. Mrs. X.," a practice which is common in Ghana. As Boateng (2015) maintained, "the empowerment activities of the successful women in S&T depend on women developing and using their agency and self-determination in attracting and joining networks necessary for their successes in the S&T experiential journeys" (p. 146).

As Stake (1995) pointed out, "single cases are not as strong a base for generalizing to a population of cases as other research designs, but people can learn much that is general from single cases" (p. 85). Although these findings are not generalizable, they do shed necessary light on the collective experiences of women scientists at the three science and technology graduate centres in Ghana.

CHAPTER 9: OVERCOMING GENDER INEQUALITY IN S&T GRADUATE EDUCATION IN GHANA

Science and technology (S&T) literacy is essential for global competitiveness. Yet, S&T research and development (R&D) in sub-Saharan Africa (SSA) including Ghana is insignificant as demonstrated by the widening gap of the development divide between the North and the South. It is also true that women's socio-economic contributions and their access to, and participation in, public decision-making processes are increasingly linked to obtaining higher-education credentials. However, too many women and girls worldwide have been held back by limited access to S&T higher education and professional qualifications, and they have been marginalized due to unequal educational opportunities. Although culture and patriarchy are the main contributors to this phenomenon globally, these factors are most influential in the context of sub-Saharan Africa. While women continue to struggle for equity and equality in general, S&T fields pose a particular challenge because of the many obstacles girls and women face on a daily basis. Empowering girls and women with the skills they need to succeed in the labour market can help break-down gender barriers and prepare a new generation of girls and women who will be able to access greater social, political, and economic power, and thus contribute to their families, their communities, their countries and society at large.

The objective of this study has been to generate empirically grounded insights into a host of educational factors and societal forces that influence, for better or for worse, the evolving status of African women in S&T programs at three Africa Centres of Excellence (ACEs) in Ghana. The conceptual framework presents the sequence of three approaches: (a) advocacy to raise consciousness about underlying gender-disparity issues; (b) a gender-affirmative-action approach to recruit and train a critical mass of female scientists and researchers; and (c) promotion of gender mainstreaming as a way of bringing gender perspectives into the universities' cultures. These policy perspectives have been analysed in relation to structuration theory used as a lens that guided the study. These frameworks have helped to shed light on the mandated sociocultural and institutional structures— affecting women's participation in S&T program at the graduate level and evidence of misalignment between the variant structures experienced by women — a sense of tension arising along with a desire and/or need to dissipate that tension. The frameworks have also helped to explain how the development and effective implementation of gender policies and

procedures can lead to the transformation of institutional, social and global structures in Ghana. Structures in turn can impact women's agency through agentic processes and help overcome gender disparity in S&T higher education in Ghana.

To better understand the factors that underlie the underrepresentation of women in S&T higher education, in this thesis, I have examined the gender disparity issue from cognitive, attitudinal, institutional, and socio-cultural perspectives. I have likewise assessed the relationship between policies, plans, and structural changes as well as educational and professional achievements of a cohort of female students, instructors, and administrators. I have also explored policy implications and women's experiences and perspectives. This chapter reflects on the research findings, policies, and procedures used to address gender inequality issues in S&T higher education, along with strategies used to overcome gender disparity mainly at the graduate level. The role of many sources of discrimination that Ghanaian women have had to overcome to gain access to, and succeed in, S&T programs at the graduate level is also discussed. I conclude with the contribution of this study to knowledge of gender inequalities in Ghanaian S&T higher education, recommendations and suggestions as well as areas for future research.

9.1 From Consciousness-raising to Gender Mainstreaming: Policies and Procedures

The findings of the analyses of policies and procedures as outlined in Chapter 7 showed that none of the institutions studied had a formal written and approved gender policy. Document review and analysis revealed that only incoherent, unclear, and informal gender-policy documents existed. The analysis of the administrators' interviews also presented in Chapter 7 helped corroborate this conclusion. Overall, the study results provide clear evidence that commitment and political will are required for the approval and the effective implementation of gender policies in Ghanaian institutions of higher learning studied.

9.1.1 Gendered Policies and Procedures: National Level

The government of Ghana continues to press for increased representation of female students in S&T at the graduate level. Various initiatives such as gender-equality and gender-responsive programs have been instituted at all levels of education to correct the historical and systemic marginalization of women. International organizations such as the UN, the World Bank, non-governmental organizations (NGOs), and other aid agencies are working with local

government officials to improve the situation of girls and women in the country. Early efforts of the government of Ghana to promote the education of girls and women have included the fee-free compulsory education system, the STME program for girls and the national gender policy (NGP). The influence of broad societal change related to girls' education has also favoured S&T education in a limited way. The STME program allowed a few female secondary-school students to gain early exposure to the advantages of pursuing careers in S&T, and this helped stimulate their interest. The program may have partly contributed to the awareness and resilience of many of the research study participants, including those from rural areas or whose parents did not have the background knowledge to steer their daughters to the sciences. Unfortunately, the STME program was discontinued before the set goal of 30% female participation had been reached. It was then replaced by STIE camps, which now admit both male and female students. Consequently, the main goal of helping marginalized young girls has been lost. Now that girls and boys are mixed in the program, the impact that could have resulted from the single-sex initiative is somewhat reduced. Contrary to the government claim of the total success of the STME program, the lack of funding, the lack of political will and poor capacity may have contributed to the cancellation and replacement of the STME clinics with the STIE camps.

At the national level, social consciousness-raising efforts started right after the independence of Ghana in 1957. However, the affirmative action bill drafted more than a decade ago has not been enacted into law to provide the required legal framework for enforcement of the policy. While leaders frequently endorse declarations and conventions espousing the notion of gender mainstreaming, too often they are unwilling or unable to follow up with the necessary mechanism for implementation. Consequently, the practical "implementation, monitoring and evaluation of gender policies, programs, and activities continue to elude those charged with the responsibilities of accounting to the public as the gap between policy and practice widens" (Morley, 2010, p. 2).

Adopting gender-sensitive and gender-responsive programs and practices require changes necessary at various levels of our institutions, particularly, structural changes at the cultural, societal, institutional and personal levels. The development of gender policies have to involve people at various layers of the bureaucratic apparatus as well as the beneficiaries of these policies. In addition, well written policies at the national level that are not effectively implemented at the university or institutional level would be a futile undertaking. Institutional efforts to mainstream

gender equality in S&T fields must first focus on raising awareness of gender issues. Second, policy development based on collective action will help bring gender to everyday life with the goal of promoting women's emancipation and empowerment. Affirmative action in recruitment is necessary to make the situation more equitable and balanced by giving an extra advantage or opportunity to women who would normally be at a disadvantage, or by attempting to take away or diminish advantages, perhaps of men. In general, women have been socialized to think that S&T fields are linked to masculinity.

In the absence of written and approved gender policies at the host universities, the ACE program has played a significant role in the adoption of aspects of the National Gender Policy (NGP), such as affirmative action and the promotion of gender mainstreaming, which in turn has contributed to the success of the study participants. The interviews provided clear evidence that gender issues needed to be revamped in the universities in Ghana. There does not seem to be any urgency in addressing gender issues. Starting from the NGP (see policy analysis document) that lacked the accountability framework related to the implementation of gender policy in higher education. The Ministry of Education that was responsible for policy documents had a detailed logical framework on its Website related to how the 'Gender Mainstreaming Policy' was going to be implemented at the higher education level, except there was no timeline attached to it. All activities are ongoing.

While the issue of gender inequality in S&T has been well established, the impact of this phenomenon on social and economic development of sub-Saharan African countries, in general, and Ghana, in particular, has not been substantially investigated. A robust system of accountability and oversight that connect policy development to policy implementation is necessary to ensure that gender perspectives are perpetually taken into consideration and planned actions assessed and evaluated in terms of their effects on women and men and that discriminating actions are eliminated to ensure gender equality.

9.1.2 Gendered Affirmative Action at the University Level

At the University of Ghana, the development, approval, and enactment of a gender policy have been in effect for more than a decade. When the question of gender equality was brought to the fore, the Centre for Advocacy and Gender Studies (CEGENSA) was created to promote gender and raise awareness within the university community. CEGENSA drafted a gender policy that

required the approval and endorsement of the university community for full implementation. However, a policy that provides the road map for addressing the gender issue on campus is yet to be endorsed, and 10 years after the development of the draft gender policy, it is still awaiting approval. Nevertheless, it would seem that some consciousness-raising on gender issues has occurred in Ghana, resulting in a superficial level of awareness in the university community. However, many members of the university community seem to be unaware of the sexual harassment policy purported to have been distributed to students and employees during orientation sessions.

The situation at the University of Ghana appears to have been a replication of what has been happening at the national level. Gender-policy debates and awareness-raising should have preceded gender-policy development, as indicated in the conceptual approach (see Chapter 5). It is thus safe to infer that only a few selected members of the University of Ghana took part in the gender-policy debate and development, and only a few people are aware of the issue of longstanding gender inequality. This was reflected in the response given by Michael (WACCI) who said: “You know this gender balance is a new thing basically. Maybe people haven't thought about it. All those established institutions... a lot of people are now becoming aware. So, policies are being developed”. This lack of awareness of gender issues may be the reason why the university community is reluctant to adopt the drafted gender policy.

With regards to KNUST, gender equality and gender policy have yet to be seriously debated. As mentioned in Chapter 7, KNUST seemed to be vague on how to move the gender debate forward. Moreover, the interviews with study participants from RWESCK revealed that only a few individuals were fully aware of what gender meant and why it was necessary to have a gender policy. The lack of gender-policy documents is clear evidence that gender is not an issue of concern for KNUST. In fact, the current strategic plan did not even make any reference to gender. It is apparent that many members of the university community have not been made aware of the need to include gender in the university systems of operation. How have the ACEs been impacted by the policy environments of their two host institutions?

9.1.3 The impact of gender practices and procedures on the three ACEs

Given the fact that the ACE project implementation plan required gender sensitive practices, the findings of this study suggest that gender has been one of the criteria used in student

admissions, and there is ample evidence that affirmative action initiatives have resulted in increased female-student representation. Nonetheless, the different ACEs use disparate affirmative-action approaches in their admission of students, and they have also adopted informal gender-supportive procedures that have helped female students, instructors, and administrators integrate into the ACE program. Moreover, informal gender policies used on an *ad hoc* basis have the potential of limiting the effectiveness of program implementation as no consistent standard is applied to every candidate.

