

**EXPLORING ENABLING INTERVENTIONS FOR INCREASING FEMALE
STUDENTS' ACCESS AND PARTICIPATION IN SCIENCE, TECHNOLOGY,
ENGINEERING AND MATHEMATICS (STEM) DISCIPLINES
IN KENYAN PUBLIC UNIVERSITIES**

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university. The thesis has been complemented by referenced sources duly acknowledged. Where text data, graphics, pictures or tables have been borrowed from other works including the Internet, the sources are specifically accredited through referencing in accordance with anti-plagiarism regulations.

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DEDICATION

To my late mother, Leah Wanjue Francis who dedicated her life to my studies and gave me hope even when everything seemed hopeless.

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TABLE OF CONTENTS

DECLARATION.....	ii
DEDICATION.....	iii
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF PLATES	xi
ABBREVIATIONS AND ACRONYMS.....	xii
ABSTRACT.....	xiii
CHAPTER ONE: INTRODUCTION AND BACKGROUND OF THE STUDY	1
1.1 Introduction	1
1.2 Background to the Study	1
1.2.1 The Status of Female Participation in STEM Disciplines Globally	1
1.2.2 Importance of Women Participation in STEM.....	4
1.2.3 Female Participation in STEM Disciplines in Kenyan Public Universities: Trends, Interventions	5
1.3 Statement of the Problem	10
1.4 Study Objectives	11
1.5 Research Questions	12
1.6 Significance of the Study	12
1.7 Limitations of the Study	13
1.8 Delimitation of the Study	14
1.9 Assumptions of the Study	15
1.10 Theoretical Framework	15
1.11 Operational Definition of Terms	21
1.12 Organisation of the Study.....	24
CHAPTER TWO: REVIEW OF RELATED LITERATURE.....	25
2.1 Introduction	25
2.2 Trends of Female Students Participation in STEM Disciplines in Universities ...	25

2.3 Female Student’s Participation in STEM Disciplines in Kenyan Public Universities in a Global Context	29
2.4 Institutional based Limitations to Female Student Participation in STEM	34
2.5 Gender Responsiveness of the STEM Curriculum	38
2.6 Existing Educational Policies and Interventions to Increase Female Students	48
2.7 Summary of Literature Reviewed and Study Gaps	52
CHAPTER THREE: RESEARCH METHODOLOGY	54
3.1 Introduction	54
3.2 Research Design	54
3.3 Study Locale	55
3.4 Target Population	55
3.5 Sampling Techniques and Sample	56
3.5.1 Sampling Techniques	56
3.5.2 Sample Size	57
3.6 Research Instruments	60
3.6.1 Questionnaires	61
3.6.2 Interview Schedules	61
3.6.3 Focus Group Discussion Guides	62
3.6.4 Documentary Analysis Framework	64
3.6.5 Content Analysis Guide	65
3.6.6 Observation Guide	66
3.7 Pilot Study	67
3.7.1 Validity of the Instruments	67
3.7.2 Reliability of the Instruments	68
3.8 Data Collection Procedure	69
3.8.1 Data Collection	69
3.8.2 Administering the Questionnaires	69
3.8.3 The Interviewing Process	69
3.8.4 Secondary Data Collection	70

3.9 Data Analysis and Presentation.....	70
3.10 Logistical Considerations (permit).....	71
3.11 Ethical Considerations.....	71
CHAPTER FOUR: PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION	72
4.1 Introduction	72
4.2 Characteristics of the Study Sample.....	73
4.3 Demographic Information of Participants by Their Universities.....	74
4.4 Trends in Female Student’s Access to STEM Disciplines.....	74
4.4.1 Trends in Students’ Access to STEM Disciplines in the Seven Kenyan Public Universities in the Period Between 2009 and 2013	75
4.4.2 JKUAT Female Enrolment in SSP and KUCCPS in STEM Disciplines	77
4.5 Female Students’ Participation in STEM Disciplines in Kenyan Public Universities.....	93
4.5.1 STEM Students Performance Based on Degree Classification	100
4.6 Institutional Based Limitations to Female Student Participation in STEM Disciplines	106
4.6.1 Existence of STEM Role Models in Secondary School and University	107
4.6.2 Category of Secondary Schools Attended	114
4.6.3 STEM Students Perceptions of the Effectiveness of the Former Secondary Schools Resources in Relation to Performance in Mathematics and Science Subjects	115
4.6.4 Career Guidance of Female Students at the University	122
4.6.5 Other Institutional Challenges Affecting Female Students participation in STEM	124
4.6.6 Opinion on the effects of venturing into STEM Disciplines on the future lives of Female Students Pursuing STEM Disciplines	129
4.7 Gender Responsiveness of STEM Curriculum in Universities.....	134
4.7.1 Gender Responsiveness of the STEM Resources.....	135

4.7.2: Location of Diagram's of Male/Female in the Sampled STEM Text Books	142
4.7.3 STEM Physical Facilities	151
4.7.4 STEM Classroom Teaching and Learning Process	154
4.8 Existing Institutional Interventions to Increase Female Participation in STEM	
Disciplines in Universities.....	157
4.8.1 Self Sponsored Programme (SSP).....	157
4.8.2 Financial Aid for Needy Female Students Pursuing STEM Disciplines.....	159
4.8.3 Affirmative Action Policy	166
4.8.4 Proposed Interventions to Increase Female Participation in STEM	
Disciplines	173
4.9 Summary Conclusions.....	178
CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS	180
5.1 Introduction	180
5.2 Summary	180
5.2.1 Trends in Female Student's Access in STEM Disciplines	180
5.2.2 Participation Trends in UoN, JKUAT and Egerton Universities in the Years Between 2009 - 2013	181
5.2.3 Institutional Based Limitations of Female Students to Participation in STEM Disciplines	181
5.2.4 Gender Responsiveness of STEM Curriculum.....	182
5.2.5 Existing Educational Policy for Gender Equality Interventions	183
5.3 Conclusions	184
5.4 Recommendations	186
5.4.1 Policy Recommendations	186
5.4.2 Recommendations for Further Research	187
5.4.3 Study Contributions to Knowledge	188
REFERENCES.....	189
APPENDICES.....	205

LIST OF TABLES

Table 3.1: Sampling Matrix	58
Table 3.2 Questionnaires Distribution of STEM Female Students.....	59
Table 3.3: Sample Matrix of FGD and Other Key Informants	60
Table 3.4 Distribution of FGD Respondents in STEM disciplines	64
Table 4.1 Demographic Information of Participants by Universities	74
Table 4.2: JKUAT Comparative Enrolments for Female KUCCPS and SSP STEM Student in 2012/2013 Academic Year	78
Table 4.3: Cross Tabulation of Mode of Admission and Female Enrolment in STEM Disciplines in JKUAT 2012/2013.....	80
Table 4.4: Trends in Number of Undergraduate Medical Students by Course and Sex between 2010-2013 Academic Years	82
Table 4.5: KUCCPS STEM Admission Trends in the Three Selected Public Universities for the Years Between 2009 to 2013	84
Table 4.6: Students Enrolment in Soft and Hard Sciences Cross Tabulation.....	86
Table 4.7 Progression Rates of Female Students at Egerton University in 2008-2013 Academic Years	97
Table: 4.8: STEM Students Performance Between 2009-2013 Academic years	101
Table 4.9: Key Career Guidance for Female Students in the Three Selected Universities	122
Table 4.10: Matrix of Selected STEM Textbooks	137
Table 4.11: Female Beneficiaries of the AA by Various Programmes Cumulatively Between 2009-2013 Academic Years.....	167
Table 4.12: Female Enrolment and Proportion of Female Beneficiaries of AA by the Various Programmes in UON, Egerton and JKUAT (Year 2011/2012)	169

LIST OF FIGURES

Figure 1.1: Policy Review and Interventions for Female Students Participation in STEM Disciplines in Public Universities.....	20
Figure 4.1: KUCCPS STEM Admission Trends for Seven Public Universities Between 2009 and 2013.....	76
Figure 4.2: Female Respondents Perceptions on Female Students' Enrolment in STEM Disciplines.....	88
Figure 4.3: Female Students Respondents' Perceptions that KCSE Performance in Mathematics and Sciences Contributes to Few female Enrolments in STEM Disciplines.....	88
Figure 4.4: Female Students Respondents' Perceptions that Societal Stereotypes Contribute to Few Female Enrolments in STEM Disciplines	89
Figure 4.5: Completion Rates of KUCCPS and SSP STEM Students at Egerton University in 2008/9 and 2012/13.....	94
Figure 4.6: Completion Rates of KUCCPS and SSP UON and JKUAT STEM Students in 2008/9 and 2012/13.....	96
Figure 4.7: Sampled Universities Comparative Graduation Trends between 2009-2013 Academic Years	99
Figure 4.8: Perceptions of Female Respondents on Female Students Participation.....	104
Figure 4.9: Female Respondents Perceptions on Limitations to Participation of Female Students in STEM Disciplines	107
Figure 4.10: Distribution of JKUAT and Egerton STEM Lecturers by Gender and Grade in 2014/2015 Academic Year.....	108
Figure 4.11: Academic Level of University of Nairobi Lecturers by Gender	109
Figure 4.12: Female Respondents Perceptions of the Effect of the Former Secondary Schools Preparedness to Science Subjects.....	116
Figure 4.13: Challenges Facing Female Students Pursuing STEM Disciplines at the University.....	125
Figure 4.14: Perceptions of Respondents on Implications of Venturing into STEM Disciplines on Future Life	129
Figure 4.15: Perceptions of Female STEM Students Towards STEM Learning Environment.....	144
Figure 4.16: Perception of Respondents on Inadequacy STEM Physical Facilities.....	151

LIST OF PLATES

Plate 4.1: Male Engineers Performing Civil Engineering Fibre Glass Project..... 140

Plate 4.2: Man Demonstrating to a Woman the Application of a Computer Programme141

Plate 4.3: A Chart in a University STEM Laboratory 146

Plate 4.4: A Picture of a University STEM Woodwork Workshop..... 147

ABBREVIATIONS AND ACRONYMS

AA	Affirmative Action
EFA	Education for All
FAWE	Forum for African Women Educationalists
GM	Gender Mainstreaming
GoK	Government of Kenya
HELB	Higher Education Loan Board
KUCCPS	Kenya Universities and Colleges Central Placement Service Formerly Joint Admissions Board
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KNBS	Kenya National Bureau of Statistics
KU	Kenyatta University
MDGs	Millennium Development Goals
MMUST	Masinde Muliro University of Science and Technology
MoEST	Ministry of Education Science and Technology
NACOSTI	National Council for Science Technology and Innovation
Ph.D	Doctor of Philosophy
SDGs	Sustainable Development Goals
SSP	Self Sponsored Programmes
STEM	Science Technology Engineering and Mathematics
UoN	University of Nairobi

ABSTRACT

Globally, studies continue to document disparities in women's access and participation in Science, Technology, Engineering and Mathematics (STEM) disciplines in the universities. In developing countries such as Kenya, such disparities are more structural and systematic. Despite existence of policies at the national and institutional level, no single and clear road mark exists on what set of interventions can best contribute to redressing this disparities. This study draws attention to the low participation of female students in STEM disciplines and especially in hard sciences in Kenyan public universities. Some studies, at the global level do indicate closing of the gender gap in some of the STEM disciplines, while in others, there is a regression leading to gendered dimensions even within the STEM disciplines. This study was conceptualized to explore interventions that are being implemented to enable access and participation of female students in Kenyan public universities. The study conceptualized participation to include: initial enrolment, persistence through a course of study, completion and graduation. Literature review for the study did reveal the persistence of socio-cultural and institutional barriers in limiting female students from participating in STEM disciplines. Three theoretical models; Social constructionist, the pipeline and the deficit model guided this study and illuminate how society persistently pushes women to partake stereotypically feminine STEM disciplines. The study utilized a descriptive survey design. Data for the study were collected in three public universities that were purposively sampled. Questionnaires, interviews, observations, content and documentary analysis were used as key instruments for data collection. Data were analyzed both quantitatively and qualitatively. The study findings revealed that, despite the existing educational gender interventions, female students' enrolment and participation in STEM disciplines in the Kenyan public universities is 30% and less than 20% in hard sciences. The study also established that a continues process of gender typing of the school curriculum which the students pick from their high schools, and which continues to manifest in universities has created a false perception among female students that soft science marketable for the female gender and are feminine compared to the hard sciences. Existence of socio-cultural and institutional barriers affects female students' participation in STEM disciplines. The study established that the following interventions if implemented at the institutions would enhance female participation in STEM disciplines. First, the government and universities need to develop educational STEM policies and interventions to increase female participation in STEM disciplines. Second, the STEM curricula should be made gender responsive with integration of additional STEM female faculty members to act as mentors to female students. Appropriate STEM mentoring and career guidance should be enhanced at all levels of education and all educational stakeholders should be involved in minimising socio-cultural, institutional barriers and stereotypes on masculinity of STEM disciplines.

CHAPTER ONE

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 Introduction

This chapter presents the background to the study, statement of the problem, objectives and research questions. It further gives the significance of the study, limitations and delimitations, assumptions, theoretical and conceptual framework and operational definition of terms.

1.2 Background to the Study

This section presents background information relating to how Science, Technology, Engineering and Mathematics (STEM) disciplines have been conceptualized, the status of female participation in STEM disciplines worldwide and the existing interventions to address gender disparity in STEM disciplines. It highlights the importance of female students' participation in STEM disciplines. The section, further gives a background to the increasing concern for the low female students' participation in STEM disciplines in Kenyan public universities.

1.2.1 The Status of Female Participation in STEM Disciplines Globally

Globally, under-representation of women in Engineering, Manufacturing and Construction, Agriculture, Mathematics, Medicine and Computer Science continue to draw concerns because of the associated development challenges this that under-representation occasions. Literature shows that female students participating in STEM range from 30-35% (National Science Board [NSB], 2010). When women of all socio-economic backgrounds enter universities, they are often concentrated in subjects

associated with low-wage sectors of the economy. STEM disciplines have the capacity to offer students opportunities to make sense to the world holistically, rather than in bits and pieces (Fisher, 2009). STEM disciplines follow interdisciplinary approaches to learning where rigorous academic concepts are coupled with real-world lessons as students apply STEM disciplines in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new world economy (Knight, Mappen & Knight, 2011).

According to NSB (2010), despite the importance of STEM disciplines, studies on university students' participation continue to show that access, retention and completion rates in the disciplines are in most cases determined by gender, with few women participating and completing studies in the STEM disciplines. In situations where they complete, their graduation scores are low compared to those of males. This situation is true of both developed and developing countries. The number of women earning degrees in STEM declines as they move through the educational ladder, a phenomenon referred to metaphorically as the "leaky pipeline". At university level, global data shows the percentage of women pursuing STEM disciplines is on the decline (NSB, 2010). In 2007, the global median share of female students at universities was 21 per cent in engineering, manufacturing and construction. Further, because world and regional data can hide wide variations across countries, studies done in the USA show that nationally, whereas women earn 57% of all bachelors' degrees, they constitute only 39% of those awarded in STEM disciplines (National Science Foundation [NSF], 2008; NSB, 2010; Knight et al., 2011). In Engineering, trends have stagnated and are highly variable within

sub-fields with women earning 35% of Chemical Engineering degrees, but only 19% in Electrical Engineering, 19% of Computer Engineering degrees and 21% of Physics degrees in 2007 (Knight et al., 2011; NSB,2010).

More worrisome is emerging evidence that even within the STEM disciplines, any increase in the participation of female students is met with the emergence of more gendered binaries between what society considered STEM subjects for the female gender and that which are not. Studies from the United States and Europe document that in 2010 women were well-represented among those who earned bachelor's degrees in the biological and agricultural sciences (60%), yet earned significantly fewer degrees in both mathematics and computer sciences (27%), as well as in engineering (19%). While 51% of all bachelors degrees in science and engineering are earned by women, only 45% of masters degrees and 39% of doctorates in these fields are earned by women, compared to 61% of bachelors degrees, 63% of masters degrees and 58% of doctorates earned by women in other fields (National Science Foundation [NSF], 2008). While the participation of women in STEM is still low in USA, it is worth noting that it is among the highest in the world (NSB, 2010). In respect of engineering, women constitute 49 per cent of students in Uruguay and 46 per cent in Mongolia, compared with 12 per cent in Japan and Uzbekistan, and 5 per cent in Cambodia (UNESCO, 2010). The scenario in USA and Europe seems better than other areas on the globe due to more effective policies and interventions that address gender disparity in STEM disciplines such as mentoring programmes, gender friendly curriculum and financial aid among other interventions (National Council of Science and Technology [NCST], 2014).

In Africa, university enrolment and participation indicate that while women participation in STEM disciplines is minimal, the greater gender imbalance is in Engineering, where one in four students was a woman in August 2010 (Mlambo, 2011). The same trend exist in Guinea, which has the lowest percentage of women in science (5.8%) (Mlambo, 2011). University enrolment in Lesotho and Cape Verde has attained gender parity in STEM disciplines with Lesotho (55.7%) and Cape Verde (52.3%). Kenyan female students constitute about 40% of students enrolment in the universities. In the STEM disciplines female enrolments average at less than 30% (Onsongo, 2009). This low enrolment of female students in STEM disciplines is the motivation for the current study.

1.2.2 Importance of Women Participation in STEM

Women should be scientifically and technologically literate if they are to fully participate in national development as equal citizens. Importantly, equal access to scientific and technological knowledge and skills by women is first a rights issue, in as much as education is a basic human right. Hill et al., (2013) argue that STEM disciplines should help students to be; problem-solvers, inventors, self-reliant, logical thinkers and technologically literate so as to apply technology appropriately. Accordingly, the United Nations, Economic and Social Council Report on the Status of Women (2010) argues that STEM and innovation can be a tool with which to accelerate the achievement of vision 2030 and the internationally agreed development goals, including the Sustainable Millennium Development Goals. The Kenya vision 2030 considers gender inequality as one of the key development challenges facing the country. The Vision assumes that the economic pillar is gender neutral despite the differential impact of economic policies on

men and women. Gender differences arise as a result of the different roles played by men and women in the society. Gender disparities exist in terms of access, ownership and control of productive resources, as well as differences in capabilities (KNBS, 2015). The country, therefore, has no choice but to make massive investment in STEM disciplines if all the set targets will be achieved. According to Forum for African Women Educationist (2014), to achieve the goals, well articulated in vision 2030, science and technology must be given due recognition and integrated in the structure of the economy.

Knowledge and skills gained through the study of STEM facilitate efforts to eradicate poverty, achieve food security, fight diseases, improve education and respond to the challenges of climate change (Onsongo, 2009). Further, empowering women in STEM can widen the pool of human resources available to perform the tasks that will help in actualising Kenya's development vision Year 2030 (KNBS, 2013) Therefore, it is critical that female students access education at all levels and acquire relevant work skills, particularly in STEM disciplines.

1.2.3 Female Participation in STEM Disciplines in Kenyan Public Universities: Trends, Interventions

The onset of Free Primary Education and interventions in secondary education has contributed to narrow the gap in participation between boys and girls in Kenya. But reforms in university education seem not to have made a significant equal impact. Female students at Form Four do not perform as high as boys, thus few qualify to join STEM disciplines in the public universities under Kenya Universities and Colleges Central Placement Service (KUCCPS).

According to UNESCO (2013), the transition rate of girls from primary to secondary level is 75%. Less than 35% female students join public universities with an average of 25.5% enrolling in STEM disciplines. The performance of girls in KCSE is a key determining factor for their access to University education and admission to STEM professional programmes such as Engineering, Medicine, and Actuarial Science. These STEM disciplines require high grades in Science subjects and Mathematics at KCSE level (Oanda & Akudolu, 2010). The overall performance of girls in KCSE in 2011 and 2012 indicates that their performance was below that of boys. For instance, in 2011 a total of 1930 candidates scored an average of Grade A in KCSE, of whom 31% were girls.

According to the Kenya National Examinations Council (KNEC), of 930 students scored an average of grade A in KCSE in 2009, 301 (32%) were girls while the proportion of girls achieving the grade A was 632 (40%) out of 1566 in 2010 (KNBS, 2011). Similarly, the KCSE mean results shows poor performance of female students compared to males in STEM subjects hence lower representation in universities in STEM disciplines. In 2010, females cumulative mean in Maths, Biology, Chemistry was 19.71, 26.99 and 22.80 compared to males cumulative mean in same subjects, which were 25.75, 31.24 and 26.62. Physics is critical for pursuance of any technological discipline at the university, yet the number of girls taking it is dismally low. The percentage of girls during 2011 and 2012 were at 35.55 and 35.48 respectively (KNBS, 2011; 2012).

This means that few girls are able to compete for degree programmes in Kenya Universities and Colleges Central Placement Service (KUCCPS) that require high level of performance in KCSE and especially in STEM disciplines all of which require a mean grade of A. For this reason, female students will not only be under represented in universities but more so in professional programmes (Chege & Sifuna, 2006; Bunyi, 2008; Mugenda et al., 2010; Kapinga, 2010; Ohara, 2010 & Oanda and Akudolu, 2010). The idea of exploring interventions, which this study addresses focuses on how public universities can sustain the gains that have been achieved in primary and secondary education by enrolling more female students in STEM disciplines. Research has shown that when the access is opened through the private scheme of public universities, more female students enrol in a range of STEM disciplines. But this option is also limited since it is only female students from economically able backgrounds who can afford the private alternative, while a majority of females from poor backgrounds, irrespective of their desire to enrol in STEM are locked out. What is needed are interventions by the institutions that are not blind to gender and socio-economic background and which give all female students an equal chance of enrolling and completing in STEM disciplines (UNESCO, 2010).

A study undertaken by UNESCO and the Kenya National Council of Science and Technology (2010), documents the continued under-participation of women in STEM disciplines at all levels. In 2009, some ten (10) universities and colleges in Kenya (public and private) had 41% of their students being female, while only 17% of these were registered in STEM related disciplines. The UNESCO figures indicate that Engineering

disciplines have the lowest female participation of less than 10% (UNESCO, 2010). This under representation of female students in engineering disciplines proves that a great section of Kenyan population has been left out from the benefits inherent in STEM disciplines. The society generally, is likely to suffer human resources deficits by neglecting a half of its population from Science and Technology (UNESCO, 2010).

In response to this problem governments and universities have put in place gender equity interventions in form of gender policies in education such as the Affirmative Action, engendering tertiary institutions, remedial disciplines, interfaculty transfers, financial aid and the self-sponsored programmes(SSP) to mainstream gender equity into STEM disciplines (Bunyi, 2003; Kapinga, 2010). Countries such as Ghana, Kenya, Uganda, Tanzania and Zimbabwe, among others, have articulated and implemented these policies to allow female candidates who have attained the minimum required marks to enter public universities at between 1 and 1.5 points (and 2 points in the case of Zimbabwe) below males (Bunyi, 2008; Mlama, 2001; Musisi, 2001).

In some countries, instead of or in addition to allowing women to enter universities at lower cut-off points, remedial disciplines are offered for particular university disciplines for the female students. For example, in Eritrea and Tanzania, to increase the number of female students in universities, a bridging course and pre-entry programmes have been implemented. Within this initiative, female students who lack the required academic grades for admission into teachers' training programmes enrol for the bridging course at

the end of which they are examined. Those who attain the required grades are admitted in the universities (Kapinga, 2010).

Engendering tertiary institutions is another intervention, African tertiary institutions were established and organized to meet the needs of male students. Consequently, in their culture and even in the infrastructure many of them are unresponsive to the needs of female students (Kapinga, 2010). According to Mapetla (1997), the National University of Lesotho, gender advocacy and support groups established units to teach and carry out gender research with a strong component of activism for gender equity in universities. The idea was to use the research findings as a basis for advocacy for gender equity. Arising from such research, the following interventions have been put in place in universities: Policies to combat sexual harassment, providing appropriate accommodation for female students, gender equity units, gender forums, gender committees and gender task forces, gender studies courses, gender sensitization, and increasing the number of and raising the levels of women academics and administrators to act as role models (Bunyi, 2003; Kapinga, 2010; Mlambo, 2011).

Although Kenya's public universities to increase access and participation of women students since 2001 have used affirmative action measures, this has only increased the number of female students being admitted to university but not necessarily in STEM discipline. Hill et al., (2013), point out that tackling the persistent low participation rates of women in STEM disciplines requires a holistic approach. The current study sought to

explore interventions for encouraging female students' participation in STEM disciplines in Kenyan public universities.

1.3 Statement of the Problem

Despite the Kenya government's gender equity and equality policies and interventions that have been in existence since 2000 such as the Affirmative Action, introduction of self-sponsored programmes (SSP), offering of financial aids, engendering of tertiary institutions, gender sensitization and outreach programmes towards female participation in universities, there is still evidence of low access and participation of female students pursuing STEM disciplines in universities. The continued under-representation of female students in STEM disciplines hinges on the fact that policies by the government and the educational institutions are not fully implemented at the institutional level and/or are not adequate to ensure female students have an equal chance of enrolling and completing a course in STEM. For instance, the AA in itself has a limitation because as practised in Kenya, it widens female access to universities but not necessarily to STEM disciplines. It would also be that public universities are not providing female students with sustainable interventions to enrol and successfully pursue courses in STEM. Globally, female students in universities generally comprise about 30% of the total number of students whereby many countries fall well below this figure with larger gender disparities more prevalent in the STEM disciplines.

In the developed countries, female students constitute 39% in STEM disciplines compared to countries in Africa whereby research gives one in four engineering students

being a woman. Kenyan female students constitute about 40% with STEM enrolments in Africa averaging 30% and 25% in Kenya respectively. These figures point to a problem that raises concerns with regard to female participation in STEM disciplines in Kenyan universities and confirms that past interventions have not worked to increase female access and participation in STEM. These concerns form the basis of this study whose overriding objective is to explore interventions that might help to address problem of gender disparity in the access and participation of female students in STEM disciplines. As Kenyan society embraces technology as a tool for development, leaving out majority of the population from STEM disciplines has potential negative implication for attainment of an industrialised nation as proposed in Kenya's vision 2030. In addition, the continued low participation of women in STEM disciplines means that any benefits that have been shown to accrue from increased female participation in STEM, including contribution to increased productivity and socio-economic development might be difficult to realize. The essence of this study is, therefore, to explore interventions for encouraging female students' access and participation in STEM disciplines in public universities in Kenya with a view to recommending viable interventions.

1.4 Study Objectives

- i. Establish trends in female student's access to STEM disciplines in Kenyan public universities between years 2009 to 2013.
- ii. Establish female student's participation in STEM disciplines in Kenyan public universities between years 2009 to 2013.

- iii. Investigate institutional based limitations that continue to bar female student participation in STEM disciplines.
- iv. Explore the gender responsiveness of the STEM curriculum to the learning needs of female students in STEM disciplines.
- v. Evaluate existing educational policy interventions that influence trends in female participation in STEM disciplines in Kenyan public universities.

1.5 Research Questions

The study was guided by the following research questions:

- i. What are the trends of female student's access in STEM disciplines in Kenyan public universities between years 2009 to 2013?
- ii. What are the trends of female student's participation in STEM disciplines in Kenyan public universities between the years 2009 to 2013?
- iii. What are the institutional based limitations that bar female student participation in STEM disciplines?
- iv. To what extent is the STEM curriculum gender responsive to the learning needs of female students in STEM disciplines?
- v. To what extent have the existing educational policy interventions influenced trends in female students' participation in STEM disciplines in Kenyan public universities?

1.6 Significance of the Study

This study will provide added information for university level policy makers and managers; including Deans of schools with important information regarding the

perception of female students on what the institutions need to do to improve their participation in STEM. While data exists on female enrolments in universities, rarely is such data desegregated down to disciplines. The concern of this mode of presenting data has been to show their numbers in the institutions, but not in which academic disciplines they are registered. Showing the trends down to the level of disciplines is significant in a policy and academic sense and researchers will find new trails for further research from what this study has documented. This study has consolidated such data and unravelled knowledge on access, participation, retention and success rates of female students in STEM disciplines in universities. In addition, the findings may underline the importance female participation in universities and in particular the participation of female students in STEM disciplines. This is because female students in STEM disciplines are considered key to technological innovation geared towards national development and advancement of human wellbeing.

1.7 Limitations of the Study

The study had the following limitations: First, the study focussed on public universities and the findings therefore may not be generalizable to private universities. Second, the study was not able to access data for SSP students for all the study years, so in several cases, conclusions were arrived at using data on students admission based on KUCCPS students' admissions only. Where data for SSP was available, the study has included it and such data does show more female participation in STEM through the SSP mode compared to the regular mode. To design more holistic enabling interventions, this study has recommended for further studies to analyse both KUCCPS and SSP admissions. This

should be possible in the context of the evolving open data regimes that the government has passed into law and which universities will have to include in their enrolment reporting. This was not the case during fieldwork for this study, as the law for open data had not been passed.

1.8 Delimitation of the Study

The study was delimited to three out of seven public universities that were in existence in Kenya at the time of the study, namely; University of Nairobi, Egerton University and Jomo Kenyatta University of Science and Technology (JKUAT). The universities were selected based on their firm foundation in STEM orientation besides high students' enrolments. Identifying them for the study would provide contexts that are representative of the other public universities. The study was further delimited to undergraduate students, academic registrars, directors of gender and affirmative action and deans of faculties housing STEM disciplines and female faculty teaching STEM disciplines and third-year female students pursuing STEM disciplines. This group of female students could be relied on to give comprehensive responses concerning the STEM disciplines and general corresponding challenges. The academic registrars, directors of Gender and Affirmative action, the deans and STEM female faculty provided key information concerning female students enrolments, institutional and curriculum-based limitations, and the existing policies that inform the participation of female students in STEM disciplines in public universities.

1.9 Assumptions of the Study

The study was based on the assumptions that universities in Kenya have put in place educational gender policies and interventions to encourage female students access and participation in STEM disciplines given that issues of gender mainstreaming in education is a public and national concern articulated even in the country's constitution. Thus, the sampled universities were in a position to provide data to meet the objectives of the study. Further, the researcher assumed that the existing gender policies and interventions have not had a positive impact on the participation of females in STEM disciplines at the university level. The study was an exploration of how existing policies and interventions can be reviewed to widen female students' participation in STEM disciplines in Kenyan public universities.

1.10 Theoretical Framework

This study was anchored on three theoretical postulates, namely; the social constructionist theory (SCOT), the pipeline model theory and the deficit model theory. The three theories complemented each other to explain female under representation in STEM disciplines emanating from societal construction of STEM discipline as masculine, STEM gendered preferences, institutional limitations, gender unfriendly STEM curriculum and inadequate educational policies and intervention in the universities.

The social constructionist theory provides an explanation for women relationship to STEM disciplines based on the fact that this relationship can be found in societal rather than biological forces (Berger & Luckmann, 1966; Cockburn & Ormrod, 1993 and

Wajcman, 1991). According to this view, the social shaping of STEM disciplines as masculine interacts with the social construction of femininity in such a way that it puts the STEM disciplines outside the domain of women. The inference that can be drawn from this perspective in addressing the level of female participation in the STEM disciplines lies in the social construction of the STEM related professions as “men’s work.”

At the same time, another school of thought within the social constructivist perspective focuses on the need to reconstruct the world of STEM disciplines to become more of a “female domain.” Webster (1996) is one of the proponents of this approach. Theorists focus is on the social shaping of gender stereotyping identity and the implication for women’s relationship to workplace technologies. She believes that there exist social cultural and structural inequalities between men and women in work and in their relationships to technology. One can, therefore, infer that her approach to addressing the gender gap in the STEM disciplines would be to operate at the social level to address “the systemic nature of gender divisions in occupations and technologies” (Webster, 1996).

The pipeline model and deficit model are closely related and the study utilizes them interchangeably given that their meanings cannot be separated. They relate to social constructionist model by the way they deal with the supply and sustenance of women in STEM disciplines (Kulis, Sicotte & Collins, 2002 & Settles; Cortina, Malley & Stewart, 2006a). The pipeline model is used as a metaphor with two possible aspects to the under representation of women in STEM. It also emphasizes the importance of increasing the

volume of flow of females from secondary schools to universities and preventing “leakage” down the line at all stages (Kulis et al., 2002). This model assumes that an enlarged female doctoral labour pool (more flow) will expand the female STEM professionals. Under this circumstance, the pipeline model suggests that there are leakage problems that female students face as they climb the educational ladder. Literature reviewed by Berger and Luckmann (1966) discusses two possible reasons for the small number of female students entering STEM fields: job preferences, which are gendered and structural-related limited job opportunities.

In summary, social constructionist theory explains how society places gender roles on its individuals. These roles are supported by socio-cultural factors that put obstacles in the STEM disciplines for female students as males advance in the same without obstacles. The pipeline and deficit theories show how the existing gender policies and interventions, institutional barriers, masculine STEM learning environment, inadequate preparation of female students on STEM disciplines and socio-cultural factors support the dropout rates (leakages) for female students in the schooling process resulting into their shortage in the STEM disciplines. These three theories guided this study by articulating the facts generated by this therein.

In the context of this study, the social constructionist theory explains low female participation in STEM disciplines as emanating from social construction of female students into stereotypically feminine disciplines, societal expectations and gender roles. In terms of gender responsiveness in STEM curriculum, the theory further explains low

participation of female students in STEM disciplines. The theory depicts that STEM disciplines and careers are masculine in nature. In reference to this study, pipeline and leakage models are metaphors that infer to the fact that female students pursuing STEM disciplines experience barriers (leakages) that hinder them from successfully pursuing STEM disciplines in the course of their studies. Like leakage found along the pipeline, female students pursuing STEM disciplines experience institutional, socio-cultural barriers, financial constraints and masculine STEM curriculum which affect their participation in STEM disciplines.

The following conceptual framework is the researcher's conceptualisation of the relationship that exists among social constructions, social cultural factors, socio-cultural pipeline, existing interventions, complementary interventions and STEM disciplines derived from the above explained theories. Social-cultural constructions assign gender roles which inform the planning of educational curriculum and individual mindsets in the society. Socio-cultural factors influence how male and female students participate in STEM disciplines in universities. The female students face more social-cultural and institutional obstacles within the educational pipeline than the male students. The result of the social-cultural pipeline process is fewer female students in STEM disciplines in the universities. This is despite the fact that there exist gender equity policies and interventions.