Overall, the lack of formal gender policies in the host institutions (University of Ghana, Legon, and KNUST) has not prevented the ACEs from taking gender into consideration in their admissions processes, procedures, and practices. In the absence of written and approved gender policies at the host universities, the ACE program has played a significant role in the adoption of aspects of the NGP, such as affirmative action in female students admissions and a slow move towards gender mainstreaming, which in turn has contributed to the success of the study participants.

The World Bank project provided a monetary incentive to entice the project implementation teams to support and encourage female participation. However, once the project comes to an end and there is no longer an incentive to include women, there is a risk of things returning to the way they were before the ACE initiative, as has been the case in many such donor funded initiatives on the African continent. Most educational reforms in Ghana, as well as in most African countries, have been very much donor driven where organizations such as the World Bank and the International Monetary Fund (IMF) have shaped the discourse around education. In fact, “discourses of social policy have become more adapted to the Washington Consensus where international donor organizations often demand specific neo-liberal reforms in exchange for funding” (Nordensvard, 2014, p. 3). Fortunately, resource mobilization is one of the objectives of this four-year ACE project. The ACEs are required to implement resource mobilization activities to raise funds for investment and operation. Hopefully, the ACE program will be sustainable and continue after donor disengagement.

In contrast to the female student participation in the ACE program, the limited number of female instructors and administrators suggests that the female staff recruitment process may not have benefitted from a gender-affirmative-action approach. This is not surprising because the ACEs have had to use the host universities’ faculty and staff and so did not recruit their own.

Females were generally underrepresented among faculty and staff in both universities studied, and this was reflected in the low percentage of female instructors and administrators at the three ACEs. There is obviously a need to bridge the gender gap, or at least bring the percentage of female instructors/administrators to at least 40% rather than the current distribution of 20% and 33% for WACCI and WACCBIP respectively at the University of Ghana. No gender-distributed data for staff were available for the RWESCK.

The gender discrimination issue has been debated globally over the years, and laws have been passed in Kenya and in many countries. Yet in Kenya, there has only been limited progress to date. Collective consciousness, only if it is followed up with, or accompanied by, political support, can be an effective impetus for change. Many institutions and countries have used gender mainstreaming to address social and educational policy issues. However, changing people's beliefs, values and attitudes, especially in a patriarchal country like Ghana, where men have enjoyed most of society's privileges for many years, is not an easy process. Formal gender policies would provide guidelines on procedures and plans, and the monitoring and evaluation of the programs' gender outcomes could only improve the operations of the ACEs and the host institutions over time.

9.2 Framing Gender Equality in S&T Higher Education

The research questions called for policy analysis and the interpretation of participants' experiences. The conceptual framework presents the sequence of three approaches: (a) advocacy to raise consciousness about underlying gender-disparity issues; (b) a gender-affirmative-action approach to recruit and train a critical mass of female scientists and researchers; and (c) promotion of gender mainstreaming as a way of bringing gender perspectives into the universities' cultures. These three approaches were complemented by structuration theory that has been instrumental in illuminating women's experiences. The literature review revealed that the concepts of consciousness-raising, affirmative action, the promotion of gender-mainstreaming and structuration theory have been used exclusively with limited effects on gender inequalities in S&T higher education. I argue that the combination of consciousness-raising, affirmative action and gender mainstreaming approaches with the structuration theory provide a stronger conceptual design to tackle the problem of gender inequalities in the S&T higher education in Ghana.

9.2.1 Consciousness-Raising/Affirmative Action/Gender Mainstreaming

Awareness campaigns and collective consciousness are good starting points to drive the gender equality discourse aiming to bring gender issues into policy development debate for subsequent transformation. In order to induce change, it is imperative to raise awareness of existing inequalities in S&T fields. The use of gender as one of the criteria for student admissions has been useful in the recruitment of an increased number of female students in this study. This affirmative action approach aiming to resolve equity issues is imperative, but is just the preliminary step to gender equality in higher education. However, it is not the panacea if used alone without structural changes. In fact, affirmative action has come under scrutiny lately, especially in the US prompting some States to ban affirmative action based on race in graduate student admission. Indeed, the outcomes have been worrisome. For example, Garces (2013) demonstrated that the enrolment rates of minority students of colour have reduced considerably mostly in science and technology disciplines when the ban on affirmative action based on race has been implemented. Affirmative action is a necessary tool to offset the unequal positions of individuals in society and level the playing fields. However, gender equality would not be achieved until the next step which is gender mainstreaming occurs.

The entire university community needs to be onboard to work together as a team to mitigate barriers and biases that exist within institutions, programs and practices in support of gender mainstreaming. Both women and men are vulnerable to the way in which gender relations unfold within society. A diversity approach including both men and women to promote and accelerate gender mainstreaming is the key. This is essentially the foundation of mainstreaming – men and women involved together in processes that will bring about a change in behaviour, mindset and a transformation of gender relations so that women around the world, and particularly in Africa, can participate fully and meaningfully in higher education and subsequently in the formal economic sector. Gender mainstreaming is a complex undertaking. It requires the use of gender perspectives in all aspects of the universities' systems of operation. More concentrated efforts are required to ensure equitable and inclusive learning environments that promote gender equality. For example, instructions that focus on the students' skills, resources, and perceived control may help students to deconstruct the internalized stereotypes in an engaging way. The inclusion of gender perspectives in S&T research practices, in particular, necessitates the re-design

of basic concepts and underlying assumptions of S&T teaching/learning and research as well as the S&T work environment.

9.2.2 Impact of Structuration Theory

As demonstrated by this study, the adoption of consciousness-raising, affirmative action and gender mainstreaming approaches – key components of structural change – can stimulate women's agency and thus help to reduce and ultimately eliminate gender disparity in higher education. Both agency and structure are understood as distinct ways of conceptualizing complex social processes. Agency and structure are thus crucial for the understanding of human interaction within a society as they shed light on social phenomena. Structural solutions are imperative to mitigate inequitable practices in the S&T higher education while focusing on power relations and the oppressive effects of historical, social, and political contexts. Of course structural changes can bring about positive or negative effects depending on the types of changes that occurred. In this study, the agency and structure interplay helped to explain how policies and procedures influenced women's experiences and actions. This structuration framework illustrated the multiple layers of structures such as social and family, institutional and of global structures that impacted the lives and personal agencies of the participants. Structuration theory explains the mutuality of individual agency and structuring of social roles and practices in the shaping of both family and professional lives of the participants. Agency and education are key mechanisms that enable women to gain a sense of accomplishment in careers and leadership positions, particularly, in sub-Saharan Africa. Education often allows women to assert agency in their career choices. Undeniably, a woman's agency often allows her to overcome social norms and challenge patriarchal underpinnings, sources of misalignment and tension in the S&T graduate education program at the ACEs in Ghana. Policies, practices and procedures such as affirmative action and gender mainstreaming are part of the institutional structures that shape people's consciousness and behaviours.

9.3 From Structure to Agency: Experiences and Perspectives of the Female Participants

As interviews in this thesis revealed, the participants were invited to discuss their interests and experiences concerning their pursuit of S&T education and careers, and their perspectives about the ACE programs and policies. The analysis of the women's stories provided insights into the intersection of gender, socio-cultural factors, organizational cultures, and how gendered

challenges impacted the professional aspirations of the women academics in the two public universities studied in Ghana. As they all stated, they perceived and/or faced numerous socio-cultural and institutional obstacles that hindered their entry and ultimate engagement in the S&T disciplines. Impediments such as socio-cultural and traditional views of girls and young women, and hostile workplace politics and environments, were highlighted. Some of the women experienced gender discrimination in their workplaces. The challenges of juggling conflicting family and career demands were very evident. They all experienced pressure to marry early, forego graduate education, and start a family. In fact, most women seemed to be defined by their husbands to the point where their educational and professional achievements were secondary in their lives. Despite all the academic and professional achievements of these Ghanaian women, from a societal perspective, motherhood and marital status took precedence over their achievements as academic professionals. Furthermore, institutional challenges such as poor teaching practices, inconvenient class schedules and inadequate daycare services for students, instructors and administrators with young children were apparent.

Nevertheless, as the narratives of the ACE program participants also revealed, they overcame these socio-cultural, socio-economic, institutional obstacles and demonstrated that support, often from family and key individuals such as particular teachers, along with the exertion of personal agency, contributed to their success in S&T fields. Supportive factors stemming mainly from the socio-economic background and professional status of the participants' families, strong family support, encouragement and advice of teachers and friends have been beneficial. In addition, the combination of globalization and institutional shifts fostered by consciousness-raising, gender affirmative action, and incremental efforts towards gender mainstreaming in the ACEs have created a gender supportive environment that contributed to the women determination to succeed in S&T. Societal change occurring gradually in favour of girls and young women's education overall has led to broader support for gender equality and enhanced women's empowerment. For most of these women, awareness of broad societal change and the impact of supportive gender-equality practices and/or procedures have helped them overcome the challenges and obstacles they faced and propelled them into S&T higher education and careers.

A key factor in facilitating their progression into S&T academic programs and contributing to the positive attitude and experiences of the female students, instructors, and administrators interviewed for this study has been the current World Bank ACE program for which gender

equality is a policy imperative. This explains why the ACEs seem to be unique with regards to their approaches to gender equality. The combination of all national policies, coupled with donor-sponsored gender-supportive programs and procedures, has been a real incentive for the ACEs to improve their systems of operation. The findings of this study have confirmed that there was indeed a need for affirmative-action policies and program initiatives in order to bring about the effective implementation of a gendered approach in student admissions and staff recruitment. Even though gender inequality in S&T is a global phenomenon, the fact that the ACEs have managed to increase the intake of female candidates to 40%—higher than the global average of less than 30% (UNESCO, 2017)—is evidence that the use of a combination of consciousness-raising and gender affirmative action, coupled with proximate supportive relations with families and mentors, can significantly boost women's agency in overcoming gender inequality in science and technology higher education.

Previous initiatives like the STME program also contributed to the participants' success. A very limited number of female students from rural areas — who took part in the STME program in secondary school — have also benefitted from initiatives implemented in urban areas. Their performance in their studies and the gender-supportive environments they found themselves in made them outstanding achievers, and several are expected to occupy highly-placed positions in their respective countries and institutions upon graduation.