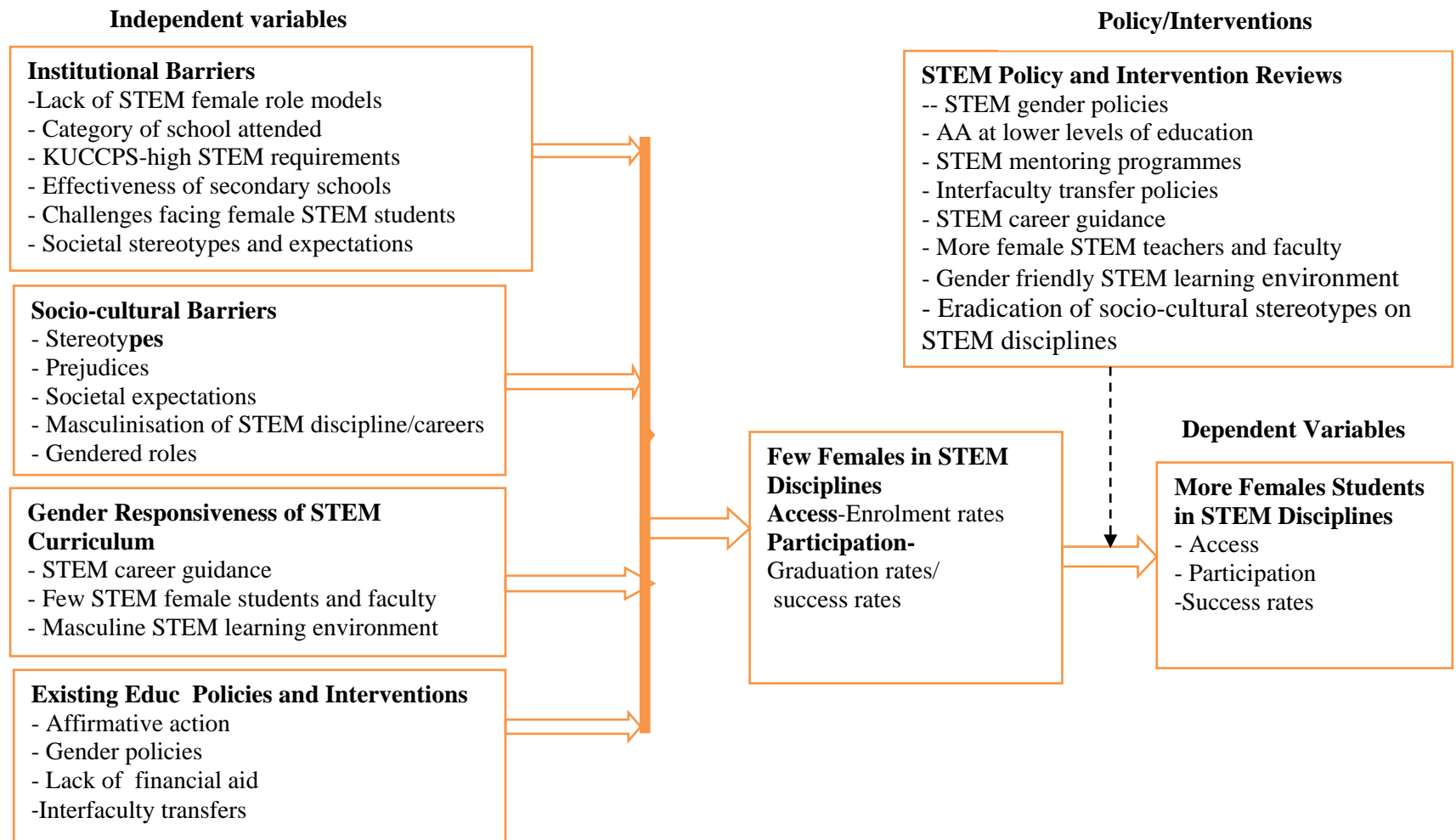
Policy review and interventions are likely to lead to more female students participating in STEM disciplines in the universities. This is because they give more options for more

interventions for female students' participation in STEM disciplines in the universities.

These gender STEM policies and interventions are what the study proposes.

1.10 Conceptual Framework

Figure 1.1: Policy Review and Interventions for Female Students Participation in STEM Disciplines in Public Universities



Source: Author with ideas from social constructionist theory (SCOT), the Pipeline and Deficit Model

1.11 Operational Definition of Terms

Access: Refers a process that entails the factors that might hinder or facilitate female students admission to STEM disciplines in the universities.

Affirmative action: A policy or programme of taking steps to increase the representation of certain designated groups by seeking to redress discrimination or bias through active measures in education and employment. It is usually achieved through discrimination against other groups.

Completion Rates: Refer to analysis of students pursuing STEM disciplines who enrolled in first-year of study to the final year of study in the sampled universities.

Educational policies and interventions: These refer to measures, principles by governments and universities that govern the operation of education systems to achieve gender equality in STEM disciplines.

Gender: This refers to the socially/culturally determined power relations, roles, responsibilities and entitlements for men, women, and the youth. The social constructs vary between cultures as well as over time.

Gender equality: Refers to equal treatment of women and men, girls and boys so that they can enjoy the benefits of development including equal access and to control of opportunities and resources.

Gender equity: Refers to the practice of fairness and justice in the distribution of benefits, access to and control of resources, responsibilities, power, opportunities and services among female and male persons. It is essentially the elimination of all forms of discrimination based on gender.

Gender friendly learning environment: Refers to learning environments that are supportive, practise fair and equal treatment of male and female students in terms of language, content of curriculum, learning environment and general organization of teaching and learning space to enable equal participation of all learners .

Gender mainstreaming: Refers to the consistent integration of gender concerns into the design, implementation, monitoring and evaluation of policies, plans, programmes, activities and projects at all levels.

Gender roles: Socially assigned or constructed masculine and feminine roles and responsibilities as opposed to biologically determined functions.

Graduation rates: These entail comparing female and male students graduation performance based on completion rates and performance trends in STEM disciplines at university.

Hard sciences: Hard sciences are STEM disciplines that require high level mathematical skills for which a gendered society and school system discourages girls due to the perceived masculinisation. Hard sciences include Engineering, Computer Science and Agriculture.

Multi faceted complementary policies: This refers to a wide range of interventions, measures, principles by governments and universities that should be developed, integrated and implemented for encouraging female students' access and participation in STEM disciplines in Kenyan public universities.

Needy STEM students: These are students pursuing STEM disciplines in the universities and require financial aid to meet their university education and tuition fees.

Participation: General term used to refer to the process that entails the enrolment, retention and graduation rates of female students in STEM disciplines at the university.

Progression rates: This entails an analysis on the number of female students who advance or proceed from one academic year to another up to graduation in STEM disciplines in the public universities.

STEM disciplines: Refer to disciplines in areas of Science, Mathematics, Technology, Engineering, Physical and Biological Sciences, Health Sciences and Computers. STEM disciplines require mathematical skill as a foundational basis for content.

STEM feminist persuasion: This refers to interventions by governments and universities that will be adopted to make in STEM curricula, content and learning environments gender friendly and inclusive of female students in STEM disciplines.

Socialization: The process of socio-cultural learning of values, the acquisition of knowledge, skills and dispositions that make women and men integrated members of the society.

Soft sciences: Soft sciences are STEM disciplines associated with some elements of caring and mothering. They are more preferred by STEM female students and the society stereotypically perceives them feminine. They include general sciences and health sciences.

Trends: Pattern or general tendency of access and participation of male and female students pursuing STEM disciplines in universities.

1.12 Organisation of the Study

The study comprises five chapters. Chapter one of this thesis includes the background to the study, which covers female participation in STEM disciplines trends and interventions. The background also focuses on importance of women participation in STEM, statement of the problem, objectives and research questions. It further gives the significance of the study, limitations and delimitations, assumptions, theoretical and conceptual frameworks and operational definition of terms. Chapter Two of the study encompasses review of related literature; Chapter Three entails research methodology whereas Chapter Four contains presentation of findings and discussion. Finally, Chapter Five encompasses summary, conclusion and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter is a review of related literature to the study under the following themes in line with study objectives: Trends of female students access in STEM disciplines, female students participation in STEM disciplines, institutional limitations that continue to act as barriers to female students participation in STEM disciplines, gender responsiveness of the STEM curriculum to female students participation in STEM disciplines, and evaluation of existing policies and interventions that influence trends in female participation STEM disciplines in Kenyan public universities.

2.2 Trends of Female Students Participation in STEM Disciplines in Universities

Globally, education is recognized as the cornerstone for socio-economic and human resource development. The universal Declaration of Human Right ratified in 1948 by the United Nations elevated education as a basic human rights (FAWE, 2014). Advocacy for the participation of women in universities is not only premised on human rights grounds but is grounded in the benefits of educating women at the university level (Oanda & Okudolu, 2010; FAWE, 2000). Ironically, gender inequity continues to be one of the most significant challenges that face many universities in the world (National Science Board, 2010). Women make up only 30 % of the total university enrolments in most countries (Oanda & Akudolu, 2010). Further, there is poor access of women to STEM disciplines yet STEM disciplines lead to strategic and marketable careers in the labour market (Chege & Sifuna, 2006; Oanda & Akudolu, 2010).

In the developed world, specifically in the United States of America and Europe, in electrical engineering, female students constitute 19% (NSB 2010 & Knight et al., 2011). Further research on nine South Eastern universities found that industrial engineering, chemical engineering and civil engineering have a higher enrolment of women than the other engineering disciplines (Cadinu et al., 2005). The study also found that female students preferred behavioural sciences, civil engineering, and chemical engineering and were not as well-represented in mechanical and computer engineering. However, these studies do not explain why there are differences. The study sought to identify this gap. In Swaziland, the percentage of women in STEM disciplines at the University of Swaziland is 30% and 4% in mechanical and automatic engineering. In Lesotho, women form the majority in faculties of education, humanities and arts and health and welfare, they are the minority in Science and Agriculture. In Zimbabwe, women comprise a lower percentage in all faculties with the lowest percentage in commerce (23.2%), Agriculture (28.8%), Engineering (6.2%), Science (25.3%) and Veterinary Studies (26%) (FAWE, 2014). Specifically, the situation in Sub-Saharan Africa where only 30% of all students enrolled at the university are women is most critical (Bunyi, 2008; Morley, 2004 & Oanda, 2008a).

Kenya has similar issues relating to the participation of women in universities like the other African countries. Female students constitute about 35% of total enrolment in the public universities and less than 30% in STEM disciplines. The proportion of girls enrolment declines as they move up the educational ladder. Worse still, majority of the few who access STEM disciplines not only fail to complete but they also perform poorly

as compared to their male counterparts (Griffin, 2007 & Oanda & Akudolu, 2010). In engineering disciplines in the University of Nairobi, female students admitted in 2006 were 10.5%, Kenyatta University had 9.4%, Jomo Kenyatta University of Agriculture and Technology 10.5%, Moi University, 9.1% and Egerton University had 7.7% (UNESCO, 2010). This under representation of female students in engineering disciplines proves that a great population of women has been left out from the benefits inherent from science and technology.

According to the KNBS (2015), female enrolments were higher in Self-Sponsored Programme (SSP) and especially in soft sciences compared to hard sciences. This was confirmed from data obtained from University of Nairobi, Moi University, Kenya Methodist University, University of Eastern Africa Baraton, Kenyatta University, Egerton University, Agha Khan University Hospital, Mount Kenya University and Masinde Muliro University of Science & Technology. Three of the disciplines represented were medicine, dental surgery, nursing and biochemistry. High female enrolments were recorded in medicine across the academic years 2010/2014 and 2014/2015. The study noted that the differences between male and female enrolment in health sciences seemed small at 47% for male students and 53% female enrolments. Female students enrolments were more in bachelor of nursing at 66% compared to male students at 34%. It was noted that high enrolments in nursing was due to the femininity of the discipline and job attractiveness. Further, the study established that the presence of private universities like Methodist and Agha Khan has pushed the number of female enrolments.

From the Kenya Economic Survey 2015 report, Bachelor of Science (Biochemistry) and Pharmacy had low female enrolment at 41% and 45% respectively. Dental sciences had similar trends to medicine and surgery with female enrolment at 47%. Female students could attribute low female enrolments in hard sciences to masculinity of the disciplines and lack of attraction to hard sciences. In health science disciplines, there were high female enrolments and in a few cases surpassing that of males. This is as a result of socio-cultural and institutional practices such as Self-Sponsored Programmes (SSP), femininity and attractiveness to the disciplines and the job market that encourages female participation.

Development of a nation should be seen to embrace female realities through participation in STEM disciplines. In many parts of the world, it is the women who have responsibility for food security, reproduction cycles and family care. Women produce 80% of food crops in Sub-Saharan Africa, 70-80% in South Asia, and 50% in Latin America and the Caribbean. Women are responsible for provision of water for people and livestock, and for the production of biomass fuels and fodder for domestic use (UNESCO, 2004). Their reproductive responsibilities also include the gathering and processing of medicinal plants and oils. For instance, women carry out 60-90 % of agricultural production activities in the developing world. They are also responsible for the provision energy for cooking; catering for community water and sanitation needs and family healthcare (UNESCO, 2004). In addition, studies show that a substantial amount of local traditional knowledge is held by women, especially in the areas of agriculture, environmental resource management, and health (Kapinga, 2010; Ohara, 2010; FAWE, 2014). In Africa,

women constitute the overwhelming proportion of the poor yet their roles and responsibilities in family and community place them at the centre of national developmental (Kapinga, 2010; Ohara, 2010). Generally, the society has suffered by neglecting a half of itself from science and technology (UNESCO, 2010).

2.3 Female Students Participation in STEM Disciplines in Kenyan Public Universities in a Global Context

For decades, researchers and policy-makers have been concerned about the pipeline of graduates in STEM disciplines. Graduates in STEM disciplines are seen as a basic driving force behind international competitiveness, innovation, and productivity growth economy wide. In an increasingly technological society, any gaps in the supply of and demand for technically trained workers and the continuing imbalances in the gender composition of these workforces present significant social and economic problems (Griffin, 2007). Concerns about the number of graduates, the gender ratio of graduates comes to the forefront in discussions about the role of universities in preparing students for the 21st century economy. A research by Higher Education Research Institute [HERI] (2010), highlighted the fact that worldwide, female completion rates has continued to be low whereas the attrition rates for STEM fields are high.

The NSF (2008) reports that, overall, women earn most of the bachelors degrees in humanities, education, psychology and social sciences other than STEM disciplines. Men earn most degrees in physical sciences; computer sciences; earth, atmospheric, and ocean sciences; mathematics and statistics and engineering. In engineering and computer

sciences, the fastest-growing STEM fields with the greatest workforce demand that the percentages of women have reached a plateau or dropped over the past decade.

Despite grades and other academic attainments equal to or surpassing those of the men who remain in STEM fields, more women than men leave science and engineering. As a result, few women are in senior or leadership positions in the STEM workforce (NSF, 2008). Primary factors that stand out among the multiple forces pushing women to leave the STEM disciplines and workforce are the socio-cultural stereotypes on masculinity of STEM disciplines, the need to balance career and family and a lack of professional networks. Despite interventions, few female students choose STEM disciplines as a university choice and the transfer rate from STEM disciplines to non-STEM further erodes the graduation rate in these fields (Griffin, 2007). In some instances, persistence and completion rates have improved but substantial gaps remain, as do many issues surrounding enrolment and retention in STEM career path. This daunting admission captures the problem: “The demand for skilled workers in STEM fields will be difficult, if not impossible to meet, if the nation’s future scientists do not reflect the diversity of the population” (Correll, 2004). Moreover, of the minority students entering universities with intended STEM majors their persistence in STEM is eroded from the first to second year at significant rates and losses continue through to their final year. In evaluating the erosion, study by Griffin, (2007) indicates that only 31% of minority students initially planning to major in a STEM field remain by the final year, while 43% of non-minority students persist at this point. This reality has implications on all educational levels. The exploration of systematic outreach and participation efforts was done within the State

University of New York as a 64 campus enterprise. The findings were that the issue is not one of enrolment, but of retention, transition and persistence to graduation within these critically needed areas of study.

Female students who enter STEM majors in university tend to be well-qualified as they must have taken and earned high grades in the prerequisite math and science classes in high school and to have confidence in their math and science capabilities. Nevertheless, many of these academically capable women leave STEM majors early in their college careers, (Hill et al., 2013). For example in engineering, the national rate of retention from entry into the major to graduation is just under 60 per cent for women (Ohara, 2010). Women comprise a smaller number of STEM students from the start, so the loss of women from these majors is of special concern and understanding why women leave STEM majors is still an important area of research.

Griffin, (2007) observes that universities are increasingly focused on improving the retention and graduation rates of their students through a variety of programmes and services. A number of institutions have developed offices, programmes, or departments specifically designed to improve retention rates through orientations or student and academic support services. Other universities have not devoted the time and financial resources required for such specialized units of operation, but still boast of various academic, social, and health services and programmes to encourage student success and overall happiness with their university experience. Institutional approaches to improving student retention rates must address both academic and non-academic factors of student

happiness and success (Hill et al., 2013). However, the majority of proved factors to improve student retention are related to academic goals, academic-related skills, and academic self-confidence. Thus, the presence of an academic advisor is essential in encouraging students to progress and achieve success in their academic careers (Ohara, 2010).