To sum up, this study confirms that as consciousness of gender inequality in higher education, and especially in S&T fields, has expanded. The government of Ghana and some university units have undertaken affirmative action policies and measures to begin to redress longstanding gender imbalances into their operations. However, tentative affirmative action initiatives have not been enough to ensure that gender equality is close to being achieved. It is important, nonetheless, to note that the gradual transformation in awareness of gender issues taking place in many institutions in the country have helped the situation of women. There is indeed hope that the situation is improving and that gender equality is gradually being promoted at all levels of the Ghanaian society. This requires the move toward gender mainstreaming at the national, local and institutional levels.

9.4 Long Road from Affirmative Action to Gender Mainstreaming

While gender-affirmative action has helped improve the percentage of female students in the ACE program in Ghana, much more needs to be done if gender equality is to be mainstreamed in all the policies, practices and procedures at national universities. It is important to note that the majority of the female participants in the ACE program came from families who were well educated, had relatively high socio-economic status, and lived mostly in urban areas. These findings align with Acheampong's (2014) study which demonstrated that women's interest and motivation in pursuing S&T studies are strongly influenced by the educational background and/or the socio-economic status of their parents. Similarly, Basant and Sen's (2014) study shows that participation in higher education increases significantly with parental-education levels and is highest with parents who have a graduate education.

Though the three ACEs hosted by the University of Ghana and the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana, had 40% female students enrolment (WACCI, WACCBIP AND RWESCK), the statistics in other programs and other universities in Ghana were different. The average female student representation in S&T programs in other universities in Ghana was around 20% in 2016. For example, the female student participation at the University of Mines and Technology, in Takwar, Ghana was 17% in the academic year 2011-2012, while there was only 14% female representation in the mining workforce in Ghana the same year. Similarly, female graduate student enrolment at the KNUST in 2015-2016 was 28%.

Higher education is still inaccessible to the majority of students from low income households globally despite tremendous efforts of the international community to improve the situation. The phenomenon is unsettling in rural areas where cultural and societal expectations are mostly detrimental to girls' education, let alone S&T higher education. In line with the findings of this study, Bassett and Salmi (2013) have observed that the majority of students enrolled in higher education come from wealthier families despite the global efforts to change the situation. The gender gap in higher education obviously translates into the low participation of women in the workforce, particularly in S&T fields in academia. This is especially true in senior level decision-making position and administrative ranks where women are underrepresented. Moreover, women who do manage to gain access into S&T fields as faculty and administrators face all kinds of challenges that militate against their retention, promotion, and access to decision-making

positions. One of the main challenges that career women face in academia includes finding mentors. This has been the case for the participants in the ACE program who argued that the institution of a formal mentoring program would have helped them make informed decision about career development.

Despite decades of efforts aimed at increasing women's representation in S&T fields, throughout the world, women remain stubbornly underrepresented at the highest levels of many S&T disciplines. For example, among individuals who earn PhDs in S&T fields in the U.S., disproportionate numbers of women fail to be among the ranks of assistant professors, and among those women who pursue academic jobs at U.S. colleges and universities, a disproportionate number fail to obtain tenure (Goulden, Frasch, & Mason, 2009; Shalala et al., 2007). Women in academia struggle for identity and power. The underrepresentation of girls and women in S&T fields is a worldwide issue. However, as demonstrated in this study, the situation is much worse in sub-Saharan Africa including Ghana.

Interestingly, women who do manage to attain positions in academia are sometimes perceived as unsupportive and unwelcoming by many of the female participants. In fact, some of the participants in this study indicated that they prefer to work with men than with women. This view was corroborated by Michael, one of the male administrators' interviewed, who observed that female students prefer going to men for information or tutoring. It is true that society judges women in powerful positions more harshly than men in similar positions. It is apparent that women are also held to higher standards than men. Toughness is stereotypically associated with men. Therefore, women trying to gain access to decision-making positions have to prove themselves. Consequently, women seem to shy away from powerful positions and seldom show interest in these positions. This was perceptible in the observation made by Don in this study. "Perhaps, the fact that women have been socialized to meet certain expectations is a concern, but the larger concern is that African institutions of higher learning provide very little space where men and women could contest the 'way things are'" (Okeke-Ihejirika, 2009, p. 217).

9.5 Contribution to Knowledge

The study makes several important contributions to the advancement of knowledge. In particular, the practical insights that help us understand gender disparities in science and technology, discrimination experienced by women, cultural context, and experiences by those

directly affected. The empirical information shed light on some of the cultural realities and broader systematic issues that arise from patriarchal practices. This is important for advancing gender and development scholarship. The research contributes to knowledge of the situation for women in S&T in Ghana with connections to the global issues that persist for women in S&T education and careers. The study not only elucidates existing literature as well as assessment of policies and practices, but is also one of the rare empirical studies that focused on gender policies and practices related to the underrepresentation of women in S&T as well as the Ghanaian women's experiences in the pursuit of graduate S&T higher education and lived experiences in the workplace, particularly, in Ghanaian universities. Overall, the study contributes to the S&T disciplines in the African context.

These findings could constitute a starting point for subsequent future studies on the problem of gender disparity in S&T field aiming to be able to resolve the issue one day. The study generates knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in S&T, as well as the experiences of women who are currently enrolled or who are teaching in the S&T graduate programs in Ghana, through an examination of policies designed to enhance women's enrollment in graduate study, and employment, in S&T fields, coupled with an assessment of the experiences and the perceptions of female graduate students, instructors, and administrators in the ACE programs. The study also helps to address a major research gap concerning the forces that affect, for better or worse, women's experiences and potential academic contributions in S&T fields in Ghana. At the same time, it contributes to the broader literature on women's experiences in male-dominated fields as well as the provision of lessons to be learned from scholarship on women in business leadership and other fields shedding light on the cultural and institutional forces that prevent or limit women's opportunities. The study also helps draw similarities and differences in these experiences with women working their way of the corporate ladder. It further helps us better understand possibly institutional culture as well as gender mainstreaming's strengths and weaknesses among other areas of analysis and how (by better unpacking gender inequality, masculinities, gender norms, etc.) humanity will eventually overcome gender issues.

Indeed, my dissertation research will serve as a contribution to the World Bank's intervention itself by adding qualitative information that is often lacking in semi-annual reports of the Bank that rely substantially on statistical data. Above all, it is my hope that evidence attained

through my research will provide information for policy making, with regard to the promotion of women's enrollment in graduate S&T programs in Ghana and elsewhere in Africa.

9.6 The Way Forward: Recommendations and Areas for Future Research

Higher education helps women acquire the skills necessary to participate in the formal economic sector and make decisions about their lives. Yet many Ghanaian women are excluded due to unequal educational opportunities. The government and the institutions of higher education need to mobilize efforts not only in raising awareness on gender issues, but in creating affirmative action measures that will open doors for women, and in so doing will usher in (hopefully) a consensus on the rights of women to succeed in higher education, thus enabling more mainstream policies and initiatives.

Women's representation and advancement in S&T fields are affected by factors external to their ability, interest, and technical skills. The organizational constraints, the differential effects of work and family demands, implicit and explicit biases, and their underrepresentation in academic leadership and decision-making positions must be addressed. Therefore, any time women's emancipation and empowerment are discussed, it is imperative to begin with consciousness-raising. Not only do men need to be sensitized about gender issues. They need to be aware of the fact that it is to the advantage of society to empower women to positively contribute to their own development and to socio-economic development. Women have to go through the same process of awareness-raising. The reasons women also need to be sensitized about gender issues is because women have been socialized to accept the status quo. The state of mind of Women must be deconstructed to accept the fact that women and men can equally succeed in S&T education and careers. They need to be empowered to know their rights and be able to claim them. Only then can they negotiate and resist patriarchal power.

There seems to be a disconnect among consciousness-raising, policy development and policy implementation processes in Ghana. Consciousness-raising on gender issues has had some success. This study has revealed that there is need for more comprehensive consciousness-raising and affirmative action programs to ensure that all stakeholders and the entire university community are involved. To induce change in S&T fields, it is necessary to raise awareness of existing inequalities. Any call for affirmative action and gender mainstreaming that ignores the crucial factor of consciousness-raising will have limited impact. Policy makers must bring to the

fore discourses in gender issues and establish new directions on how to move the gender inequality debates forward. Once stakeholders are aware of the situation and are comfortable with the need for change, efforts can then be made to bring about such change through gender mainstreaming. The integration and mainstreaming of gender within the academy will provide a strong momentum for the necessary modernization of the universities. Gender mainstreaming entails a perpetual use of gender perspectives at all stages of the development and implementation of policies, plans, programs, projects as well as S&T curricula and teaching practices. Gender mainstreaming promotes gender equality within institutions if implemented effectively, thus enhances social justice.

Consequently, it is necessary for the Ministry of Education, the National Council of Tertiary Education, the University of Ghana, and the KNUST to develop, endorse, and implement gender policies in order to address gender inequality. It requires the improvement of key policies through discussions of all gendered assumptions, processes, and perceptible results. The gender equality policies, programs, and procedures at the national and institutional levels must be supported by the required financial and human resources in order to bridge the gap between policy development and implementation. Moreover, the gender policy implementation process requires a robust accountability mechanism. The government of Ghana needs to prioritize the implementation of gender policies. Decision-makers and all stakeholders have to admit that gender equality is an essential element in national development and agree to work together to achieve gender equality. While the provision of universal access to basic education remains an unattained goal in most African countries, including Ghana, there is clearly an urgent need to identify methods and strategies that will enhance women's participation in global socio-economic development.

Most of the women in the graduate-study programs are married. Therefore, scholars and policy-makers should aim for a family-friendly environment, which can be done by fostering the perception that S&T studies and careers can be combined with family goals. Policy-makers and higher-education institutions should institute policies to address discrimination faced by married women and women with children in school and the workplace. Even though these policies are beneficial to the realities of women in any field of study and careers, they are most crucial for the success of girls and women in the S&T field. Stereotypical views of girls and women in the scientific fields and the extent of the gender disparity in the disciplines make these policies more

relevant if society is determined to promote gender equality in S&T fields. In both universities in Ghana where I conducted my study, as well as elsewhere in the world, adequate childcare services that take into consideration the unique and specific needs of students and staff alike can help alleviate the daily stress of mothers trying to balance work and family life. This would allow female students to focus on their studies while instructors, administrators, and other support staff could be more productive and make professional contributions to society.

It is equally important to have policies related to family leave. It would be beneficial to consider paternity leave as a national policy in order to give the opportunity to fathers to help in child-rearing. Paternity leave would relieve the pressure on mothers and allow fathers to share parenting and to play an active role in child-rearing. In fact, having paternity leave would mitigate career penalties that women experience when they take time from work to raise their children.

In order to monitor the effects of affirmative action policies, it is imperative that gender-disaggregated data on female intake in S&T higher education and female staff recruitment be collected at national levels (e.g., from the Ministry of Education and the National Council for Tertiary Education) and at institutional levels (e.g., University of Ghana and the KNUST). Related to the ACEs, the centres should also establish a database containing gender-disaggregated statistics and information for both scholarship-based and project-based capacity-building programs. These data would be utilized to inform internal and external policies related to gender equality and to enhance program design, procedures, guidelines, rules, and regulations. Evidence-based data that can be used for policy and program development and implementation, and findings can be used by educational institutions to improve gender responsive strategies for student training and particularly recruitment of female faculty and administrators in the ACEs studied. Eventually, improved strategies can be extended into the host institutions (University of Ghana and the KNUST) as well as the entire Ghanaian higher-education sector and those of other sub-Saharan African countries.

In addition, there is need for academic women to organize, network and try to move into decision-making positions. In such positions, they could promote change in the educational system. Furthermore, formal mentorship programs should be created at the higher educational institutions. As well, affirmative-action policies, coupled with gender mainstreaming in programs, curricula, gender-sensitive and gender-responsive teaching practices, should be effectively implemented, monitored, and evaluated. It is important to make the science and technology

education and careers more attractive and further create awareness on the advantages of pursuing a career in the field. Institutions of higher education should promote gender supportive and gender sensitive teaching practices in S&T education programs.

The issue of gender equality has been a matter of concern not only for scientists, but has been a matter for politicians for several decades, prompting national leaders and international development agencies to collaborate, formulate and implement more focused interventions to bring about gender equality in formal education. If the developing world is to succeed economically, culturally, and politically, it must have a strong inclusive postsecondary sector. Hence, universities have to play a major role in preparing both men and women to achieve future development goals. The promotion of gender equality in S&T worldwide not only provides opportunities for attaining global sustainable-development goals but also reduces discrimination against women.

After a number of interventions to mitigate the underrepresentation of women in S&T, African universities are still lagging behind in gender equality initiatives. Gender-based affirmative action campaigns have persisted at the international, national and local level domains for far too long, and the observation that academic debates on the subject in the area of education in particular have continued unabated, is a reflection that records on the achievements of affirmative action strategies fail to meet the expectations of gender-based development activists and other stakeholders. Gender issues are linked to culture and history. These, in turn, influence people's perceptions and practices. Fortunately, culture does change, but it takes a lot of efforts and good will. Universities in sub-Saharan Africa need to strategically readjust their policies in response to the heightened demands of social and economic transformation in the wake of globalization.

Gender equality is the fifth of the 17 new Sustainable Development Goals. The challenge of achieving gender equality in the world, and in sub-Saharan Africa in particular – especially in African higher education institutions – must begin with gradual steps that will engage all stakeholders and agencies relying on public/private partnerships. This is not a task that should rest solely on the shoulders of women alone, but must be a collaborative undertaking between men and women to help with behaviour change and institutional transformation. African universities and the larger society have much to gain by including women in knowledge creation and in leadership positions. In order to be adequately prepared for the challenge of moving the continent beyond the

twenty-first century, African women must fully and meaningfully participate in S&T higher education, and careers. In order to do so, it is important that they gain access to decision-making positions in greater numbers so they can influence decisions that affect their lives.

Future work might target both male and female students in rural areas (probably at the secondary level); the reasons why universities are reluctant to adopt a standard and unified gender policy; and the perspectives of university management teams regarding accountability related to gender issues. Follow-up studies should be conducted to determine the extent to which the study participants who had been successfully influenced by supportive family, social, institutional and global structures have in turn contributed to gender equality in S&T disciplines. Engaging men and boys in valuing women, national campaigns aimed at improving women's well-being and equality are proposed areas of further work. Further research using feminist intersectionality theory in the area of reducing gender inequality in graduate S&T level will ideally have a broader cross-section of women and help understand the human dynamic and its structuration. Potential questions of future study in the domains are: How can women who participated in the ACE program in Ghana as students contribute to gender equality efforts in the S&T fields? What accountability measures are necessary to bridge the gap between gender policy development and implementation at the national level?

This study has added to understanding of factors that impede and/or enhance women's efforts to pursue advanced degrees in S&T, as well as the experiences of women who are currently enrolled or who are teaching in the three ACE (WACCI, WACCBIP, and RWESCK) graduate programs in Ghana. An examination of policies designed to enhance women's enrolment in graduate study and employment in S&T fields, coupled with an assessment of the experiences and the perceptions of female graduate students, instructors, and administrators in those programs has shed some light on the gender policies and women's agency in relation to S&T. The study also helps to address a major research gap concerning the forces that affect, for better or worse, women's experiences and potential academic contributions in S&T in Ghana and elsewhere in the world and it adds to the broader literature on women's experiences in male-dominated fields. It would be useful to compare the conclusions of this study with scholarship on women in other humanities fields, and business in order to help draw similarities and differences in these experiences with women working their way up the corporate ladder.

Beyond a better understanding of women's experiences, this study helps us understand gender inequalities and the societal norms and practices and patriarchal forces that permeate societies and impose structural barriers to women's advancement. The experiences of the women interviewed for this study speak to their agency and ability to navigate these systems of inequality. Yet much more is needed to also tackle the structural barriers. Affirmative action policies are important and a first step, ending laws that discriminate against women and promoting gender equality in all social aspects. Unfortunately, however, many institutions have well written policies but fail to adequately implement them, thus limiting the possibility of mainstreaming the latent potential of women and their abilities to contribute to the socio-economic development of their countries. African (male) leaders frequently speak of their commitments to women's issues, but time and again they fail to follow up on this rhetoric with necessary actions and often shrewdly evoke patriarchal and contradictory rules that hinder women's advancement in society. The role of men in public education to create transformative change generate buy-in at all levels is critical. Progress is being made in Ghana and in many parts of the world, yet much remains to be done, particularly, in sub-Saharan Africa. In order to create a world that celebrates the diversity and utilizes the talents of each individual towards the task of transforming society, African women must join the march and not sit on the sidelines watching men as they march on.

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LIST OF APPENDICES

Appendix 1: Sample Formal Letter

November 28, 2016

Dear Dr. X,

It was a pleasure talking to you today. As a follow up to our conversation, I am writing to send you a formal request for approval to conduct a research at your centre (xxxxxx). This approval letter is required to allow me to submit an application to the University of Ottawa's Research Ethics Board for approval to conduct my doctoral dissertation research.

I am planning to conduct a research about women in sciences. The title of my dissertation is: "Challenging gender disparities in African higher education: A case study in three science and technology centres in Ghana". I will be conducting a mixed methods research about the experiences of female students, faculty, administrators and staff at your centre. I will count on your assistance in doing this study.

I will be very grateful if you can send me a formal letter to the following email address: xxxxx to allow me to proceed with my Ethics Certificate issue here at the University of Ottawa. Please do not hesitate to contact me should you require further information.

Best regards,

Signature

Appendix 2: Policies and Plans: Gender and Tertiary Education in Ghana

| Name | Date | Background | Purpose/Justification | SOURCE |
|--|------|--|---|---|
| NATIONAL POLICIES | | | | |
| Science Mathematics & Technology Education Program | 1987 | To continue to promote the access to and participation of women and girls in education, science and technology, being convinced that science and technology are crucial for modernization, industrialization and socio-economic development | Designed to address the gender imbalance and misconception about girls' participation in Science, Technology and Mathematics Education. The ultimate goal of the program was to achieve the target of 30% of female students at the tertiary level taking up science, mathematics and technology related courses. | Permanent Mission of Ghana to the United Nations Website. |
| National Science, Technology and Innovation Policy | 2010 | After its independence in 1957, Ghana aspired for a rapid social and economic development using knowledge and tools derived from Science and Technology (S & T). However, many years passed and there has not been much progress in ensuring that Science, Technology, and Innovation drove socio-economic | The main objective of the national science, technology and innovation policy is to advance, insights, tools, and practices derived from science and technology will be applied in all ministries, departments and agencies, indeed in all sectors for social and economic development. S & T will be | Ministry of Environment, Science, and Technology (MEST) Website |

| Name | Date | Background | Purpose/Justification | SOURCE |
|------------------------------------|------|---|---|-------------------------------------|
| | | activities. The creation of the Ministry of Environment, Science and Technology in the third republic, which began as the Ministry of Industry, Science and Technology, the promotion, management, coordination and harmonization of S&T policies and institutions that were finally mainstreamed into Ghana's government machinery. | the driver to the achievement of sectoral goals, objectives, and programs. All ministries will be expected to have Science Technology and Innovation desk offices to work in cooperation with the MEST to ensure that sector programs and activities are indeed driven by S & T programs. | |
| Education Strategic Plan 2010-2020 | 2010 | The current plan builds upon its four predecessors and upon earlier visionary strategies such as " <i>free Compulsory Universal Basic Education</i> " (fCUBE), the policy of decentralization, etc... It describes the main changes that took place in the education sector between 2002 and 2008, i.e., the first six years of the previous strategic plan, Education Strategic Plan (ESP) 2003 – 2015. The goals were grouped into the following four areas of focus: | The objectives of this new strategic plan are: (1) improve equitable access to, and participation in quality education at all levels; (2) bridge gender gap in access to education; (3) improve access to quality education for people with disability; (4) mainstream issues of population, family life, gender, health, human rights and environment in the curricular at all levels; (5) improve quality of teaching and learning; (6) promote Science and | Ministry of Education (MoE) Website |

| Name | Date | Background | Purpose/Justification | SOURCE |
|------------------------|------|---|---|---|
| | | <ol style="list-style-type: none"> 1. Access to Education 2. Quality of Education 3. Education Management 4. Science, Technology, and TVET. | <p>technical education at all levels; (7) strengthen links between tertiary education and industry; and (8) improve management of education service delivery.</p> | |
| National Gender Policy | 2015 | <p>Ghana's goals towards achieving gender equality and women empowerment are guided by the 1992 Constitution, the targets in National Development Frameworks (NDF) (past and present), and the commitments to International Frameworks and Instruments on human rights, social protection, good governance and accountability for development with emphasis on the rights of women, men and children. After the Beijing Conference in 1995, the National Council on Women and Development (NCWD) formulated guidelines for the promotion of Gender equality, rights, and opportunities for women.</p> | <p>The National Gender Policy (2015) provides broad policy guidelines, strategies and institutional framework to operationalize government's commitments for achieving gender equality and women's empowerment targets in its national vision of "A stable, united, inclusive and prosperous country with opportunities for all". The policy framework will enable all stakeholders to have a common understanding of the issues and strategies for addressing gender inequality and issues of social injustice. Gender, Children, and Social Protection.</p> | <p>The Website of the Ministry of Gender, Child and Social Protection (MoGCSP).</p> |