Study by Dweck (2006) provides insights into why so many students begin college interested in STEM majors but fewer complete one. One area focuses on the importance of early academic performance. There is significant evidence that relative performance in lower levels of education is an important determinant of undergraduate major choice. This literature is particularly important to an understanding of STEM major choice because in most colleges and universities, STEM majors are among the lowest grading departments. Along with introductory course performance, this literature highlights the importance of high school preparation and coursework, math aptitude, preferences for particular disciplines, career goals, and STEM course experiences as important factors in the choice of a STEM major (Kulis et al., 2002).

Both sets of literature suggest that major choice is a complex decision that is influenced by many different forces. Students come to college with expectations and abilities based upon their high school coursework, achievement parental and social influences. These expectations and abilities then collide with the collegiate STEM curriculum with its professors, labs, grades, and peers. When students take their first STEM course, all of these factors come together to alter their preferences and expectations and they decide

whether to take another course. Eventually, this sequence of decisions leads to a declaration of a major, sometimes within a STEM department, more often outside of the STEM majors.

Attrition in STEM fields is a problem several colleges are trying to tackle. Conventional wisdom says that while there are many barriers for women pursuing advanced degrees, the “pipeline” to the sciences, technology, engineering and math is particularly leaky (NSF, 2008). The decline in STEM enrolments along with retention problems raise concerns about the “shrinking” and “leaking” pipeline, the metaphor most often used to describe declining enrolments and the differential retention of women in STEM fields (Hill et al., 2013). As enrolments of women in STEM majors continue to decline, the pipeline “supplying” them to these fields is said to be shrinking (Eccles, 2007). The lack of support in the traditional STEM environment may be particularly harmful to women given that researchers and theorists (Cialdini, 2004 and Dweck, 2008) have emphasized the importance of relationships and interpersonal connections to women’s psychological development and well-being. Despite the growing demand for highly skilled workers, engineers, and those with technology expertise, the academy has not been able to rectify the lower participation and still lower graduation rates for female students in STEM disciplines (Onsongo, 2008). This study therefore explores intervention to increase female participation in STEM disciplines in Kenyan public universities.

2.4 Institutional based limitations to female student participation in STEM disciplines

Research shows that women and men respond differently to the way in which content is packaged and taught (Jacobs and Rossi Becker, 2006). Empirical work in both secondary and post-secondary settings supports theories that suggest females are more interested in topics related to their lives, society, and broader concepts than males (Brannon, 2003).

Hill et al., (2013) explains how there exist different cultures of student engagement across STEM disciplines. The study identified five dimensions of effective academic engagement, including active or collaborative learning, student-faculty contact, level of academic challenge, enriching educational experiences, and supportive campus environment. A factor analysis of the engagement items yielded two different cultures that separated according to academic discipline. A social sciences culture, characterized by high student/ faculty interaction, discussion and questioning by students in classes, the connection of ideas across disciplines and students who go above and beyond the required workload. A STEM culture dominated by high quantitative and computer skills, high levels of collaboration with peers, a focus on problem-solving, and a pervasive interest in obtaining high-paying and well-paying jobs. Settles, (2006b) discusses how different cultures of engagement of the disciplines may either attract or repel students from enrolling in a given discipline. Students are recruited into a STEM discipline and undergo a socialization in which they discover and adopt the attributes that are recognized within that discipline.

The study by Wawire, Ombunda, Mbirianjau and Simiyu, (2011) states that there are differences in the way STEM disciplines are presented to students. The presentation influences male and female participation in STEM disciplines. The different academic cultures of science and engineering versus humanities and social sciences may indicate that women are more attracted to a certain type of engagement in the classroom. Even within STEM, women tend to gravitate toward the soft, pure, life fields (NSB, 2010). Women may be underrepresented in STEM disciplines because they are simply uninspired by potential coursework, suggesting that shifts in pedagogical techniques could potentially influence recruitment. Differences in sex stereotyping between disciplines also may steer females to enrol in certain fields and avoid others.

The decision on how students select STEM disciplines of study is an important indicator of career choice, earnings, and professional satisfaction. Many factors have been shown to contribute to STEM choice, including gender (Jacobs & Rossi, 2006), race (Thomas, 2009), ethnicity (Trower, 2008), and labour market returns (UNESCO, 2004). While there is an extensive literature on the influences that a student's background has on access to and success in universities, there is a void in how it influences his or her academic plan. Considering gender issues, the choice of STEM discipline are a logical starting point for analyzing differences between males and female students in career choice and earnings (Brannon, 2003).

Another determining factor in decisions in STEM disciplines of study is related to sex stereotyping (Bunyi, 2008). There exist differences across STEM disciplines in the

degree to which sex stereotyping occurs. Society has a pervasive view that STEM professions are "male-dominated" thereby causing negative attitudes toward these disciplines among women; this phenomenon is an example of sex stereotyping. Relative to men, women tend to have less overall interest and perceive fewer educational and career benefits by pursuing STEM disciplines (NRC, 2006; NSB, 2010).

Despite an overall weak understanding of what engineers actually do by the general public, the sex stereotyping of the "white male" engineering profession still begins at a young age and is carried throughout all levels of education, making it discouraging for women to enrol in programmes once they reach college (David et al., 2015). Perhaps the field has sustained this stigma within the general public because males have always dominated it, but the literature has not resolved the cause of the perception. This stereotype threat negatively affects access and participation of female students in STEM disciplines, as they must cope with feelings of isolation within STEM disciplines. Cadin et al., (2005) in a study of females assigned to either a stereotype threat condition or no condition while taking a math test, women under the threat condition reported higher negative feelings with respect to mathematics during the exam inaction. The control group also performed better overall than the group under threatening conditions. In similar research, Kiefer and Sekaquaptewa, (2007) observed students in a college-level calculus course under various sexual stereotype conditions. Women under the treatment performed worse on the course's first examination and had a reduced desire to pursue a mathematics-related career relative to women who experienced low stereotyping. Sexual stereotyping explained why women who were equally prepared for challenging

mathematics disciplines underperformed relative to classmates of the same intellectual level.

Cadinu et al., (2005) explain on how cognitive structures vary under different conditions of sex stereotype threat. Using magnetic resonance imaging to determine which neural structures explained the underperformance on mathematics tasks in certain females, they found that certain neural networks are activated during mathematical learning. If a female is in a threat condition, rather than activating this neural network, she instead activates a neural network that controls social and emotional processing. Thus, women who are in a threat situation may not perform as well because the threat causes a preoccupation of the cognitive process.

Developing a greater sense of engagement and application to society has also happened through service learning disciplines. The study examined the impacts of community engagement on political science students' learning and knowledge acquisition. Students were randomly assigned to course sections that either had a community service component or a traditional framework that acted as the control condition. For the community service sections, students were required to complete twenty hours of service of their choice during the semester. Reflections through course discussions and short papers also accompanied these experiences. Students in the traditional course followed a typical lecture-discussion model that required a longer term paper assignment. In comparing scores on a common midterm and final examination across sections, students in the community service sections performed 0.29 of a standard deviation (11 percentile

points) better than students in the traditional section. This was evident despite beginning the course with no significant differences in academic ability or student characteristics. Similar findings of improved learning through community service requirements have been found in numerous settings (Astin & Sax, 1998; Ikeda, 2000 & Pajares, 1996). In comparison to students enrolled in traditional-style disciplines, students in disciplines with community service requirements indicate that they are better able to apply concepts from the course to new situations.

2.5 Gender Responsiveness of the STEM Curriculum

Graduating well-educated students in STEM disciplines has become a national priority, particularly as the nation looks to maintain its global competitiveness in light of continuing gender disparities affecting graduation rates and the ever increasing demand for a highly skilled labourforce needed to sustain a global competitive position (Byamugisha, 2011). The President's Council of Advisors on Science and Technology (PCAST) has indicated that the nation's economic forecasts point to a need to produce one million college graduates in STEM fields to maintain economic advantage. Impending decline in the STEM workforce has contributed to the looming crisis the country and its industry is currently experiencing. Proactive steps should be taken now to insure the proportionate inclusion of such a large part of female population in STEM, throughout all levels of academia.

A study by Margolis and Fisher, (2002) identified numerous barriers to the success and persistence of women in STEM curricula, including lack of viable mentors, socio-cultural

stereotypes, low self-efficacy, and the glass ceiling effect. Expanding on efforts to understand the under representation of women in STEM curricula, we turn to coping. In terms of policy, identifying the most effective coping strategies for women in STEM fields can provide information regarding where additional resources should be allocated and what kinds of resources are likely to help girls and women in STEM curricula to cope (Bunyi, 2008).

According to NSF (2008), STEM instructors need to begin to question the continued use of traditional lecturing in everyday practice as traditional lecturing has dominated undergraduate instruction for most of a millennium and continues to have strong advocates. Current evidence suggests that a constructivist approach may lead to strong increases in student active learning and may get good results in terms of retention (NSB, 2010). Limited exposure to science achievement and inquiry skills, due to inadequate learning environments, which is echoed in reports dealing with the under-preparation and lack of STEM familiarity. The lack of equitable education opportunity also increases the lack of genuine understanding of STEM careers is also deemed responsible for the early departure from STEM programmes (Brannon, 2003). Another significant and well-studied phenomenon hinges on providing curriculum experiences that incorporate aspects of relevant life experiences that are specific to the underrepresented minority student.

Hill et al., (2013) notes that creative pedagogical approach to the teaching of STEM disciplines would benefit a more diverse student population. These findings provide evidence on the nurture side of the nature-nurture debate, demonstrating that social and

environmental factors clearly contribute to the under representation of women in STEM. The findings are organized into three areas: social and environmental factors that shape girls' achievements and interest in mathematics and science; the college environment; and the continuing importance of bias, often operating at an unconscious level, as an obstacle to women success in STEM fields.

Further research by Hill et al., (2013), shows that negative stereotypes about girls' abilities in mathematics are still relevant today and can lower girls' test performance and aspirations for science and engineering careers and are manifested in STEM learning environments. One of the most consistent, and largest, gender differences in cognitive abilities is found in the area of spatial skills, with male students consistently outperforming females. If girls are in an environment that enhances their success in STEM with spatial skills training, they are more likely to develop their skills as well as their confidence and consider a future in a STEM field. Likewise, universities can attract more female science and engineering faculty if they improve the integration of female faculty into the departmental culture. University administrators can recruit and retain more women by implementing mentoring programmes and effective work life policies for all faculty members.

Traditional curriculum reinforces the masculine characterization of science as abstract and disconnected from social and environmental concerns (Cadinu et al., 2005). It also associates science education with pedagogy of telling or transmitting knowledge. For female students, STEM curriculum and methods of instruction are far from ideal. Schools

tend to emphasize abstract science that often is not obviously related to real world issues and problems. Generally, factual information is delivered to students by authoritative sources (teachers and texts) to be memorized and given back on standardized tests. There is an emphasis on competition rather than cooperation that also generally works against female students (Woodzicka et al., 2010).

Contemporary science developments and issues are often not addressed as many official lesson plans and some science standards remain focused on 19th and 20th century scientific achievements. The exploration of original student generated research questions as a way to experience science as working scientists' practices is extremely rare. Study of scientific principles in an abstract vacuum rather than in the context of recognizable real-world issues along with little mention of science's humanitarian and cultural value is another reason school science fails to engage girls (Settles et al., 2006a). In addition to the abstract content and authority focused pedagogical approach, the formal school science setting is often socially detrimental for girls. When female students arrive at their first academic courses they are often behind their boy counterparts in terms of relevant STEM experience (Margolis & Fisher, 2002). Teachers who are not sensitive to this initial girl disadvantage may exacerbate the problem as more aggressive boys dominate limited classes and equipment, relegating girls to the role of note taking, observer and bystander roles.

Negative stereotypes about girls and women abilities in STEM learning environment persist despite girls and women's considerable gains in participation and performance in

these areas during the last few decades. Two stereotypes are prevalent: girls are not as good as boys in mathematics, and scientific work is better suited to boys and men. As early as elementary school, children are aware of these stereotypes and can express stereotypical beliefs about which STEM disciplines are suitable for females and males (Cadinu et al., 2005). Furthermore, female students have been found to be aware of, and negatively affected by the stereotypical image of a scientist as a man (Kiefer et al., 2007). Although largely unspoken, negative stereotypes about women and girls in STEM are very much alive.

Negative stereotypes affect women and girls' performance and aspirations in mathematics and science through a phenomenon called "stereotype threat." Even female students who strongly identify with mathematics, who think that they are good at mathematics and being good in math is important to them, are susceptible to its effects (Hill et al., 2013). Stereotype threat may help explain the discrepancy between female students' higher grades in STEM and their lower performance higher retakes and dropout rates. Additionally, stereotype threat may also help explain why fewer girls than boys express interest in and aspirations for careers in mathematically demanding fields. Girls may attempt to reduce the likelihood that they will be judged through the lens of negative stereotypes by saying they are not interested and by avoiding these fields. Stereotype threat also has implications beyond test performance (Mlambo, 2011).

In an interview with AAUW (2007), Aronson suggested that one reason girls lose confidence as they advance in STEM from "the stereotyping that students are exposed to

in school, the media, and even at home that portrays boys as more innately gifted and math as a gift rather than a developed skill. Without denying that biological factors may play a role in some mathematics domains, psychology also plays a big role.” Additionally, a repeated or long-term threat can eventually undermine aspirations in the area of interest through a process called “misidentification.” Aronson describes misidentification as a defence to avoid the risk of being judged by a stereotype. In extreme cases, rather than repeatedly confronting a negative stereotype, girls and women might avoid the stereotype by avoiding STEM disciplines altogether.

Stereotype threat can be alleviated by teaching students about it reassuring students that tests are fair and exposing students to female role models in mathematics and science. Another promising approach involves encouraging students to think of their mathematics abilities as expandable can lift stereotype threat and have a significant positive effect on students’ grades and test scores (Hill et al., 2013). Exposing female students to role models will enable them to understand STEM curriculum and the learning process. Stereotype threat also has implications beyond test performance. Further, the study suggested that one-reason girls lose confidence as they advance in school stems from “the stereotyping that students are exposed to in school, the media, and even at home that portrays boys as more innately gifted and mathematics as a gift rather than a developed skill”.

According to Hill et al., (2013), female students will perform well in STEM disciplines if identification of evidence based instructional strategies for improving academic outcomes

as well as consideration of environmental and structural challenges contributing to these gaps are addressed. Interestingly, the findings of these studies point to pedagogical practices long considered canon in out-of-school (OST) learning environments, including hands-on learning experiences, inquiry-based pedagogy, and contextualized content (Hill, et al., 2009; National Research Council, 2006). In fact, there are some STEM areas in which girls are outperforming boys (AAUW, 2008). However, once girls reach middle school and high school where students have more choice and/or are tracked into particular courses of study, their participation in STEM class plummets, regardless of their prior successful performance.

Another significant challenge to engagement in STEM learning is the cultural divide between the gender lived experiences and the cultural lens through which STEM content is traditionally presented. The STEM learning environments are male-dominated and this makes female students feel out of place and misfits. Building participants' science identities and sense of self-efficacy by creating hands-on learning experiences that focus on developing technical skills and aptitudes, increasing self-confidence, persistence, and leadership skills and promoting greater awareness and interest in STEM careers (Brannon, 2003).

Hill et al., (2013) in the study discusses building networks of support for the girls participating in the programme through role models and mentors, who in turn serve as networks of support and advocates for STEM disciplines. Development of female students' strategies for developing a sense of "belonging" in STEM is of the utmost

importance. Having access to programme staff and role models that reflect their identity and that are adequately trained to help female students negotiate and overcome social and psychological hurdles for developing positive science identity is critical (Knight et al., 2011). Content should be relevant to female students' lives and experiences, Provision of tangible technical skill-building, building positive peer relationships, provide access to role models and mentors and providing opportunities for family and friends support (Kapinga, 2010).

Margolis and Fisher (2002) insist that the goal of STEM disciplines should not be to fit “women into computer science but rather to change computer science.” The majority of the women interviewed, including those who remained in computer science, expressed dissatisfaction with the culture of the discipline. Margolis and Fisher stress that departments should pay attention to the student experience to improve recruitment and retention of women and that having diverse faculty is also critical. As a result of Margolis and Fisher's work, the School of Computer Science at Carnegie Mel-lon implemented several changes that helped create a more welcoming culture and improved the recruitment and retention of female students (Margolis & Fisher, 2002).

Many scholars have provided various explanations for why the problem exists and a nature-nurture debate has raged for centuries. Some argue that the cause is primarily nature; that gender differences reflect biological differences in cognitive abilities that underlie true abilities in mathematics, physical sciences and technology (Kimura, 2002). The other side of the argument is that nurture is primarily responsible for gender

differences in STEM. Feminist theory posits that science has an underlying ideology that can be interpreted as masculine. It goes beyond counting heads of women and men in science. It is the a world view with the implicit belief that science is objective, gender neutral, but at the same time science narratives reinforce that great scientists are men (Mlama, 2001).