| Name | Date | Background | Purpose/Justification | SOURCE |
|--|------|--|--|--------------------------------|
| UNIVERSITY POLICIES | | | | |
| <i>University of Ghana (Legon)</i> | | | | |
| Centre for Gender Studies and Advocacy (CEGENSA) | 2005 | To address the issue of gender inequality at the University of Ghana, the Council of the University established the Centre for Gender Studies and Advocacy (CEGENSA) in 2005 as an outlet and space for the University community to access policy, resources, and information related to gender issues. CEGENSA was inaugurated in 2006. | The goals of the Centre for Gender Studies and Advocacy (CEGENSA) are to institutionalize gender, promote research on gender issues; provide documentation on, and dissemination of, gender-related research; provide services to faculty to meet some of the unique needs of female staff and students; and promote advocacy and initiate policies on gender in the University. | CEGENSA's Website. |
| Sexual Harassment Policy | 2009 | Ghanaian universities are grappling with the issue of sexual harassment on the campus. Consequently, the sexual harassment policy has been formulated by the University of Ghana as a response to that challenge. | The aim of the policy is to oppose sexual abuse by taking steps to prevent sexual harassment and abuse; respond promptly and effectively to reports of sexual harassment and sexual abuse, and to administer appropriate disciplinary measures when a violation is found to have occurred. | University of Ghana's Website. |

| Name | Date | Background | Purpose/Justification | SOURCE |
|-----------------------------------|------|--|---|---|
| Strategic Plan 2014-2024 | 2013 | The University of Ghana has undergone significant transformations since the 2006 review of the processes, outputs, and outcomes in the pursuit of its core mission. The current strategic plan derived from the previous plan that covered the period of 2001 to 2011. The objective of the previous strategic plan has been to produce world class human resources. | The goals of the Strategic Plan 2014-2014 are to increase the numbers of graduate students, expand the total number of distance education, increase the number of faculty members; support all department and colleges to develop strong research units; expand physical infrastructure, and develop management capacities. | Collected from the WACCBIP Secretariat. |
| Gender Policy (Awaiting Approval) | Daft | This policy is in response to research that confirms that the University of Ghana is a gendered institution. This is evident in terms of the unequal representation of males and females in the student population, and in teaching, administrative and governance positions. Research findings also indicate that the formal and informal policies and practices of the university have a differential impact on men and women. | The aim of the policy is to achieve a gender equitable environment that is inclusive and supportive of both males and females; enables optimal productivity; engages both males and females in decision making; harnesses women and men's diverse skills, perspectives and knowledge; and values diverse perspectives. | Collected from the Director of CEGENSA. |

| Name | Date | Background | Purpose/Justification | SOURCE |
|---|-------------------|--|---|---|
| | | The University is committed to addressing this situation by providing equal opportunity to all its current and prospective employees, students, interns, teaching assistants regardless of gender | | |
| <i>Kwame Nkrumah University of Science and Technology (KNUST)</i> | | | | |
| Sexual Harassment Policy | Draft | KNUST adheres to the principles and traditions of academic freedom and recognizes that these freedoms must be in the balance with the rights of others, including the right of individuals not to be sexually harassed. It is understood that the principles of academic freedom allow topics of all types, including those with sexual content, to be part of courses, lectures, and other academic pursuits. | The University seeks to create a peaceful and cordial atmosphere devoid of sexual harassment of any form. The University abhors all forms and manifestations of sexual harassment and will take the necessary steps to correct the situation. | Collected from the University Quality Assurance Unit. |
| Equality & Diversity Policy | Awaiting Approval | Commitment to inclusiveness to support teaching, learning, research, administration, and student support services. | Avoid all forms of discrimination and promote fairness, dignity, and respect. | Collected from KNUST Quality Assurance Unit |
| Ethics Policy | Draft | Main guideline for ethical issues | Set the standard of behaviour for all | Collected from |

| Name | Date | Background | Purpose/Justification | SOURCE |
|------------------------------------|------|---|---|---|
| | | | staff and students. The policy principles include Excellence, Diversity, Equal Rights; Integrity, and Stewardship. | KNUST Quality Assurance Unit |
| Corporate Strategic Plan 2016-2025 | 2016 | Commitment to continuously improve in all areas: teaching, research, entrepreneurship, and service. | Ensure an environment of understanding and respect for cultural diversity and equal opportunity among staff and students, i.e., Leadership in Innovation and Technology; Culture of Excellence; Diversity and Equal Opportunity for All; Integrity and Stewardship. Establishment of Strategic Plan Implementation Committee. | Collected from KNUST Quality Assurance Unit |

Appendix 3: Data Collection, Rationale, Sources and Analysis

| Questions | Type | Rationale | Data Sources | Analysis |
|--|---|---|---|---|
| What gendered affirmative action and gender mainstreaming policies and procedures for S&T education have been formulated and implemented in Ghana in general, and at the various educational institutions in particular? | <ul style="list-style-type: none"> ▪ Policy documents ▪ One-on-one interviews | <ul style="list-style-type: none"> ▪ Provide baseline data on policies instituted to address gender issues in the selected centres if any. ▪ Procedures used to attract and retain more females into S&T programs at the graduate level. ▪ | <ul style="list-style-type: none"> ▪ Respective Government Websites ▪ Universities’ Websites ▪ centres-WACCI, WACCBIP and RWESCK | <ul style="list-style-type: none"> ▪ In-depth portrait of the case (Creswell, 2013; Stake, 2006). ▪ Qualitative thematic analysis to interpret the participants’ experiences and perceptions (Maxwell, 2013) to identify patterns and themes facilitated by Nvivo. ▪ Comparison of various sources (Stake, 2006; Yin, 2009). |
| What are the experiences of women in the S&T fields in Ghana and to what extent have they been affected by policies | <ul style="list-style-type: none"> ▪ Semi-structured one-on-one interviews. | <ul style="list-style-type: none"> ▪ I focused on the factors that hindered and the challenges women face in pursuit of higher education. as well as factors that favored women’s access and | <ul style="list-style-type: none"> ▪ Female students ▪ Female faculty ▪ Administrators | <ul style="list-style-type: none"> ▪ Qualitative thematic analysis to identify gender practices and procedures as well as experiences (Maxwell, 2013) to identify |

| Questions | Type | Rationale | Data Sources | Analysis |
|--|--|--|---|--|
| and procedures? | | <p>participation in S&T</p> <ul style="list-style-type: none"> ▪ These provided relevant information on the current institutional structures and provided recommendation on how to improve the situation if needed. | | <p>patterns and themes facilitated by Nvivo.</p> <ul style="list-style-type: none"> ▪ Triangulation of various sources (Stake, 2006; Yin, 2009). |
| What are participants' perceptions of the policies and procedures and the status of girls and young women vis à vis S&T education overall? | Semi-structured one-on-one interviews. | The interviews helped determine the participants' views and shed lights on their overall views on their status as scientists and technologists | <ul style="list-style-type: none"> ▪ Female students ▪ Female faculty ▪ Administrators | <ul style="list-style-type: none"> ▪ Qualitative thematic (Maxwell, 2013) facilitated by Nvivo. ▪ Triangulation of various sources (Stake, 2006; Yin, 2009). |

Appendix 4: Invitation to Participate in a Doctoral Research Project

Université d'Ottawa
Faculté d'éducation

University of Ottawa
Faculty of Education

Date:

Dear Participant,

You are invited to participate in a research study entitled *Women in science and technology in higher education in Ghana: Policy environments and experiences*. My name is (name removed), and I am a doctoral student specializing in Leadership, Evaluation, Curriculum and Policy Studies in the Faculty of Education at the University of Ottawa, Canada.

Purpose: The purpose of this study is to learn more about women's experiences in science and technology fields in Ghana and the extent to which they have been affected by policies and procedures. The study will examine aspects of academic and professional life including access, participation, and achievements as well as aspects of the personal lives of women related to their studies and careers in the Africa Centres of Excellence (ACE) program in Ghana. A series of one-on-one interviews will be conducted to elicit the experiences of female graduate students and/or female faculty and administrators in the ACE Program and their perception of their current status and the status of girls/young women vis à vis science and technology education overall.

Participation: Your participation will consist essentially of one audio-recorded interview session lasting approximately 45 minutes. The interview will be scheduled for a date, time and location that are convenient for you.

Risks: Since your participation in the study will entail responding to

questions related your academic and professional life, and related aspects of your personal life history, it may cause you to feel that you are sharing personal reflections and insights. Please receive my assurance that every effort will be made to respect your personal reflections in the writing and reporting of the research. Should you experience psychological distress during or after the interview, the following contact persons at the respective ACEs can be contacted for referral to the respective university health centres: (name removed) can be reached at (phone number removed) at (removed) can be reached at (email address removed).

Tel/Tél : 613-562-5804

Fax/Télé : 613-562-5144

145, Jean-Jacques Lussier
Ottawa ON K1N 6N5
Canada

www.education.uOttawa.ca

Benefits: Your participation in this study will generate knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in science and technology, as well as the experiences of women who are currently enrolled or who are teaching or are administrators in the ACE science and technology graduate programs in Ghana. Evidence attained through my research will also provide information for policy making, with regard to the promotion of women's enrolment in graduate science and technology programs in Ghana and elsewhere in Africa.

Confidentiality and Anonymity: Please receive my assurance that the information you will share will remain strictly confidential. Your anonymity will be protected by codes and pseudonyms. In rare cases due to the limited number of the pool of participants, it may be difficult to conceal the participant's identity. In such eventuality, you will be given the opportunity at the beginning of the interview to withdraw if you foresee any repercussions. The contents will be used only for the researcher's Doctoral Dissertation.

Conservation of data: The audio recordings and transcripts will be kept in a secure manner on a password protected computer. Hard copies of the transcripts will be kept in a locked filing cabinet. The data will be

destroyed after five years.

Voluntary participation: You are under no obligation to participate, and if you choose to participate, you may withdraw from the study at any time and/or refuse to answer any questions. If you choose to withdraw, all data gathered by the time of withdrawal will be destroyed.

Should you have any questions concerning this research study, you may contact me at any time by phone at (removed) or by e-mail at (removed). As part of the requirements for a Ph.D. degree in Leadership, Evaluation, Curriculum, and Policy Studies, I will conduct research under the supervision of Prof. Richard Maclure. You may contact (removed) by phone at (removed) or by email at (removed).

This study has been reviewed and received ethics clearance through the University of Ottawa's Research Ethics Board 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca. Please contact me at (phone number removed) if you are interested in participating in this study.

Sincerely,

(Signature and name removed)

Appendix 5: Interview Protocol - Students

| PERSONAL DATA | |
|---|--|
| Name: | _____ |
| Nationality: | _____ |
| Age: | 20-24 <input type="checkbox"/> 25-29 <input type="checkbox"/> 30-34 <input type="checkbox"/> 35-39 <input type="checkbox"/> 40-44 <input type="checkbox"/> 45-49 <input type="checkbox"/> 50-over <input type="checkbox"/> |
| ACE: | WACCI <input type="checkbox"/> WACCBIP <input type="checkbox"/> RWESCK <input type="checkbox"/> |
| Program of Study: | _____ |
| Level of study: | Master's <input type="checkbox"/> Doctoral <input type="checkbox"/> Postdoctoral <input type="checkbox"/> Other <input type="checkbox"/> |
| Year of Study: | First <input type="checkbox"/> Second <input type="checkbox"/> Third <input type="checkbox"/> Fourth <input type="checkbox"/> |
| Funding: Do you have a scholarship? | YES <input type="checkbox"/> NO <input type="checkbox"/> N/A <input type="checkbox"/> |
| If not, how are funding your studies? | Personal <input type="checkbox"/> Family <input type="checkbox"/> |
| Name of undergraduate institution: | _____ |
| Was it a public or private institution? | Public <input type="checkbox"/> Private <input type="checkbox"/> |
| Was the institution in a rural or an urban area? | Rural <input type="checkbox"/> Urban <input type="checkbox"/> |

STUDENTS

1) Tell me about your experiences gaining access to science and technology programs as an undergraduate and a graduate student?

- What factors impeded your recruitment, retention and achievement in graduate science and technology programs? What are the obstacles that Ghanaian females perceive in pursuing tertiary degrees in STEM disciplines?
- What factors have been favorable to your recruitment, retention and achievement in science and technology programs?

2) What policies and procedures have been put in place to overcome the problem of gender disparity in science and technology programs in Ghana? Do you know what the University is doing in support of females in S&T? Are there policies governing female's participation in S&T disciplines?

- To what extent have these policies and procedures succeeded, or failed?
- What do you think about gender affirmative action policies?
- What are your views on gender mainstreaming in science and technology programs in higher education?

3) What have been your experiences as a student in science and technology programs?

4) What are your perspectives concerning factors that affect girls' relative interest and pursuit of studying science and technology education in higher education today?

5) What are your perceptions of the status of girls and young women vis-à-vis science and technology education overall?

Comments and suggestions on how to address the issue of gender inequality in S&T programs at the graduate levels in Ghana and elsewhere in Africa

Appendix 6: Interview Protocol - Instructors

1) Tell me about your experiences gaining access to science and technology fields as a student and as an instructor?

- What factors impeded your recruitment, retention and achievement as a faculty member in science and technology education?
- What factors have been favorable to your recruitment, retention and achievement in science and technology programs?

2) What policies and procedures have been put in place to overcome the problem of gender disparity in science and technology teaching profession?

- To what extent have these policies and procedures succeeded, or failed?
- What do you think about gender affirmative action policies?
- What are your views on gender mainstreaming in science and technology programs in higher education in Ghana?

3) What have been your experiences as a female student, instructor and/or administrator in science and technology programs?

4) What do you see as the biggest challenges Ghanaian faculty face in higher education?

5) What are your perceptions of the status of girls/young women vis-à-vis science and technology education overall?

Comments and suggestions on how to address the issue of gender inequality in S&T programs at the graduate levels in Ghana and elsewhere in Africa

Appendix 7: Interview Protocol-Administrators

1) What policies and procedures have been put in place to overcome the problem of gender disparity in science and technology programs?

- What gendered affirmative action policies and procedures for science and technology education have been formulated in Ghana?
- Do you have gender mainstreaming in your programs, procedures and policies?
- If so, how have they been implemented and to what extent have they been effective?

2) Before policies have been formulated has there been any consciousness-raising of gender issues? If so, what type of consciousness-raising method has been used (workshop, advocacy etc..?)

3) To what extent have these policies and procedures succeeded, or failed?

- What challenges have you faced trying to implement these policies?
- If any, how have they been overcome?

4) What have been your experiences as a female student, instructor and/or administrator in science and technology programs?

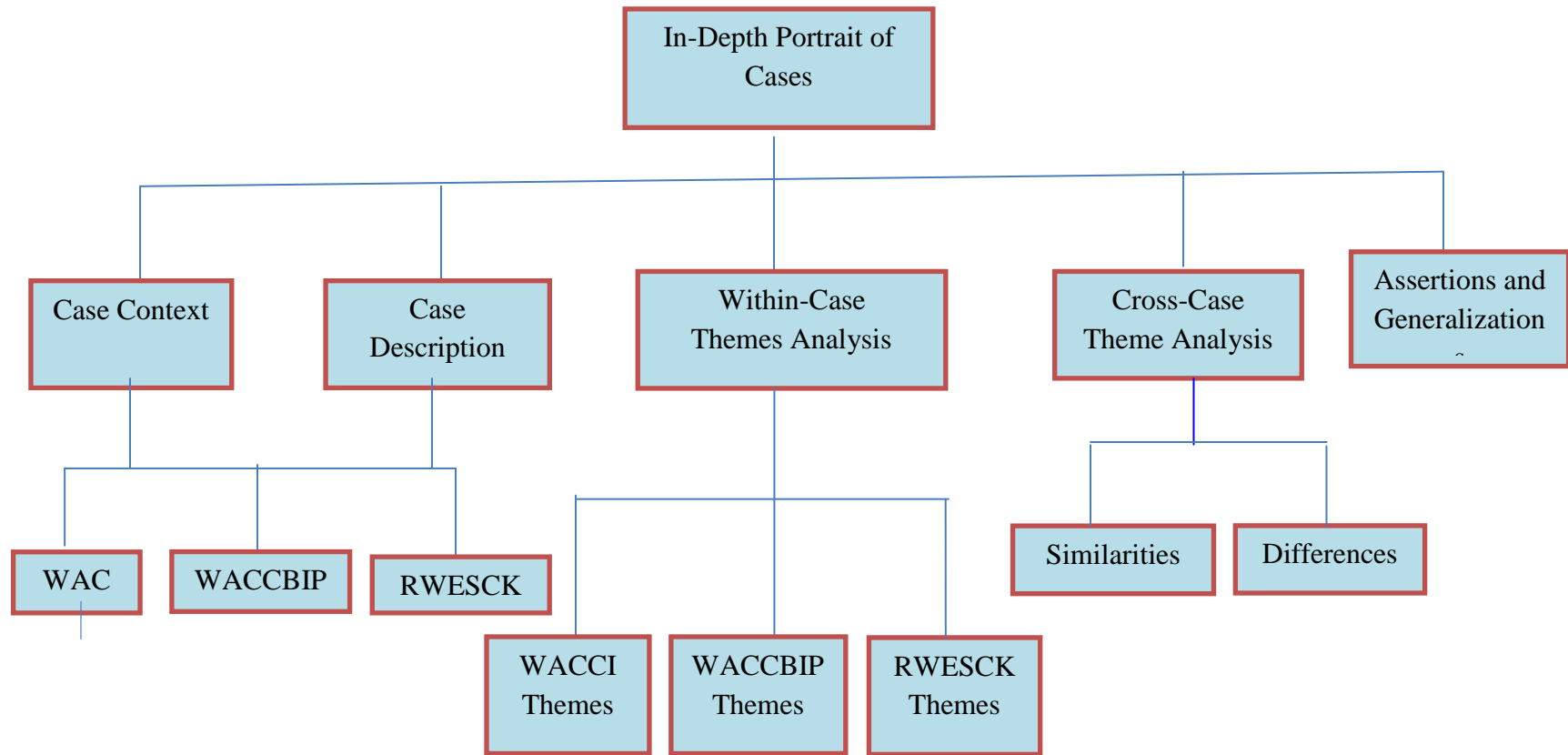
5) What are your perceptions of the status of girls/young women vis-à-vis science and technology education overall?

Comments and suggestions on how to address the issue of gender inequality in S&T programs at the graduate levels in Ghana and elsewhere in Africa

| Activity | 2017 | | | | | | | | | | | | 2018 | | | | | | | | | | | | 2019 | | | | | | | | | | | | | | | |
|--|------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|-----|-----|------|-----|------|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|------|--|--|--|--|--|--|--|--|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | May | Jun | Jul | Aug | Sept | | | | | | | | |
| Office for formal evaluation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dissertation defence, final revisions and submission | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Appendix 9: Coding the Case Study (Using a Multiple Case Approach)

Adaptation (Creswell, 2013, p. 209)



Appendix 10: Approval Letter - WACCI



WACCI West Africa Centre for Crop Improvement

University of Ghana, Legon

College of Basic and Applied Sciences (CBAS) xxxxxx.

PMB LG 30, LEGON, Accra, GHANA

Telephone: 233-307-079427 Email: info@wacci.edu.gh

December 1, 2016



Dear (name removed),

RESEARCH VISIT: (name removed)

With reference to your letter dated November 22nd 2016, I write to approve your request to conduct a research project at West Africa Centre for Crop Improvement (WACCI), University of Ghana, Legon on the topic "**Challenging gender disparities in African higher education: A case study in three science and technology centers in Ghana**".

Dr. Daniel Dzidzienyo, (copied), The Deputy Centre Leader, ACE Project, will host you during your visit

Yours sincerely,

(Signature removed)

Prof. Eric Danquah
Director, WACCI

cc: Dr. Daniel Dzidzienyo

Mrs. Jennifer Saint-Acquaye Programme Manager

Appendix 11: Approval Letter – WACCBIP



UNIVERSITY OF GHANA

West African Centre for Cell Biology of Infectious Pathogens

African Centre of Excellence for Higher Education

College of Basic and Applied Sciences



November 29, 2016

Dear (name removed),

APPROVAL TO CONDUCT RESEARCH AT WACCBIP

I write to inform you that you have been granted approval to conduct your research at the West African Centre for Cell Biology of Infectious Pathogens (WACCBIP), University of Ghana.