Hill et al., (2013) on the development and impact of learned societies and the masculinisation of science in France in the 19th century explains how ideologically it became entrenched in the modern world. She expounds that: It is difficult for many to appreciate how pervasive and powerful, yet subtle and unconscious the effects of stereotyping are influencing attitudes, expectancies, cognitions and motivations of females to pursue academic studies and a career in STEM, or not. Stereotypes affect peer, parental, teacher, indeed, societal attitudes and expectancies, which in turn affect the social environment of females, which influences not only their likes and dislikes but also their beliefs about their abilities and their performance in STEM subjects.

Although many do not believe that social and psychological factors can be that powerful in accounting for gender inequity in STEM, Bennett and Sharpe (2013) position regarding the socio-psychological framework is that it is a powerful explanatory hypothesis. Certainly, the evidence is that peers, parents, teachers and others hold stereotypic views of which sex is better at STEM, of which sexes are engaged in STEM occupations resulting in less peer support for STEM interests among girls. Eccles (2007) indicates in her model of achievement related choices, expectations of success as a main

component of career choice. If girls or young women observe that women in a male-dominated profession experience discrimination due to their sex, or if girls expect sex discrimination should they pursue a male-dominated profession, they may lose interest in that profession and choose another.

Additionally, because of sex stereotyping, females do not see STEM as congruent with female sex role identity that can drive their choice of subjects and careers away from STEM. Substantive experimental research has been conducted on how negative stereotypes can undermine aspirations and actual intellectual functioning (Hill et al., 2013). Much work has found that people who experience negative stereotypes in the form of a stereotype threat, self-fulfil the stereotypes and the unintentional fulfilment of the stereotype reinforces the stereotypic belief, thus leading to a dangerous cyclical process.

The language of STEM textbooks, websites and teaching/learning materials is one of these: texts usually imply a positivist view of science, with masculine language, and (nearly without exceptions) male exemplars for STEM professionals, not even mentioning female STEM excellence (Kanter, 2014). This is worsened by the fact that in many schools (despite policy intentions or even prescriptions), daily teaching is textbook based, and so is the learning process expected from students. Thus students are primarily exposed to this attitude. Textbooks still have a masculine approach and use masculine terms (like conquering nature, revealing the secrets of nature) and concepts that are meant to raise interest: instead, many of them make girls (probably even unconsciously) disgusted or turn them away from natural sciences. Also, there are few female role

models in science textbooks. This means that girls have less chance to have comfortable situations, and face more tension in learning: usually, they would prepare more than boys, but when it comes to application, they face problems. Research states that most teachers tend to neglect the social and local aspects of learning environments, whereas female students are highly sensitive about these. These features transmit messages that are usually absorbed at a non-conscious level yet they act strongly and have a crucial role in establishing attitudes and motivation in STEM learning (Ohara, 2010). The STEM teaching and learning materials should have an inclusive approach with attention given a gender responsive STEM curriculum.

Classroom and extracurricular settings should provide a more relaxed, less stressing, less competitive learning environment for students, including girls. Indistinguishable or extremely high expectations, selective and result-driven preparation can interfere with excelling at important occasions, also impeding the development of self-esteem and self-efficacy needed for performance. If this is paired with a fixed mindset approach, most students get discouraged. Inclusive learning environments impose challenges, but without threatening of failure, they let students make mistakes, and then learn from them (Bennett, 2013).

2.6 Existing Educational Policies and Interventions to Increase Female Students Participation in STEM Disciplines

The STEM disciplines are characterized as the engine-room of economic development in the world. The wealthiest nations secure their economic edge through increasingly knowledge-based economies. Advanced and developing economies alike, seek to ensure

that their education systems provide a sufficient number of tertiary educated people in STEM disciplines (Roeser, 2006). In some highly developed countries, this vowed aim is not always easily achieved and is increasingly accompanied by tensions and problems when the education system is not able to fulfil the labour force demands for skilled and talented individuals (Jacobs et al., 2006). Other countries such as India and China are investing heavily to ensure that participation in these disciplines will result in sufficient numbers of people being prepared to pursue university education and careers in STEM (Roeser, 2006).

In Tanzania, most of the existing gender equity strategies focus on equalizing the opportunities of women in universities in terms of access and retention and include, formulation of gender policies, scholarships for women, pre-science remedial programmes and integrating gender into the curriculum (Kapinga, 2010). Widening female students' participation in universities is a policy priority in many national locations. This has been driven both by national and international initiatives. In Kenya for instance, the vision 2030 which is the government road map to industrialisation, requires manpower in STEM to transform Kenya's future. It aims at making Kenya a newly industrializing, middle income country providing high quality life for all its citizens by the year 2030. The vision which is based on three "pillars" namely; the economic pillar, the social pillar and the political pillar regards gender inequality as one of the key development challenges facing the country.

Gender dimensions arise as a result of the different roles played by men and women in the society and in terms of access, ownership and control of productive resources, as well as differences in capabilities. The government should aim to reduce gender inequality in all sectors. <http://www.vision2030.go.ke/>. Empirical studies show that countries with a higher proportion of STEM graduates tend to grow faster than countries with a higher proportion of graduates in other disciplines (UNESCO, 2013). In addition, future technical change is likely to be linked to abilities and tasks related to STEM disciplines. The untapped potential of fully trained and credentialed women who might be interested in STEM but choose not to pursue degrees in these fields or who decide to change careers because of obstacles, real or perceived, represents an important lost opportunity not only for women themselves but also for society as a whole. Career impediments for women deprive societies of scarce human resources, which is detrimental to competitiveness and development (Kapinga, 2010).

African governments and universities, including those in Kenya, have put in place gender equity interventions. These are in form of policies and programmes, to improve access of female students to universities. These include Affirmative Action (AA) policies that entail lowering the university admission entry marks for female students. Individual universities have adopted the Gender Mainstreaming (GM) strategy, which has its roots in the 1995 Beijing's Platform for Action of the Fourth International Women's Conference, as a gender equity measure (Bunyi, 2008; Kapinga, 2010).

Guanawardena et al., (2005), argue that where AA policies and GM strategies have been adopted, they in most cases do not incorporate monitoring and evaluation procedures. These procedures would be used to determine their effectiveness in addition to pinpointing areas of change to maximize the equity opportunities for female students. In fact, preliminary discourse analysis on the issue of GM points to controversial and problematic implementation processes that require change in the male-dominated rigid and bureaucratic structures in African universities (Morley et al., 2005).

According to Kapinga (2010), University of Dar es Salaam has several policies such as; affirmative action, special scholarships to female students in professions where they are not well-represented such as engineering, pre-entry programme, a gender centre to monitor gender equity and equality issues together with sexual and other non-harassments policies have been put in place. Despite these efforts by the Tanzanian government to increase women access to universities, no gender parity has been realized especially in STEM disciplines. This is due to lack of proper financial sustainability and accountability (Kapinga, 2010). In Uganda, female enrolment in STEM disciplines is still disproportional, despite mitigating strategies like girl education, engendering curricula, guidelines for mainstreaming gender, gender-responsive teaching, learning materials and facilities, use of gender-sensitive language, rules, practices and ensuring equity in classrooms (UNESCO, 2013).

In Rwanda, programmes implemented to strengthen gender mainstreaming in STEM include, role model programmes and mentorship at the community level, associations for

women professionals in science and technology visiting schools, scholarship award system for women who have given birth, research and networking, research grants, local innovation funds and awards to best performing STEM female students. The situation is similar in Kenya indicating a consistent stagnation of female overall participation in universities with an average mean of 35 per cent (Oanda & Akudolu, 2010; Griffin, 2007). This is because Kenya does not have a specific implementation programmes on gender mainstreaming in Science and Technology apart from some general provisions which are not strong enough to mainstream gender equity into STEM disciplines (UNESCO, 2013).

2.7 Summary of Literature Reviewed and Study Gaps

The above literature has identified trends of female students participation in STEM disciplines; institutional and curriculum based limitations as well as policies and interventions to recruit women in universities. The study has failed short of explicating the following:

First, the existing STEM trends are not current and are scanty. This study sought to establish the recent STEM trends that reflect the educational reality on female students participation in STEM disciplines between 2009-2013. Second, the institutional and curriculum based limitations are presented generally and not specifically. This makes it hard to bring about meaningful interventions. This study seeks to establish concrete institutional and curriculum based limitations that appear to hinder STEM female students from competing with the STEM male students. Third, the existing educational gender policies and interventions are evidently bringing little impact in female students

participation on STEM disciplines. This can be attributed to lack of identification of problems that lead to less effective policies and interventions. This study sought to evaluate existing educational gender policies and interventions that can increase female participation in STEM disciplines.

In essence, lack of research into the intersection of these four areas: the subject of access and participation of female students in STEM disciplines, institutional-based limitations, the gendered nature of STEM disciplines and ensuing policies and interventions formed the central focus of this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research design that was used in the study, the study locale, target population, sampling techniques and the sample size, research instruments, piloting, data collection procedures and analysis and lastly the ethical considerations.

3.2 Research Design

This study adopted a descriptive survey research design entailing both qualitative and quantitative methodologies including survey and observation. A descriptive survey design involves obtaining pertinent and precise information concerning the current status of phenomena and wherever possible draw valid general conclusions from the facts discovered (Lokesh, 1984). Reduced to its basic elements, a survey design involves posing a series of questions to willing participants and summarizing their responses with statistical indices and then drawing inferences about a particular population from the responses of the sample (Lokesh, 1984; Bell, 2005 & Orodho, 2008). Surveys also aim at obtaining information, which can be analyzed, patterns extracted and comparisons made (Bell, 1993; Kombo & Tromp, 2006). The design was, therefore, appropriate for this study since the researcher was interested in exploring interventions to encourage female students participation in science, technology, engineering and mathematics (STEM) disciplines in Kenyan public universities.

The design allowed the researcher to describe, explain and examine facts, trends and patterns that emerged from the study. Kerlinger (2002) observes that a descriptive survey

focuses on people, beliefs, opinions, attitudes, motivation and behaviour. The survey method addresses points of views or attitudes that are held, processes that are going on and effects that are being felt and trends that are developing. Surveys are also cost-effective and have the advantage of reaching a large number of individuals in a short time and that is why the design was appropriate for this study (Orodho, 2009).

3.3 Study Locale

This study was carried out in three selected public universities in Kenya, namely; University of Nairobi (UoN), Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Egerton University (Appendix XVI). University of Nairobi is located in Nairobi town in Nairobi County in Nairobi Province. It is situated along university way, Uhuru highway and Harry Thuku road. Jomo Kenyatta University of Agriculture and Technology is located in Juja, near Thika in Kiambu County in Central Province. It is around 15km from Nairobi town off Nairobi Thika highway. Egerton University is located in Njoro, Nakuru in Nakuru County in the larger Rift Valley Province. It is around 5km from Nakuru town off Nakuru Eldoret road. The universities were purposively selected based on their strong traditions in STEM orientation, STEM facilities and high students' enrolments (KNBS, 2014). They provided contexts that were representative of the other public universities.

3.4 Target Population

The target population for this study was 8475 third year-female students in STEM disciplines, registrars in charge of academic affairs, affirmative action directors, deans of faculties offering STEM disciplines, and female faculty members teaching STEM

disciplines. In addition, a small group of male students in STEM disciplines were also targeted for their views on female participation in STEM disciplines. All these were sampled from the selected universities.

3.5 Sampling Techniques and Sample

This section outlines the sampling techniques and the sample drawn from the target population for the current study.

3.5.1 Sampling Techniques

The study employed three sampling techniques, namely; purposive, stratified and simple random sampling. Purposive sampling was guided by the criteria of strength in STEM orientation, STEM facilities and student enrolments. Thus, three public universities; UoN, JKUAT and Egerton were selected out of the seven existing public universities at the time of the study. These three were considered representatives of the other public universities. STEM departments and all the key informants that included registrars, deans of STEM disciplines, STEM female faculties, directors of gender and affirmative action and female students pursuing STEM discipline were also purposively sampled. This is because the researcher was interested in getting specific respondents that bear attributes that could achieve the study objectives and is in line with survey study procedures that require inclusion of informants with information concerning the area of study (Orodho, 2008). Second, stratified sampling was used to sample students pursuing STEM disciplines into five different areas, namely; Bachelor of Science, Engineering, Agriculture, Computer Science, and Health Sciences. Once stratified this way, random sampling was employed to select female students, and female faculty and deans in each

strata. Simple random sampling ensures that each and every respondent has equal chances to participate in the study. All the registrars in charge of academic affairs and the affirmative action directors were included in the sample.

3.5.2 Sample Size

Three out of the seven public universities targeted were sampled for the current study.

In each of the three universities, faculties offering STEM disciplines relating to the areas of focus for the study were also sampled. It was found that in total there were 18 such faculties distributed as follows: UoN, seven (7), JKUAT, five (5) and Egerton six (6). The faculties had a total of 85 departments relevant to the study distributed as follows: UoN 42, JKUAT 19 and Egerton 24. From the 85 departments a sample of 20 was drawn for the study. In addition, 15 out of the 18 deans of faculties offering STEM related disciplines were also selected for study.

With regard to students, there were a total of 8475 third-year female students pursuing STEM disciplines in the three universities however, a sample was taken from 3600 that were on session during the period of study. The 3600 female students pursuing STEM disciplines were selected from the 20 sampled departments which comprised both KUCCPS and SSP students in session in the 2012/2013 academic years where 10% (360) were selected for the study. According to Kombo and Tromp (2006), a minimum sample size of ten per cent is considered acceptable for a research study in a large population.

In relation to female faculty in the selected departments, there were a total of 153 out of whom 15 participated in the study. Further, three registrars in charge of academic affairs and three directors of gender and affirmative action were sampled. In addition, a sample of 24 males was included in the focus group discussions. In total the study worked with 444 respondents. Table 3.1 summarizes the study sample.

Table 3.1: Sampling Matrix

Population	Target Population	Sample	%
Universities	7	3	43%
Faculties	18	18	100%
Departments	85	20	24%
3 rd year STEM female students in the sampled universities	8475	3600	42%
3 rd year STEM female students in session in the selected departments	3600	360	10%
STEM female faculty	153	15	10%
Academic registrars	3	3	100%
STEM deans	18	15	83%
Directors of gender and affirmative affairs	3	3	100%

Source: Researcher Compilation

The key respondents in this study were STEM female students who filled in the questionnaires. Table 3.2 summarizes the distribution of the selected STEM female students who responded to the questionnaires across the selected universities.

Table 3.2 Questionnaires Distribution of STEM Female Students

Sampled Universities	STEM Faculties	STEM Departs	Total Respondents	KUCCPS Respondents	SSP Respondents	BSC	AGRI	ENG	H/S	C/SCI
UON	7	42	173	76	96	73	8	12	38	42
JKUAT	5	19	147	65	82	51	6	16	23	51
Egerton	6	24	40	18	22	16	3	3	5	13
Total	18	85	360	159	201	140	17	31	66	106

Source: Compiled from UoN, JKUAT and Egerton Universities Records

Key

UoN implies University of Nairobi

JKUAT entails Jomo Kenyatta University of Agriculture and Technology

STEM implies Science Technology Engineering and Mathematics

KUCCPS respondents entail Joint Admission Board respondents

SSP respondents entail Self-Sponsored Programmes respondents

BSC (Bachelor of Science disciplines) includes physical and biological sciences

ENG (Engineering disciplines) includes civil and construction engineering, electrical and information engineering, geospatial and space technology, mechanical and manufacturing engineering, environmental, and bio systems engineering, software engineering,

H/S (Health Sciences) includes dental sciences, medicine, infectious diseases, pharmacy, nursing, health sciences laboratory sciences

AGRI (Agricultural disciplines) includes faculty of agriculture, veterinary medicine, horticulture

C/SCI (Computer Science) includes information technology, computer technology and computer science

STEM DEPARTS entails STEM departments

As shown in Table 3.2, the study sampled third-year female students pursuing STEM disciplines in 2012/2013 academic year. The female respondents were considered useful with regard to giving comprehensive responses concerning the access and participation in STEM disciplines, STEM curriculum and besides the challenges they face as female students undertaking STEM disciplines. The study further randomly sampled 16 respondents (8 males, 8 females) from STEM disciplines from each of three sampled universities making a total of 48 additional FGD respondents. The FGD sought to gather

additional and comprehensive information relating to female participation in STEM disciplines.

Others respondents included in the study were: three registrars, three Directors of Gender and Affirmative Action, fifteen deans in STEM disciplines and fifteen female faculties teaching in STEM disciplines. All these were interviewed. The academic registrars, directors of Gender and Affirmative Action deans and STEM female faculty provided key information concerning female students enrolments, institutional and curriculum-based limitations, and the existing policies that inform the participation of female students in STEM disciplines in public universities. Table 3.3 summarizes the distribution of FGD and other respondents used in the study.

Table 3.3: Sample Matrix of FGD and Other Key Informants

Respondents	No. Of Respondents	UON	JKUAT	EGERTON
FGDs(Male &Female)	48	16	16	16
Registrars academic	3	1	1	1
Gender A.A	3	1	1	1
STEM Deans	15	5	5	5
STEM Female Faculty	15	5	5	5
TOTAL	84	28	28	28

Source: Compiled from UoN, JKUAT and Egerton University Records

3.6 Research Instruments

This study utilized six research instruments to generate data and develop vital knowledge for the discussions. The instruments included the questionnaires, interview schedules,

FGD guides, content analysis guides, observation guide and documentary analysis frameworks.