It is my understanding that you will be conducting a mixed methods research about the experiences of female students, faculty, administrators and staff at WACCBIP.

We look forward to meeting you.

Yours sincerely,

Appendix 12: Approval Letter - RWESCK



COLLEGE OF ENGINEERING

KWAME NKURUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Office of the Provost

Kumasi, Ghana West Africa

Tel: xxxxxx

Fax xxxxxxxx

E-mail: xxxxxx



Our Ref: CoE-RO/CONT/5

Date: 20th December, 2016

RWESCK-KUMASI

Dear (name removed)

Re: PERMISSION TO CONDUCT RESEARCH AT THE RWESCK

I write with reference to your letter number CE/ACE RWESCK/94 on the above-stated subject-matter dated 6th December, 2016. The Provost has granted permission for (name removed), a PhD student of the University of Ottawa, Canada to commence her research at the Centre.

Yours sincerely

Registrar / University Solicitor

COLLEGE OF ENGINEERING

CC:

Appendix 13: Ethics Certificate – University of Ottawa

Université d’Ottawa University of Ottawa

Bureau d’éthique et d’intégrité de la recherche

Office of Research Ethics and Integrity

Ethics Approval Notice

Social Sciences and Humanities REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

| <u>First Name</u> | <u>Last Name</u> | <u>Affiliation</u> | <u>Role</u> |
|--------------------------|-------------------------|---------------------------|--------------------|
| Richard | Maclure | Education | Supervisor |
| (removed) | | Education | Student Researcher |

File Number: 04-17-04

Type of Project: PhD Thesis

Title: Women in science and technology in higher education in Ghana: Policy environments and experiences

| Approval Date (mm/dd/yyyy) | Expiry Date (mm/dd/yyyy) | Approval Type |
|-----------------------------------|---------------------------------|----------------------|
| 05/12/2017 | 05/11/2018 | Approval |

Special Conditions / Comments:

N/A

Université d'Ottawa University of Ottawa

Bureau d'éthique et d'intégrité de la recherche

Office of Research Ethics and Integrity

This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement (2010) and other applicable laws and regulations in Ontario, has examined and approved the ethics application for the above named research project. Ethics approval is valid for the period indicated above and subject to the conditions listed in the section entitled "Special Conditions / Comments".

During the course of the project, the protocol may not be modified without prior written approval from the REB except when necessary to remove participants from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the project (e.g., change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, including consent and recruitment documentation, should be submitted to the Ethics Office for approval using the "Modification to research project" form available at: <https://research.uottawa.ca/ethics/forms>.

Please submit an annual report to the Ethics Office four weeks before the above-referenced expiry date to request a renewal of this ethics approval. To close the file, a final report must be submitted. These documents can be found at: <https://research.uottawa.ca/ethics/forms>.

If you have any questions, please do not hesitate to contact the Ethics Office at extension xxxx or by e-mail at: ethics@uOttawa.ca.

Signature:

(Signature removed)

Protocol Officer Ethics in Research

For (name removed), Social Sciences and Humanities REB

Appendix 14: Consent Form – WACCI Students



Université d'Ottawa
Faculté d'éducation

University of Ottawa
Faculty of Education

Doctoral Dissertation Research Consent Form – Students-WACCI

Name of Supervisor: Prof. Richard Maclure
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Name of Student: (removed)
Faculty of Education, University of Ottawa
Telephone: (removed); Email: (removed)

Invitation to Participate: I am invited to participate in the research study entitled *Women in science and technology in higher education in Ghana: Policy environments and experiences* conducted by (removed) for the Doctoral Dissertation.

Purpose of the Study: I understand that the purpose of the study is to learn more about women's experiences with regard to access, retention and success in science and technology fields in Ghana and the extent to which they have been affected by gender policies and procedures through a series of semi-structured one-on-one interviews to elicit the experiences of a cohort of African women in three Africa Centres of Excellence (ACE) Program namely: WACCI, WACCBIP & RWESCK, in Ghanaian university departments. My participation will help identify and assess the factors that they have had to overcome to enter and succeed in graduate studies in science and technology programs as students, instructors or administrators.

Tel/Tél : 613-562-5804

Fax/Télé : 613-562-5144

145, Jean-Jacques Lussier

Ottawa ON K1N 6N5

Canada

www.education.uOttawa.ca

Participation: My participation will consist essentially of one audio-recorded interview session of approximately 45 minutes. The interview has been scheduled for a date, time and location that are convenient for me.

Risks: Since my participation in the study will entail responding to questions related my academic and professional life, and related aspects of my personal life history, it may cause me to feel that I am sharing personal reflections and insights. I received assurance from the researcher that every effort will be made to respect my personal reflections in the writing and reporting of the research. -

Benefits: I will receive no direct benefit from my participation in this study, but my participation may help in creating awareness about women in science and technology. I may also find it personally helpful to talk about my experiences. My participation in this study will generate knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in science and technology, as well as the experiences of those women who are currently enrolled or who are teaching or are administrators in the ACE science and technology graduate programs in Ghana. Evidence attained through this research will also provide information for policy making as this relates to the promotion of women's enrolment in graduate science and technology programs in Ghana and elsewhere in Africa.

Confidentiality and Anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. The contents will be used only for the researcher's doctoral dissertation.

Conservation of data: The audio recordings and transcripts will be kept in a secure manner on a password protected computer. Hard copies of the transcripts will be kept in a locked filing cabinet. The data will be destroyed after five years.

Voluntary Participation: I am under no obligation to participate, and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed. Should you experience any psychological distress during or after the interview, please contact (removed) for referral to the health service centre at Legon.

Acceptance: I, _____, agree to participate in the above research study conducted by (removed) of the Faculty of Education under the supervision of Prof. Richard Maclure. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study.

I AGREE to have the data used for completion of the researcher's doctoral dissertation.

If I have any questions about the study, I may contact the student and/or the professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca. There are two copies of the consent form, one of which is mine to keep.

Please check one:

I agree to have my identity associated with the interview data collected

I prefer that my identity remains anonymous

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____

Appendix 15: Consent Form – WACCBIP Students



Université d'Ottawa
Faculté d'éducation

University of Ottawa
Faculty of Education

**Doctoral Dissertation Research Consent Form – Students-
WACCBIP**

Name of Supervisor: Prof. Richard Maclure
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Name of Student: (removed)
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Invitation to Participate: I am invited to participate in the research study entitled *Women in science and technology in higher education in Ghana: Policy environments and experiences* conducted by (removed) for her Doctoral Dissertation.

Purpose of the Study: I understand that the purpose of the study is to learn more about women's experiences with regard to access, retention and success in science and technology fields in Ghana and the extent to which they have been affected by gender policies and procedures through a series of semi-structured one-on-one interviews to elicit the experiences of a cohort of African women in three Africa Centres of Excellence (ACE) Program namely: WACCI, WACCBIP & RWESCK, in Ghanaian university departments. My participation will help identify and assess the factors that they have had to overcome to enter and succeed in graduate studies in science and technology programs as students, instructors or administrators.

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Ottawa ON K1N 6N5

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Participation: My participation will consist essentially of one audio-recorded interview session of approximately 45 minutes. The interview has been scheduled for a date, time and location that are convenient for me.

Risks: Since my participation in the study will entail responding to questions related my academic and professional life, and related aspects of my personal life history, it may cause me to feel that I am sharing personal reflections and insights. I received assurance from the researcher that every effort will be made to respect my personal reflections in the writing and reporting of the research. -

Benefits: I will receive no direct benefit from my participation in this study, but my participation may help in creating awareness about women in science and technology. I may also find it personally helpful to talk about my experiences. My participation in this study will generate knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in science and technology, as well as the experiences of those women who are currently enrolled or who are teaching or are administrators in the ACE science and technology graduate programs in Ghana. Evidence attained through this research will also provide information for policy making as this relates to the promotion of women's enrolment in graduate science and technology programs in Ghana and elsewhere in Africa.

Confidentiality and Anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. The contents will be used only for the researcher's doctoral dissertation.

Conservation of data: The audio recordings and transcripts will be kept in a secure manner on a password protected computer. Hard copies of the transcripts will be kept in a locked filing cabinet. The data will be destroyed after five years.

Voluntary Participation: I am under no obligation to participate, and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed.

Acceptance: I, _____, agree to participate in the above research study conducted by (removed) of the Faculty of Education under the supervision of Prof. Richard Maclure. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study.

I AGREE to have the data used for completion of the researcher's doctoral dissertation.

If I have any questions about the study, I may contact the student and/or the professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca

Should I experience any psychological distress during or after the interview, I will contact (name and address removed) (WACCBIP) for referral to the health services centre at Legon. There are two copies of the consent form, one of which is mine to keep. Please check one:

I agree to have my identity associated with the interview data collected

I prefer that my identity remains anonymous

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____

Appendix 16: Consent Form RWESCK Students



**Doctoral Dissertation Research Consent Form – Students-
RWESCK**

Université d'Ottawa
Faculté d'éducation

University of Ottawa
Faculty of Education

Name of Supervisor: Prof. Richard Maclure
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Name of Student: (removed)
Faculty of Education, University of Ottawa
Telephone: (removed); Email: (removed)

Invitation to Participate: I am invited to participate in the research study entitled *Women in science and technology in higher education in Ghana: Policy environments and experiences* conducted by (removed) for her Doctoral Dissertation.

Purpose of the Study: I understand that the purpose of the study is to learn more about women's experiences with regard to access, retention and success in science and technology fields in Ghana and the extent to which they have been affected by gender policies and procedures through a series of semi-structured one-on-one interviews to elicit the experiences of a cohort of African women in three Africa Centres of Excellence (ACE) Program namely: WACCI, WACCBIP & RWESCK, in Ghanaian university departments. My participation will help identify and assess the factors that they have had to overcome to enter and succeed in graduate studies in science and technology programs as students, instructors or administrators.

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Ottawa ON K1N 6N5

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Participation: My participation will consist essentially of one audio-recorded interview session of approximately 45 minutes. The interview has been scheduled for a date, time and location that are convenient for me.

Risks: Since my participation in the study will entail responding to questions related my academic and professional life, and related aspects of my personal life history, it may cause me to feel that I am sharing personal reflections and insights. I received assurance from the researcher that every effort will be made to respect my personal reflections in the writing and reporting of the research.

Benefits: I will receive no direct benefit from my participation in this study, but my participation may help in creating awareness about women in science and technology. I may also find it personally helpful to talk about my experiences. My participation in this study will generate knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in science and technology, as well as the experiences of those women who are currently enrolled or who are teaching or are administrators in the ACE science and technology graduate programs in Ghana. Evidence attained through this research will also provide information for policy making as this relates to the promotion of women's enrolment in graduate science and technology programs in Ghana and elsewhere in Africa.

Confidentiality and Anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. The contents will be used only for the researcher's doctoral dissertation.

Conservation of data: The audio recordings and transcripts will be kept in a secure manner on a password protected computer. Hard copies of the transcripts will be kept in a locked filing cabinet. The data will be destroyed after five years.

Voluntary Participation: I am under no obligation to participate, and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed.

Acceptance: I, _____, agree to participate in the above research study conducted by (name removed) of the Faculty of Education under the supervision of Prof. Richard Maclure. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study.

I AGREE to have the data used for completion of the researcher's doctoral dissertation.

If I have any questions about the study, I may contact the student and/or her professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca.

Should I experience any psychological distress during or after the interview, I will contact (name and address removed) for referral to the health services centre at KNUST. There are two copies of the consent

form, one of which is mine to keep. Please check one:

I agree to have my identity associated with the interview data collected

I prefer that my identity remains anonymous

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____

Appendix 17: Consent Form Instructors and Administrators-WACCI



Université d'Ottawa
Faculté d'éducation

University of Ottawa
Faculty of Education

Doctoral Dissertation Research Consent Form-Faculty & Administrators WACCI

Name of Supervisor: Prof. Richard Maclure
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Name of Student: (removed)
Faculty of Education, University of Ottawa
Telephone: (removed); Email: (removed)

Invitation to Participate: I am invited to participate in the research study entitled *Women in science and technology in higher education in Ghana: Policy environments and experiences* conducted by (name removed) for her Doctoral Dissertation.

Purpose of the Study: I understand that the purpose of the study is to learn more about women's experiences with regard to access, retention and success in science and technology fields in Ghana and the extent to which they have been affected by gender policies and procedures through a series of semi-structured one-on-one interviews to elicit the experiences of a cohort of African women in three Africa Centres of Excellence (ACE) Program namely: WACCI, WACCBIP & RWESCK, in Ghanaian university departments. My participation will help identify and assess the factors that they have had to overcome to enter and succeed in graduate studies in science and technology programs as students, instructors or administrators.

Participation: My participation will consist essentially of one audio-recorded interview session of approximately 45 minutes. The interview has been scheduled for a date, time and location that are convenient for me.

Risks: Since my participation in the study will entail responding to questions related my academic and professional life, and related aspects of my personal life history, it may cause me to feel that I am sharing personal reflections and insights. I received assurance from the researcher that every effort will be made to respect my personal reflections in the writing and reporting of the research.

Benefits: I will receive no direct benefit from my participation in this study, but my participation may help in creating awareness about women in science and technology. I may also find it personally helpful to talk about my experiences. My participation in this study will generate knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in science and technology, as well as the experiences of those women who are currently enrolled or who are teaching or are administrators in the ACE science and technology graduate programs in Ghana. Evidence attained through this research will also provide information for policy making as this relates to the promotion of women's enrolment in graduate science and technology programs in Ghana and elsewhere in Africa.

Confidentiality and Anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. Given the fact that there may be limited numbers of administrators and faculty, it may be hard to totally conceal the identity of the participants. In that case, I will be informed at the

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beginning of the interview to give me the opportunity to withdraw should there be any repercussions. The contents will be used only for the researcher's doctoral dissertation.

Conservation of data: The audio recordings and transcripts will be kept in a secure manner on a password protected computer. Hard copies of the transcripts will be kept in a locked filing cabinet. The data will be destroyed after five years.

Voluntary Participation: I am under no obligation to participate, and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed.

Acceptance: I, _____, agree to participate in the above research study conducted by (name removed) of the Faculty of Education under the supervision of Prof. Richard Maclure. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study.

I AGREE to have the data used for completion of the researcher's doctoral dissertation.

If I have any questions about the study, I may contact the student and/or her professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca.

Should I experience any psychological distress during or after the interview, I will contact (name and email address removed) for referral to the health services centre at Legon. There are two copies of the consent form, one of which is mine to keep. Please check one:

I agree to have my identity associated with the interview data collected

I prefer that my identity remains anonymous

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____

Appendix 18: Consent Form-Instructors & Administrators-WACCBIP



uOttawa

**Doctoral Dissertation Research Consent Form-Inst. & Adm.
WACCBIP**

Name of Supervisor: Prof. Richard Maclure
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Name of Student: (removed)
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Invitation to Participate: I am invited to participate in the research study entitled *Women in science and technology in higher education in Ghana: Policy environments and experiences* conducted by (name removed) for her Doctoral Dissertation.

Purpose of the Study: I understand that the purpose of the study is to learn more about women's experiences with regard to access, retention and success in science and technology fields in Ghana and the extent to which they have been affected by gender policies and procedures through a series of semi-structured one-on-one interviews to elicit the experiences of a cohort of African women in three Africa Centres of Excellence (ACE) Program namely: WACCI, WACCBIP & RWESCK, in Ghanaian university departments. My participation will help identify and assess the factors that they have had to overcome to enter and succeed in graduate studies in science and technology programs as students, instructors or administrators.

Université d'Ottawa
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Faculty of Education

Participation: My participation will consist essentially of one audio-recorded interview session of approximately 45 minutes. The interview has been scheduled for a date, time and location that are convenient for me.

Risks: Since my participation in the study will entail responding to questions related my academic and professional life, and related aspects of my personal life history, it may cause me to feel that I am sharing personal reflections and insights. I received assurance from the researcher that every effort will be made to respect my personal reflections in the writing and reporting of the research.

Benefits: I will receive no direct benefit from my participation in this study, but my participation may help in creating awareness about women in science and technology. I may also find it personally helpful to talk about my experiences. My participation in this study will generate knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in science and technology, as well as the experiences of those women who are currently enrolled or who are teaching or are administrators in the ACE science and technology graduate programs in Ghana. Evidence attained through this research will also provide information for policy making as this relates to the promotion of women's enrolment in graduate science and technology programs in Ghana and elsewhere in Africa.

Confidentiality and Anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. Given the fact that there may be limited numbers of administrators and faculty, it may be hard to totally conceal the identity of the participants. In that case, I will be informed at the beginning of the interview to give me the opportunity to withdraw should there be any

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repercussions. The contents will be used only for the researcher's doctoral dissertation.

Conservation of data: The audio recordings and transcripts will be kept in a secure manner on a password protected computer. Hard copies of the transcripts will be kept in a locked filing cabinet. The data will be destroyed after five years.

Voluntary Participation: I am under no obligation to participate, and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed.

Acceptance: I, _____, agree to participate in the above research study conducted by (name removed) of the Faculty of Education under the supervision of Prof. Richard Maclure. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study.

I AGREE to have the data used for completion of the researcher's doctoral dissertation.

If I have any questions about the study, I may contact the student and/or her professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca

Should I experience any psychological distress during or after the interview, I will contact (name and address removed) for referral to the health services centre at Legon. There are two copies of the consent form, one of which is mine to keep. Please check one:

- I agree to have my identity associated with the interview data collected
- I prefer that my identity remains anonymous

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____

Appendix 19: Consent Form-Instructors & Administrators-RWESCK



Université d'Ottawa
Faculté d'éducation

University of Ottawa
Faculty of Education

Ethics Consent Form Faculty & Administrators RWESCK

Name of Supervisor: Prof. Richard Maclure
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Name of Student: (removed)
Faculty of Education, University of Ottawa
Telephone: (removed) / Email: (removed)

Invitation to Participate: I am invited to participate in the research study entitled *Women in science and technology in higher education in Ghana: Policy environments and experiences* conducted by (removed) for her Doctoral Dissertation.

Purpose of the Study: I understand that the purpose of the study is to learn more about women's experiences with regard to access, retention and success in science and technology fields in Ghana and the extent to which they have been affected by gender policies and procedures through a series of semi-structured one-on-one interviews to elicit the experiences of a cohort of African women in three Africa Centre of Excellence (ACE) Program namely: WACCI, WACCBIP & RWESCK, in Ghanaian university departments. My participation will help identify and assess the factors that they have had to overcome to enter and succeed in graduate studies in science and technology programs as students, instructors or administrators.

Participation: My participation will consist essentially of one audio-recorded interview session of approximately 45 minutes. The interview has been scheduled for a date, time and location that are convenient for me.

Risks: Since my participation in the study will entail responding to questions related my academic and professional life, and related aspects of my personal life history, it may cause me to feel that I am sharing personal reflections and insights. I received assurance from the researcher that every effort will be made to respect my personal reflections in the writing and reporting of the research.

Benefits: I will receive no direct benefit from my participation in this study, but my participation may help in creating awareness about women in science and technology. I may also find it personally helpful to talk about my experiences. My participation in this study will generate knowledge on the factors that impede and /or enhance women's efforts to pursue advanced degrees in science and technology, as well as the experiences of those women who are currently enrolled or who are teaching or are administrators in the ACE science and technology graduate programs in Ghana. Evidence attained through this research will also provide information for policy-making as this relates to the promotion of women's enrolment in graduate science and technology programs in Ghana and elsewhere in Africa.

Confidentiality and Anonymity: I have received assurance from the researcher that the information I will share will remain strictly confidential. Given the fact that there may be limited numbers of administrators and faculty, it may be hard to totally conceal the identity of the participants. In that case, I will be informed at the beginning of the interview to give me the opportunity to withdraw

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should there be any repercussions. The contents will be used only for the researcher's doctoral dissertation.

Conservation of data: The audio recordings and transcripts will be kept in a secure manner on a password protected computer. Hard copies of the transcripts will be kept in a locked filing cabinet. The data will be destroyed after five years.

Voluntary Participation: I am under no obligation to participate, and if I choose to participate, I may withdraw from the study at any time and/or refuse to answer any questions. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed.

Acceptance: I, _____, agree to participate in the above research study conducted by (name removed) of the Faculty of Education under the supervision of Prof, Richard Maclure. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study.

I AGREE to have the data used for completion of the researcher's doctoral dissertation.

If I have any questions about the study, I may contact the student and/or her professor at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca.

Should I experience any psychological distress during or after the interview, I will contact (name removed) (RWESCK) for referral to

the health services centre at Legon. There are two copies of the consent form, one of which is mine to keep. Please check one:

- I agree to have my identity associated with the interview data collected
- I prefer that my identity remains anonymous

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____