3.6.1 Questionnaires

The questionnaire was used to collect information from a sample of the third-year female students pursuing STEM disciplines in the three selected public universities in Kenya. The questionnaires enabled the researcher to obtain diverse opinions from a large group of respondents. It solicited their views on institutional-based limitations that continue to act as barriers to female student participation in STEM disciplines; nature of STEM curriculum in STEM disciplines and how existing policies and interventions have widened female student participation in STEM disciplines. In addition, the questionnaires helped gather the respondents' suggestions on complementary educational policies and interventions that could be adopted to increase participation of female students in STEM disciplines in Kenyan public universities.

3.6.2 Interview Schedules

An interview involves the gathering of data through direct verbal interaction between individuals on a topic of mutual interest for greater depth of data collection. An interview has a higher response rate because respondents are more involved and motivated and know more about the research problem thus tend to give insightful information (Cohen, & Manion, 1994). The interviews allow the interviewer flexibility to pursue ideas and thoughts that emerge and thus enhance clarity of issues being discussed. This also enables the researcher to acquire detailed information from the respondents. Interviews are

justified on the grounds that they are suited for occasions where the questionnaire is limiting more information (Lokesh, 1984).

The interviews were conducted to elicit key information from the Academic Registrars, Directors of Gender and Affirmative action, the Deans of faculties offering STEM disciplines and STEM female faculty from the three selected universities. The interviews collected data on access and participation of female students enrolled in STEM disciplines; institutional-based limitations; STEM curriculum limitations to women participation in STEM disciplines and on how the existing policies and interventions have improved participation of female students in STEM disciplines in the Kenyan universities. Further, the interviews enabled the study to solicit suggestions on institutional policies and interventions to encourage female participation in STEM disciplines in Kenyan universities.

3.6.3 Focus Group Discussion Guides

According to Kombo and Tromp (2006), FGDs comprise groups of between 6 and 12 persons who are facilitated by the researcher or a moderator to reflect and discuss specific issues of interest to the study. In FGDs, there is major interaction among the members, who work through the idea, issue or problem that the researcher has selected. In addition, the group interaction, rather than provision of answers to questions, produces insights to communicate perspectives. FGD participants may argue points, correct one another, give exceptions and support their points with examples from their own experiences (Kane, 1995). These kinds of group dynamics are key to analysing data from FGDs. In this

regard, the tool was used to triangulate data collected from other instruments. The instrument was useful in terms of its flexibility and probity in discussions, which illuminated group opinions and norms. In this study, FGDs provided an atmosphere for open dialogue and enabled the researcher to gain in-depth understanding of the respondent's views, opinions, experiences and perceptions towards female students participation in STEM disciplines. The FGDs elicited information on challenges STEM female students faced and suggested educational policies and interventions that would encourage participation of female students in STEM disciplines.

Male and female discussions were carried out separately as single sex discussions groups have been found to take advantage of homogeneity in experience, to enable individuals to freely express themselves on matters pertaining to sexuality. The principal researcher facilitated the discussion, while two research assistants recorded the discussion both manually by taking notes and electronically using a voice recorder. There were a total of six FGDs conducted in the three selected universities, two (one male, one female) from each university. Each FGD had 8 respondents totalling to 48 respondents. The constitution of the FGDs is summarized in Table 3.4.

Table 3.4: Distribution of FGD Respondents in STEM Disciplines

University	Gender	Total	SSP	KUCCPS	Eng	Agric	Comp/Sc	B/SC	H/Scie
UON	M	8	3	5	3	2	1	1	1
	F	8	2	6	2	1	1	2	2
JKUAT	M	8	4	4	2	3	1	1	1
	F	8	3	5	2	1	2	1	2
EGERT	M	8	4	4	2	2	1	1	2
	F	8	2	6	1	1	2	2	3
Total		48	18	30	12	8	9	8	11

Source: Compiled from FGD respondents from the sampled universities

As evident in Table 3.4 above, FGD respondents were students pursuing STEM disciplines. This mix of the gender for this sample was intended to help establish respondent's opinions on female participation in STEM disciplines in public universities from both male and female students' perspectives. Male FGDs provided independent and objective opinions on female participation in STEM disciplines. During the discussion, the researcher took interest in non-verbal gestures and hesitation, both of which signal alternative interpretation, made connections between the different ideas from the participants.

3.6.4 Documentary Analysis Framework

Documentary analysis relies on documents as sources of data (Peil, 1995). The researcher analysed records from the sampled institutions particularly on enrolment and graduation trends of the years 2009 -2013 of STEM disciplines. This was to establish the associated enrolment and participation trends for female students in STEM disciplines.

Documentary analysis was used as a supplementary method of gathering information especially from institutional records. Data were obtained from Joint Admission Board (KUCCPS) and universities SSP records on enrolments and participation of STEM discipline students in public universities.

3.6.5 Content Analysis Guide

The researcher used content analysis as a research tool to examine emerging patterns in the STEM textbooks and learning environments by focusing on the actual content and internal features. Curriculum materials sampled for content analysis included STEM text books and STEM teaching and learning resource materials. The STEM textbooks were sampled from course outline reading lists obtained from the five STEM deans who confirmed that they were the referenced class texts. In essence, the content analysis process aimed at determining gender bias as demonstrated by the presence of certain words, concepts, themes, phrases, characters, sentences, diagrams, photographs and illustrations within STEM textbooks, resource materials and learning environments (Obura, 1991). The texts were coded, and then organised thematically into manageable categories on a variety of levels and the results were used to make inferences about the messages within the texts that indicate pertinent features of coverage or the intentions, biases, prejudices, and oversights of authors on women participation in STEM disciplines (Palmquist's,1990). Thus, the process became vital in quantifying gender biases in the STEM curriculum in an objective manner. This enabled the researcher to achieve objectives two and three.

3.6.6 Observation Guide

Observation guide attempts to derive data directly rather than relying on the report of the respondents, as done in the case of interview (Kombo & Tromp, 2006). According to Peil (1995), observation involves more than just looking at what is going on. It also includes listening, asking questions and often participating in the activities of the group to get first-hand experience of what daily life involves. Observation varies on a continuum from complete participation of the observer to complete non-participation where the observer takes no part and has no contact with those being observed (Patton, 1990). The study undertook direct observation of the teaching and learning process whereby a semi-structured direct observation guide was used during STEM practical lessons to record and analyse STEM learning environments. The researcher sat in the STEM lecture rooms during the teaching-learning process and manually recorded direct observations of specific STEM lessons in addition to taking photographs of the STEM learning environments. Observation focussed on the male and female interactions, learner-faculty interactions, gender friendly learning environments, learning facilities and equipment, general class arrangement and the STEM language used during the STEM learning process.

A semi-structured observation guide was preferred because it allowed for considerable flexibility in the research process and provided complete and direct information relating to STEM teaching and learning environment in an objective manner. In addition, the guide provided systematic rather than haphazard or opportunistic observation to increase the validity of the results.

3.7 Pilot Study

To enhance reliability and validity of the research instruments, a pilot study was conducted. This was done in Kenyatta University as it has similar characteristics with the three selected Universities in terms of the STEM disciplines orientation. The pilot study enabled the researcher to determine the extent to which the research instruments were able to provide reliable and valid information (Kombo & Tromp, 2006). Piloting revealed that some of questions in the questionnaire for female students pursuing STEM disciplines were too lengthy, ambiguous or repetitive. Furthermore, some items on the interview schedule were found unclear on the information they sought. Consequently, after the piloting, adjustments, review and modifications were made to each of the items in the relevant research instruments.

3.7.1 Validity of the Instruments

According to Orodho (2008), validity is a non-statistical method used in ascertaining the content applied in research tools such as questionnaire and structured interviews. Validity indicates the degree to which an instrument measures what it is supposed to measure. In other words, validity is the degree to which results obtained from the analysis of the data actually represent the phenomena under study. To ensure validity, triangulation of data collection instruments was employed. Triangulation entails use of more than one method of data collection. Therefore, data for the study were collected using questionnaires, FGDs, interviews and observation. This helped ascertain the correctness of the information got from one instrument as well as to fully explain the richness and complexity of human behaviour by studying it from more than one perspective.

3.7.2 Reliability of the Instruments

Mugenda and Mugenda (2003), define reliability as a measure of the degree to which a research instrument or a measuring procedure yields consistent results or data after repeated trials. Standardization of the research instrument for the study was done through a number of ways: First, the researcher went through the instruments and compared them with the set objectives to ensure that the instruments provided answers to the set questions and fulfilled the set objectives. Second, expert input from the supervisors and authorities in the area of study was sought to scrutinize the relevance of the items on the instruments against the set objectives. The instruments were then piloted in Kenyatta University within a population similar to the target population. The piloting enabled the researcher to eliminate ambiguity in question items, establish problems in administering the instruments, test data collection instructions, establish the feasibility of the study, and to anticipate and amend any logical and procedural difficulties regarding the study.

The test-retest method was used to check the reliability of the questionnaires. The instrument was administered to respondents in the pilot study and was then scored manually. After two weeks, the same instrument was re-administered to the same respondents and scored manually. A comparison of the first and second score was made using Pearson's product moment correlation coefficient to determine the reliability of instrument. A correlation coefficient of 0.8 was obtained and was considered high enough to judge the instrument as reliable for the study.

3.8 Data Collection Procedure

Data collection was organized into two main phases. The first phase was the preliminary phase or what Patton (1990) refers to as the entry stage of data collection. This involved obtaining official clearance both at the Ministry of Education, Science and Technology (MoEST) and university levels. The second phase consisted of the actual data collection from the sampled universities.

3.8.1 Data Collection

Primary data were collected using four main tools, namely; questionnaires, interviews, FGD and observation. Secondary data were sourced through documentary analysis framework of relevant institutional documents and content analysis guide of STEM teaching and learning materials. These tools generated both qualitative and quantitative data.

3.8.2 Administering the Questionnaires

The researcher liaised with deans of the faculties to get the class schedules for the STEM disciplines in the sampled universities. With the help of three research assistants from Kenyatta University, the researcher administered questionnaires to the sampled female students pursuing STEM discipline in different STEM faculties from the three selected universities. The questionnaires were administered during the lecture sessions.

3.8.3 The Interviewing Process

The researcher first made a courtesy call to the identified registrars, deans and directors of gender and affirmative action to book an appointment with each one of them agreeing on a specific date, time and place for the interview. When booking the appointments, the

researcher introduced herself, explained the study expectations to each of the respondents who had voluntarily accepted to participate in the study. The researcher ensured them of confidentiality of the information given. The interviews were conducted with the help of research assistants and data were recorded both manually and electronically.

3.8.4 Secondary Data Collection

Secondary data were drawn from the analysis of relevant institutional documents and teaching and learning materials. Among documents analyzed included enrolment records, graduation booklets and STEM textbooks

3.9 Data Analysis and Presentation

Data obtained were analyzed qualitatively and quantitatively. The questionnaires contained both closed and open-ended questions. The closed questions were analysed quantitatively. The open-ended questions were thematically coded and thematic patterns analysed. Data from the interviews, FGDs observation and the teaching learning materials were first transcribed where necessary then thematically analysed and patterns highlighted. All the quantitative data gathered were further analysed using the Statistical Package for Social Sciences (SPSS) and summarized using descriptive statistics specifically frequencies, means, percentages. Further data on SSP and KUCCPS female admission and male and female enrolment in soft and hard sciences was analysed using chi-square test. The results were then presented in form of tables and figures.

3.10 Logistical Considerations

The researcher obtained permission from the Ministry of Higher Education to carry out research in accordance with the requirements for the research of this magnitude. Further, permission and consent were sought from relevant authorities at the sampled universities to be allowed to collect data in the STEM disciplines.

3.11 Ethical Considerations

The researcher guaranteed the privacy and confidentiality of the respondents by not indicating their names both in the instruments and the report. The purpose of the study and the data gathering process were clearly explained to all the respondents in order to obtain their informed consent to participate in the study. Photography and recording of interviews were done with the express consent of the respondents concerned. After collecting the data, the researcher sent an appreciation note to the respondents as a reciprocal gesture.

CHAPTER FOUR

PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.1 Introduction

The chapter presents the findings and discussion of the study based on the five research objectives. To recapitulate, the following were the research objectives as outlined in the first chapter of this study.

- i. Establish trends in female students access to STEM disciplines in Kenyan public universities between years 2009 to 2013.
- ii. Establish female student's participation in STEM disciplines in Kenyan public universities between years 2009 to 2013.
- iii. Investigate institutional based limitations that continue to bar female student participation in STEM disciplines.
- iv. Explore the gender responsiveness of the STEM curriculum to the learning needs of female students in STEM disciplines.
- v. Evaluate existing educational policy interventions that influence trends in female participation in STEM disciplines in Kenyan public universities.

The chapter is organized into seven sections revolving around demographic information of participants and the objectives of the study. After the introduction, details of the characteristics of the study sample and the demographic information of the participants are outlined. The rest of the chapter concentrates on the key issues of female access to and participation in STEM disciplines in Kenyan public universities, institutional-based limitations to female students' participation, gender responsiveness of the STEM

curriculum and the existing institutional interventions to encourage female participation in STEM disciplines. The chapter closes with the section that summarises and draws some conclusion from the presented findings and discussions.

4.2 Characteristics of the Study Sample

This study sought to explore interventions to encourage female students' participation in Science Technology, Engineering and Mathematics (STEM) disciplines in Kenyan public universities. To realize the purpose of this study, three public universities namely; University of Nairobi, JKUAT and Egerton universities were purposively selected out of the existing seven universities during the period of the study. The universities were selected based on their strong traditions in STEM orientation and high students enrolments. The universities sampled had in place gender policies and interventions such as Affirmative Action (AA), institutional policies and interventions such as SSP, financial aid, inter-faculty transfers, mentoring programmes and career guidance programmes.

The universities were aware of the need for increased female access and participation in STEM disciplines as indicated in the sampled universities strategic plans. Further, the universities provided contexts that were representative of the other public universities (Strategic plans, Egerton, UoN, JKUAT, 2012). Within the universities, female students in the STEM disciplines, female faculty teaching in the STEM disciplines, registrars in charge of academic affairs, deans of faculties housing STEM disciplines, directors in charge of gender and affirmative action and some male students pursuing STEM disciplines formed the sample for the study.

4.3 Demographic Information of Participants by Their Universities

This study sought to establish the gender, average age, category of secondary school attended, mode of admission into the university and STEM discipline students enrolled. This background information was relevant as it has implications for access, participation and interventions to encourage female participation in STEM disciplines which were the major concerns of the current study. Table 4.1 presents the demographic information:

Table 4.1: Demographic Information of Participants by Universities

UNIVERSITY	UoN			JKUAT		EGERTON	
Gender	M		F	M	F	M	F
	8		181	8	155	8	48
Average age	22		22	22	22	22	22
Category of secondary school attended	National	4	70	3	52	4	33
	County	3	83	3	63	2	42
	District	1	17	2	14	2	10
Mode of admission to university	KUCCPS	3	78	3	68	4	20
	SSP	5	103	5	87	4	28
STEM disciplines enrolled	Eng	3	14	2	18	2	4
	Agri	1	9	3	7	2	4
	Comp SC	2	43	1	53	1	15
	B/SC	1	75	1	52	1	17
	H/SC	1	40	1	25	2	8

Source: Compiled from UoN, JKUAT and Egerton University Records

4.4 Trends in Female Students Access to STEM Disciplines

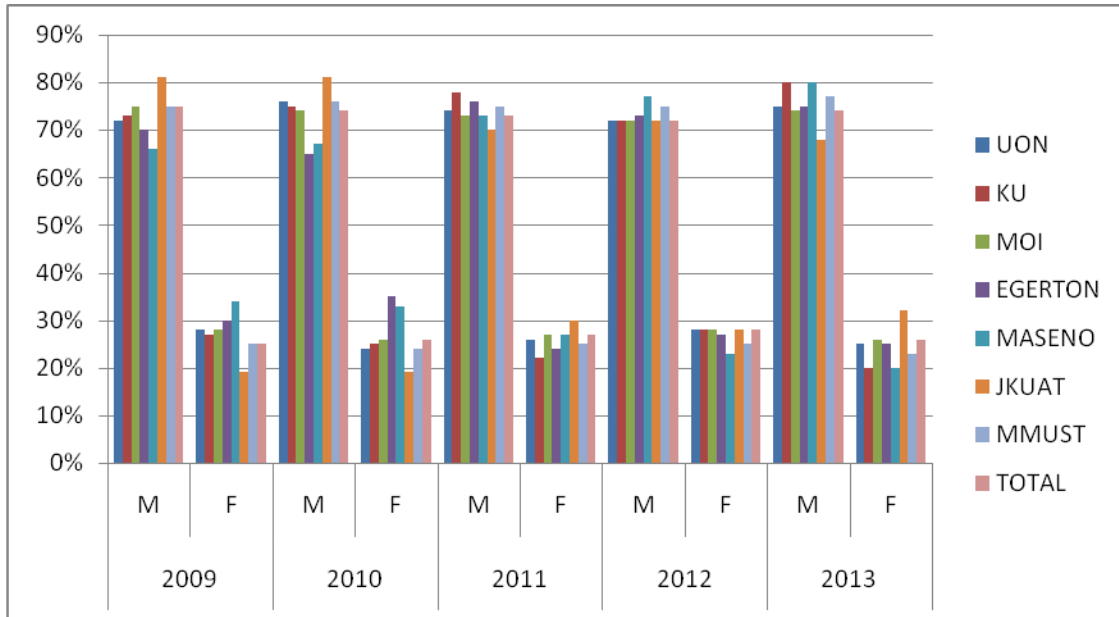
The first objective of this study focused on trends in female students access to STEM disciplines in Kenyan public universities. First, an analysis of the trends in all seven public universities in existence during the period of the study, (between 2009-2013). The

data accessed from KUCCPS records are presented and discussed below. Thereafter an in-depth analysis of the trends in the three sampled universities follows.

4.4.1 Trends in Students Access to STEM Disciplines in the Seven Kenyan Public Universities in the Period between 2009 and 2013

A general trend in students access to STEM disciplines in the seven Kenyan public universities in existence during the period 2009-2013 were first analysed. The information provided a broad base upon which trends of access by female students in the selected universities could be analysed. Data for the seven universities were obtained from the Kenya Universities Colleges Central Placement Service (KUCCPS) secretariat for first year KUCCPS students. Figure 4.1 presents the findings on general trends.

Figure 4.1: KUCCPS STEM Admission Trends for Seven Public Universities between 2009 and 2013



Source: Data Compiled from Joint Admissions Board (2009-2013) records

KEY

JKUAT: Jomo Kenyatta of Agriculture and Technology

KU: Kenyatta University

MMUST: Masinde Muliro University of Science and Technology

From Figure 4.1, it can be seen that between 2009 and 2013, the overall 5-year trend for KUCCPS female enrolment in STEM disciplines in the seven public universities remained below 30%. JKUAT, which is one of the three sampled universities, had a female enrolment in STEM disciplines that was below 20% in 2009. However, five years later in 2013, this enrolment had risen to 32% which is more than ten percentage increase. In comparison, Maseno University female enrolment in STEM disciplines had plummeted by nearly 14 per cent from 34% to 20% in the same period. At University of Nairobi, which is one of the sampled universities, female enrolments oscillated within

four percentage between 28% in 2009 and down to 25% in 2013 with lowest female enrolment in STEM being 24% in 2010. The other sampled university, Egerton, registered 30% and 35% in 2009 and 2010 respectively but began plummeting to rest at 25% in 2013. From this figure, it is clear that apart from JKUAT that demonstrated upward trend in female enrolment in STEM disciplines, all the other six universities, including the two sampled ones, had generally a downward trend in female enrolment in STEM disciplines compared with that of the male. Arguably, if this general situation is not addressed and appropriate evidence-based measures implemented to reverse the trend, it is most likely that deterioration of overall female enrolment in STEM disciplines would continue to decline to the detriment of the national objectives of attaining gender equality and equity not only at all levels of education but also through educational transitions into the workforce. Thus, by implication, Kenya would be failing in the education goal stipulated in the sustainable development goals (SGDs).

4.4.2 JKUAT Female Enrolment in SSP and KUCCPS in STEM Disciplines

To ascertain distribution of STEM opportunities across STEM disciplines, the study further obtained data from JKUAT for the 2012/2013 academic year. While fewer females were admitted to the institutions through KUCCPS, there has been accumulated evidence to suggest that the SSP stream often had more female students. These data were not available from all the sampled universities, but for JKUAT where the data were availed, this assertion was confirmed. There were 4017 female students in STEM disciplines out of which 55.8% were enrolled in SSP compared to 44.2 % in KUCCPS

programmes. Comparative KUCCPS and SSP admission trends for JKUAT were provided for the purposes of illustrations as shown in Table 4.2.

Table 4.2: JKUAT Comparative Enrolments for Female KUCCPS and SSP STEM Student in 2012/2013 Academic Year

STEM Discipline	KUCCPS	SSP	Total
Agriculture	449(78.8%)	121(21.2%)	570
Engineering	341(54.1%)	290(45.9%)	631
Bachelor of Science	777(54.4%)	651(45.6%)	1428
Computer Science	137(18.2%)	620(81.8%)	757
Health Sciences	72(11.4%)	559(88.6%)	631
Total	1776(44.2%)	2241(55.8%)	4,017

Source: Compiled from JKUAT Enrolment Records in 2012/2013 Academic Year

From Table 4.2, it is evident that KUCCPS enrolments in Agriculture, Engineering and Bachelor of Science is higher standing at 78.8%, 54.1% and 54.4% respectively compared to the SSP 21.1%, 45.9% and 45.6% respectively for the same disciplines. On the other hand, Computer Science and Health Sciences had higher enrolments in the SSP mode of admission with 81.8% and 55.8% respectively compared to KUCCPSS at 11.4% and 44.2% respectively.

The findings presented above could be attributed to the fact that female students in SSP have a choice and flexibility of admission criteria due to the low cut-off-point requirements. The SSP is relatively expensive mode of admission and targets the students from high social economic status. The *East African Standard* on 15th may 2013 reported that SSP STEM students have options to choose the STEM discipline of their choice based on their interests and job market opportunities. They also can afford to pay fees

than the KUCCPS STEM students. They have an upper hand over area of specialization unlike the KUCCPS STEM students which is determined by the KUCCPS. The government should re-consider formulating a policy which will ensure that bright and needy students who score highly in KCSE are given priority in public universities. Public universities should not block out bright students who miss the cluster points by minute decimals to replace them with SSP students. There is a way in which the country does not utilise the sharp brains around if, for instance, an A student is denied a chance to pursue a degree in medicine and surgery because of some decimal points yet the same faculty admits SSP student who scored as low as a B plus. This portrays the ever widening inequality gap between the rich and the poor: [.http://www.standardmedia.co.ke](http://www.standardmedia.co.ke).

The study further established that female students are more inclined to Health Sciences especially in nursing and not the core health disciplines such as medicine and surgery and dental surgery. Similarly, more female students in computer disciplines in SSP as compared to KUCCPS are inclined to information science and not computer engineering. This is due to the perceived stereotypes on the femininity of the soft sciences and their opportunities in the job market. This makes them more attractive to the female students. Comparably, the study by NSB (2010) indicates that female students are attracted to Health Sciences due to the work involved, psychological and socio-cultural factors. Computer Science attracted more female SSP students and this was attributed to its currency and is highly attractive in the job market. This notwithstanding Table 4.3 above shows that Agriculture attracts few female SSP STEM students despite the low cut-off point requirement by universities. The study found that lack of interest in Agriculture was

due to the fact that it was associated with perceived masculinity, socio-cultural stereotypes and prejudices associated with the discipline as well as the job market.

The study further conducted a chi-square test on the mode of SSP and KUCCPS admission into STEM disciplines in JKUAT in the 2012/2013 academic year. In essence, the chi-square test enabled the study to establish levels of significance between enrolment trends of female students in SSP and KUCCPS programmes. The findings of the chi-square test are tabulated in Table 4.3 below:

Table 4.3: Cross Tabulation of Mode of Admission and Female Enrolment in STEM Disciplines in JKUAT 2012/2013

STEM discipline	KUCCPS		SSP		Row Totals
	Observed Frequencies	Expected Frequencies	Observed Frequencies	Expected Frequencies	
Bachelor of Science	777	261	651	218	1428
Engineering	341	54	290	46	631
Agriculture	449	64	121	17	570
Computer Science	137	26	620	117	757
Health Sciences	72	11	559	88	631
Column Totals	1776(44.2%)		2241(55.8%)		4017
Computed χ^2	46.19				
Table χ^2	9.88				
Df	4				
Alpha	0.05				

It is evident from Table 4.3 that out of a total sample of 4017, 1776 (44.2%) and 2241(55.8%) were KUCCPS and SSP respectively. A chi-square test of relationship was conducted to establish whether the two variables (mode of admission and STEM

disciplines) were independent of each other. The calculated χ^2 was 46.19, while the table χ^2 (alpha = 0.05 df = 4) was 9.88. Since the computed chi-square value is higher than the table value, it means there is a relationship between the mode of admission and female students enrolments in STEM disciplines; in other words, the two variables are not independent of each other. Enrolment trends in STEM discipline in JKUAT indicate that female students enrolments were higher through the SSP mode of admission compared to the KUCCPS. Interesting to note from the chi-square test is that the result concurs with the studies by Morley (2006) and Bunyi (2003), who argue that SSP mode of admission broadens access opportunities for female students in STEM disciplines especially in soft sciences offered in the Kenyan universities.

KNBS (2015) confirmed high female enrolment in SSP in health sciences in Kenyan universities. Data were obtained from University of Nairobi, Moi University, Kenya Methodist University, University of Eastern Africa Baraton, Kenyatta University, Egerton University, Aga Khan University Hospital, Mount Kenya University and Masinde Muliro University of Science & Technology. Three of the disciplines represented in the findings were medicine, dental surgery, nursing and bio-chemistry. From 2010 to 2013, data were analysed to show the current SSP and KUCCPS trends in both public and private universities. High female enrolments were recorded in medicine across the 2010-2013 academic years. The study by the Economic Survey (2015), noted that male and female enrolment in health sciences was at par at 50%.

Female students recorded higher enrolments in Bachelor of nursing at 66% compared to male students at 34% due to the femininity and job attractiveness of the discipline. Further the study established that the presence of private universities like Methodist and Agha Khan has pushed the number of females up as shown in Table 4.4. Bachelor of Science (Biochemistry) and Pharmacy have low female enrolment at 42% and 48% respectively. The trend in dental sciences is similar to medicine and surgery with female enrolment at 48% as shown in Table 4.4 below.

Table 4.4: Trends in Number of Undergraduate Medical Students by Course and Sex between 2010-2013 Academic Years

Undergraduate	2010/2011		2011/12		2012/13		Total	
	M	F	M	F	M	F	M	F
Medical Degrees								
Medicine and Surgery	1,317	1,074	1,373	1,099	1,649	1,521	54%	46%
Bsc(Nursing)	577	1,090	630	1,302	781	1,368	34%	66%
Dental Surgery	103	91	118	100	138	130	53%	47%
Environmental Health	286	233	307	233	409	671	46%	54%
Pharmacy	281	205	168	130	207	259	52%	48%
Bsc(Bio-Chemistry)	623	433	321	180	186	194	58%	42%
Sub-Total	3,187	3,126	2,917	3,044	3,370	4,143	50%	50%

Economic Survey 2015 showing data for University of Nairobi, Moi University, Kenya Methodist University, University of Eastern Africa - Baraton, Kenyatta University, Egerton University, Aga Khan University Hospital, Mount Kenya University & Masinde Muliro University of Science & Technology.

The above trend in Table 4.4 above is an indication that female enrolment in all the disciplines closing. The data provides notable steady rise in enrolment each year in all the disciplines apart from biochemistry. Female students enrolment in Bachelor of Nursing was higher than that of males at 66% and males at 34%. This can be attributed to socio-

cultural and institutional practices, SSP mode of admission, femininity of soft sciences. Further, the job market encourages female students participation in Health sciences and more so Degree in Nursing. Further, the data inform the study that while institutions have limited options for females in sciences through such interventions as affirmative action and KUCCPS admissions, the private programmes seem to be providing this opportunity. The second implication is that the lower female enrolments in STEM especially through KUCCPS are not a consequence of female capacity to pursue STEM disciplines. Universities lack opportunities and are not able to adequately address gender inequality in STEM disciplines especially the hard sciences. This is despite the gender mainstreaming campaigns and strategic plans in place in the universities (<http://www.standardmedia.co.ke>).

These findings are further confirmed by Hill et al., (2013) in the study “Why So Few” whereby they indicated that environmental and social barriers continue to block women from participating in STEM disciplines and more so in Engineering. Further, Dwerk and Leggett (1988) argue that female students question their abilities and lack confidence to pursue STEM disciplines and are likely to give up because they believe they are not “good enough” as the society restrains them to pursue feminine and not masculine disciplines.

To further address Objective One, the researcher collected secondary data from KUCCPS admission records for the three selected public universities in the period 2009-2013 in different STEM faculties. These included the University of Nairobi, Egerton University

and JKUAT. The admission data were based on gender, year of admission and the STEM disciplines. The collected secondary data enabled the researches to profile the enrolment trends of male and female STEM students in the three selected universities for the last five years. The findings are presented in Table 4.5 below:

Table 4.5: KUCCPS STEM Admission Trends in the Three Selected Public Universities for the Years Between 2009 to 2013

STEM DISCIPLINE	UNIVERSITY	MALE	FEMALE	TOTAL
ENGINEERING	UON	2570	830	3400
	JKUAT	1870	445	2315
	EGERTON	1103	216	1319
	TOTAL	5543(79%)	1491(21%)	7034
AGRICULTURE	UON	1560	546	2106
	JKUAT	1246	346	1592
	EGERTON	667	136	803
	TOTAL	3473(77%)	1028(23%)	4501
COMPUTER SCIENCE	UON	2347	658	3005
	JKUAT	1567	335	1902
	EGERTON	462	222	684
	TOTAL	4376(78%)	1215(22%)	5591
HEALTH SCIENCE	UON	1723	760	2483
	JKUAT	986	335	1321
	EGERTON	369	173	542
	TOTAL	3078(70%)	1268(30%)	4346
BACHELOR OF SCIENCE	UON	4923	2056	6979
	JKUAT	2356	1287	3643
	EGERTON	1470	672	2142
	TOTAL	8749(69%)	4015(31%)	12764
	GRAND TOTAL	25219(73%)	9017(27%)	34236

Source: Data compiled from KUCCPS Records

Information in Table 4.5 indicates that STEM female students enrolment are less than a third compared to the male students in all STEM faculties in the three selected universities. The lowest female enrolment is in engineering discipline at less than a quarter compared to male student enrolment that was recorded at 79%. The same trends were recorded in Computer Science and Agriculture. Relatively higher female enrolment was recorded in Bachelor of Science and Health Sciences at 31% and 30% respectively.

Higher representation of female students in Bachelor of Science and Health sciences discipline could be attributed to the STEM female students' perception that the two disciplines are soft sciences and Engineering and Agriculture are hard sciences and masculine. Health sciences are perceived as nurturing disciplines and female students are motivated to select them as a scenario that is less experienced in the other STEM disciplines and as noted by Kane (1995), this is as discussed below from FDGs interviews.

To establish whether there was a significant relationship between hard and soft sciences, a chi-square test of association was conducted. The results are presented in Table 4.6.

Table 4.6: Students Enrolment in Soft and Hard Sciences Cross Tabulation by Gender

STEM Disciplines	Male		Female		Row Totals
	Observed	Expected	Observed	Expected	
Soft Sciences	1722	864	1231	618	2953
Hard Sciences	2078	1035	851	424	2929
Column Totals	3800	1899	2082	1042	5882
Computed χ^2	4.0				
Table χ^2	3.841				
Df	1				
Alpha	0.05				

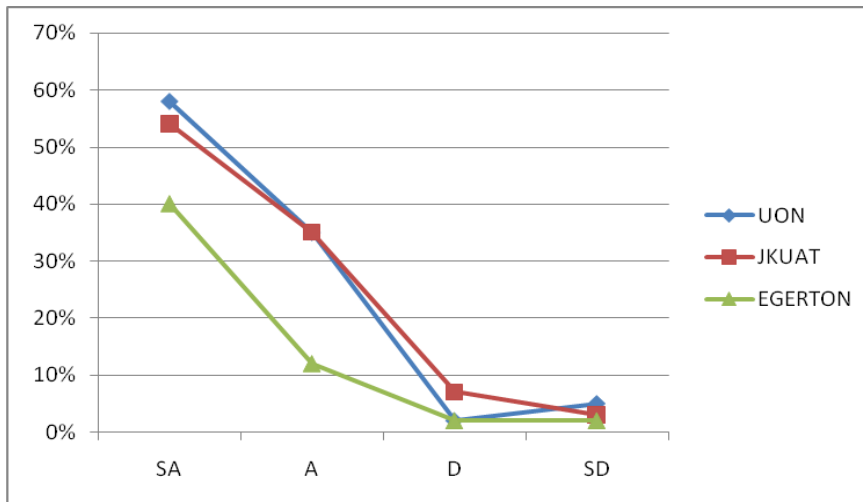
The findings from Table 4.6 show that there is a relationship between gender and choice of soft and hard sciences. The computed value of chi-square is 4.0 while the table chi-square value at alpha 0.05 and df 1 is 3.841. Since the computed chi-square value is higher than the table value, it means that there is a relationship between gender and soft and hard sciences. The two variables are not independent of each other and the chi-square test is statistically significant. Therefore, this study established that choosing a soft or hard STEM discipline is influenced by gender. This then confirms female student's attraction to soft sciences as compared to hard sciences in universities as a result of gender typing of institutions and STEM disciplines as discussed on page 92.

The study established low enrolments of KUCCPS female students in STEM disciplines as compared to SSP and this attributed to the high cut-off requirements, societal stereotypes on masculinity of STEM disciplines and the job market. Further enrolment in

STEM disciplines are categorized into soft and hard sciences due to the perceived masculinity of STEM disciplines and the job market demand. There are, thus fewer female students enrolled in Engineering and Agricultural disciplines as they are perceived as hard sciences compared to health sciences and computer Science disciplines which attract more female students. The findings of Objective One are manifestations of female under representation in STEM disciplines and particularly the hard sciences.

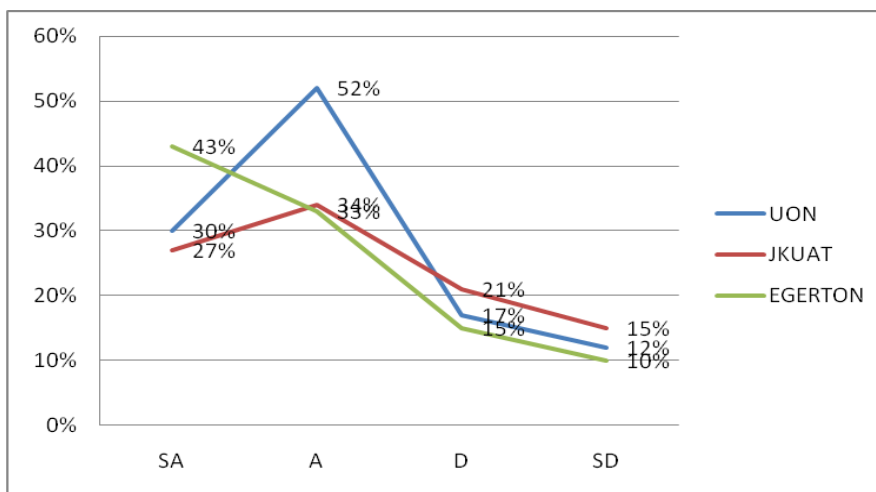
The findings on female students are under representation in STEM disciplines were confirmed by the sampled female respondents who indicated that high enrolments were in SSP especially in Health Sciences, which is perceived as soft sciences. Engineering and Agriculture had low female enrolments and is referred to as hard sciences. Majority, 316 (88%) of the female respondents agreed that female students are few in STEM disciplines whereas 223 (62%) of the respondents indicated that poor performance at KCSE in mathematics and sciences contributed to low female students enrolments in STEM disciplines whereas 122 (34%) disagreed. The KUCCPS high cut-off point requirement of mean grade A hinders female students from qualifying for the STEM disciplines as compared to SSP requirements, which has lower. Nevertheless, 248 (69%) of the female respondents expressed societal and institutional barriers and the perceived masculinity of STEM disciplines that make STEM unattractive to female students. Figures 4.2, 4.3 and 4.4 below present a comprehensive analysis of the same.

Figure 4.2: Female Respondents perceptions on Female Students' Enrolment in STEM Disciplines



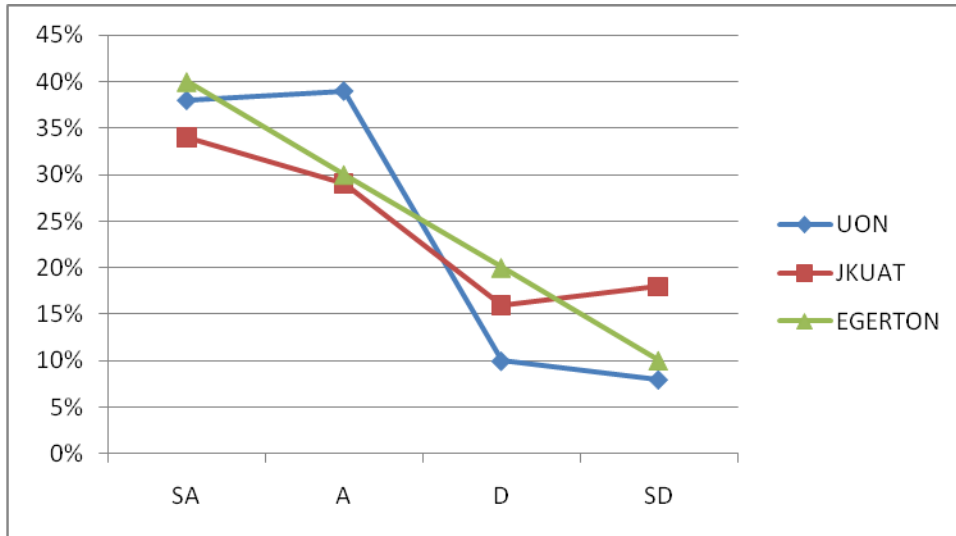
Source: Researcher (2013)

Figure 4.3: Female Students Respondents' Perceptions that KCSE Performance in Mathematics and Sciences Contributes to Few female Enrolments in STEM Disciplines



Source: Researcher (2013)

Figure 4.4: Female Students Respondents' Perceptions that Societal Stereotypes Contribute to Few female Enrolments in STEM Disciplines



Source: Researcher (2013)

In all the three universities, majority of the students agreed that female students are comparatively few in their STEM class with UoN and JKUAT almost at a par in their responses. Figure 4.4, above shows that over 70% of the female students in both UoN and Egerton agreed that the reason for having fewer female students enrolled in STEM disciplines in their university was because of comparatively poor performance of girls in KCSE mathematics and science. Further, over 65% of female respondents in Figure 4.4 indicated that Societal Stereotypes contribute to few female enrolments in STEM disciplines. This suggests that there was a considerable sample of female students who had other reasons which were not captured in the likert scale. For this reason, the researcher pursued these possible reasons through interviews and FGDs as will be presented in the chapter.

Interviews with the registrar of the UoN STEM deans, STEM female faculty and FGDs indicate that female students pursuing STEM disciplines are fewer compared to male students especially in hard sciences due to perceived masculinity and job market demand of the discipline as noted below:

Female students pursuing STEM disciplines are fewer compared to males. The most affected are Engineering and Agriculture disciplines. This is a result of poor performance of female students in Mathematics and Science subjects at KCSE and perceived stereotypes on masculinity of Engineering and Agriculture disciplines. Female students associate Mathematics and Sciences with masculinity and the societal expectations are that female students should take feminine disciplines and leave masculine disciplines to male counterparts (Engineering Dean, University C).

As much as there are barriers to female students participation in STEM disciplines...in some instances both KUCCPS and SSP female students are not attracted to the STEM hard Sciences even when they qualify ...in some instances they apply for interfaculty transfers to soft sciences where they feel at home (Registrar, University A).

In SSP, nursing and information technology attract more females students than other STEM disciplines. This is due to the societal expectations, femininity and perceived job opportunities of the disciplines (STEM Female Faculty, University B).

We are only two female students out of fifteen in my Electrical Engineering class. In mechanical Engineering there are no female students. Most females hardly qualify for Engineering disciplines and others are not interested as they have a perception that they are a male domain (Female FGD, JKUAT).

We are only three female students as compared to twenty male counterparts in Electrical Engineering. (Female FGD, UoN).

According to the information collected from the questionnaires and interviews, the low enrolment of female students in STEM disciplines is due to poor performance in mathematics and science subjects at KCSE as well as perceived societal stereotypes on the masculinity of the disciplines. UNESCO (2013) concurs that female students who perform well in mathematics and sciences still opt for the perceived feminine STEM

disciplines. Gender stereotypes and market attractiveness appear to be the most significant determinants of female enrolment in the STEM disciplines. This view is strongly supported by the views of UoN registrar who revealed that at times, due to stereotypes and the job market, there are instances of female students qualifying for the hard sciences but later seek interfaculty transfers to soft sciences where “they feel at home”.

Further interviews were conducted with the registrars, STEM deans and female faculty concerning the enrolment and admission trends among the SSP and KUCCPS female students pursuing STEM disciplines. The discussants confirmed that there are higher female enrolments in SSP as compared to KUCCPS. Further, female students are attracted to soft sciences more than hard sciences as presented below:

SSP is attracting more female students compared to the KUCCPS... due to the high cut point requirements of KUCCPS students, only a few female students qualify especially in the hard sciences (Registrar, University B).

KUCCPS female students are enrolled more in Agriculture...it is a hard science and there are many stereotypes on the masculinity of agriculture and engineering discipline even for the SSP students where the cut point requirements are low...in a class of 20 students in Bachelor of Food science Technology there were 13 female students (STEM Female Faculty, University B).

Civil and telecommunication engineering are more preferred by SSP female students compared to Mechanical and Electrical Engineering...there are 3 female students in telecommunication engineering and none in mechanical engineering...this is due to the perceived stereotypes and attractiveness of job market (Dean, Engineering, University B).

SSP attracts more female students in Computer Science and Health Sciences discipline due to the femininity of the disciplines and the job market attractiveness (Dean Computer Science, University B).

From the above views, some arguments can be deduced. For instance, in as much as the registrar of JKUAT attributes the low enrolment of female students in KUCCPS to the high cut off points requirements in hard sciences, the study and foregoing literature established that perceived stereotypes on masculinity of hard science play a significant role in shaping these trends. Accordingly, even when the SSP cut off points were lowered for the hard sciences these factors still come into play and impose certain limits to enrolment into STEM disciplines. The views by the STEM female faculty at JKUAT, despite painting a relatively different picture end up reiterating the fact those stereotypical perceptions of STEM disciplines (Agriculture and Engineering) are still significant determinants of enrolment trends in these disciplines. But the views by deans, faculties of Engineering and Computer Science, beyond confirming the deterministic role of stereotypes in enrolment into STEM disciplines, introduce another determinant, marketability or the market demand and market attractiveness.

The study established that even though cut off points may bar some female students from enrolling in some STEM disciplines, stereotypical perceptions and marketability of STEM disciplines, socio-cultural, institutional barriers and the existing educational policies and interventions currently tend to play a significant and deterministic role in low enrolment into STEM disciplines. It is interesting to note that this viewpoint is supported by literature reviewed in this study which also identified stereotypes and marketability of soft sciences as determinants of low female participation in STEM disciplines.

The study findings further confirm the global related discourse of female students under representation in STEM disciplines in the universities and especially in hard sciences are significant enough to elicit serious educational concerns for any government (FAWE 2014). The above findings confirmed studies by National Science Foundation [NSF] (2008) on female student under representation in STEM disciplines that enrolment in STEM disciplines is to a large extent masculine and a societal construction.

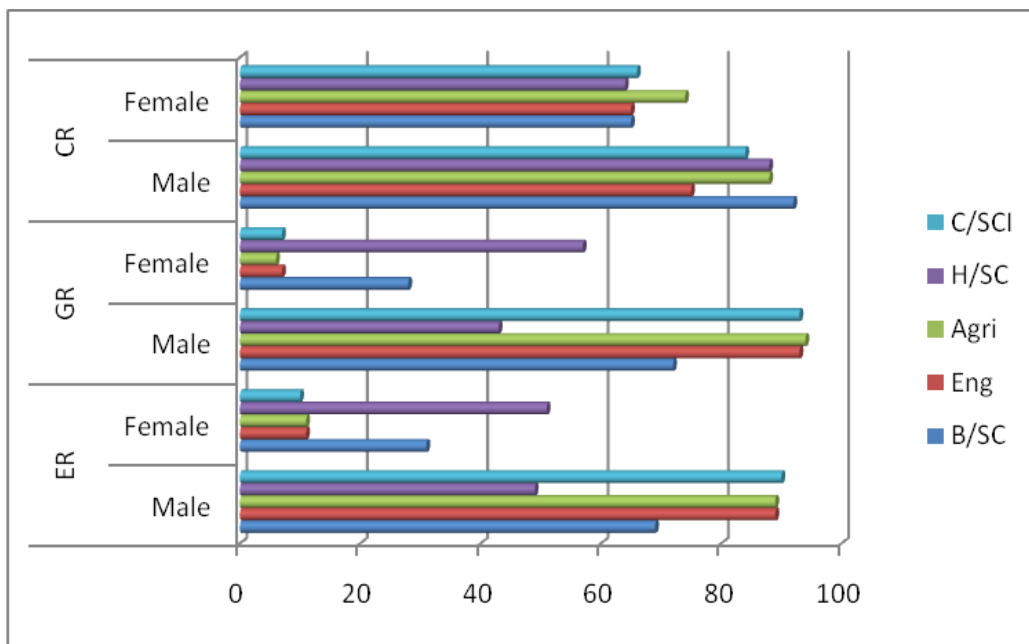
4.5 Female Students Participation in STEM Disciplines in Kenyan Public Universities

The Second Objective sought to establish trends in female students' participation in STEM disciplines in Kenyan public universities in 2009 and 2013 academic years. Participation trends were based on documentary analysis of completion rates, progression trends, graduation trends of male and female students in STEM disciplines. The enrolments, progression and graduation records from the three sampled public universities provided the basic data.

The study established that the participation trends of female students pursuing STEM disciplines were lower compared to males and especially in hard sciences such as engineering, Agriculture and Computer Sciences. Soft sciences such as health Sciences and Bachelor of Science disciplines had higher female participation rates. Participation rates were measured in terms of completion rates, progression rates and graduation trends of male and female students pursuing STEM. Female students had higher retakes, repetition, dropouts, poor performance and low attrition compared to male students' disciplines.

The study did an analysis of enrolment trends in 2008/9 academic year for students pursuing STEM disciplines against graduation trends in 2012/13 (for four and five years programmes) in Egerton University as a case in point. This enabled the study to establish the completion rates of female students pursuing STEM disciplines. Figure 4.5 presents the findings:

Figure 4.5: Completion Rates of KUCCPS and SSP STEM Students at Egerton University in 2008/9 and 2012/13



Source: Compiled from Egerton University Enrolment and Graduation Records

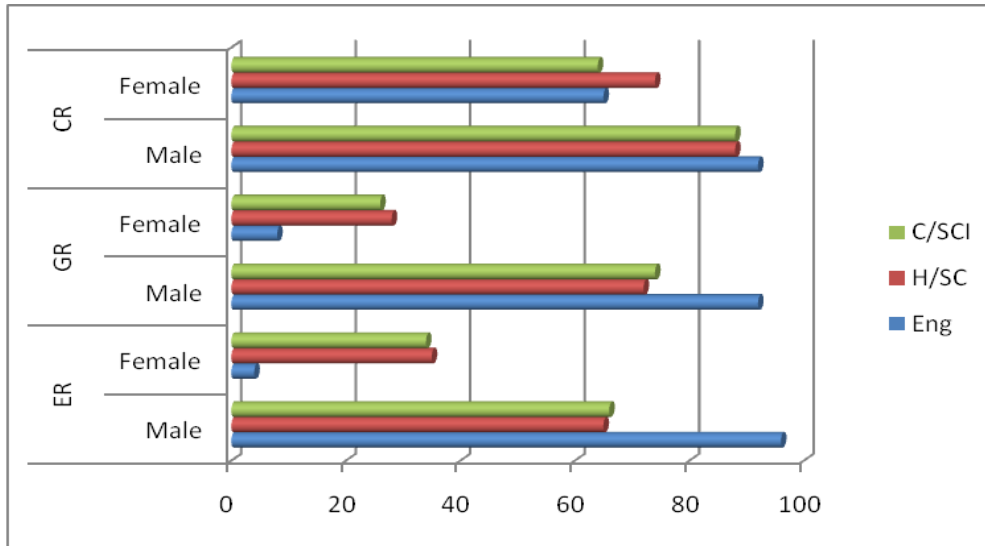
KEY:

ER:	Enrolment Rate
GR:	Graduation Rate
CR:	Completion Rate
B/S:	Bachelor of Science
ENG:	Engineering Disciplines
AGRI:	Agricultural Disciplines
C/SCI:	Computer Science Disciplines
H/S:	Health Science Disciplines

In a bid to determine the completion rates of students pursuing STEM disciplines, an analysis was done on enrolments in 2009/2009 and graduation rates in 2012/2013 and 2013/2014 for the four and five year STEM disciplines at Egerton University. The study established that male students enrolled in STEM disciplines had higher completion rate of 80% compared to females at 60%. The study recorded the highest completion rate of 79% in Bachelor of Science and 72% in Health Science while the lowest completion rate was 45% and 52% in Agriculture and Engineering respectively.

The study further established completion rates for male and female students pursuing STEM disciplines in the other sampled universities (UoN and JKUAT). Male students had a higher completion rates at 84% compared to female students at 66% in the sampled STEM disciplines. Health sciences had the highest female completion rates of 74% compared to Computer Science and Engineering at 64% and 65% respectively. Figure 4.6 below confirms the findings.

Figure 4.6: Completion Rates of KUCCPS and SSP UON AND JKUAT STEM Students in 2008/9 and 2012/13



Source: Compiled from UON and JKUAT Enrolment and Graduation Records

KEY:

ER: Enrolment Rate
 GR: Graduation Rate
 CR: Completion Rate
 ENG: Engineering Disciplines
 C/ SC: Computer Science Disciplines
 H/S: Health Science Disciplines

Findings from Figures 4.5 and 4.6 indicate that female students in the sampled universities have lower completion rates compared to the male students in STEM disciplines and particularly in the hard sciences.

To further ascertain the participation trends of female students pursuing STEM disciplines, the researcher analysed the progression rates of female students in Egerton University as a case in point due to availability of consolidated data as compared to the other sampled universities. In a bid to determine the progression rates, an analysis was done on the number of female students who progressed from one academic year to

another up to graduation level. The study established that female students had lower progression rate in hard sciences such as Agriculture, Computer Science and Engineering at 45%, 50% and 52% respectively. Higher progression rates were recorded in Bachelor of Science and Health sciences at 79% and 72% respectively which is regarded as soft sciences. The lowest progression rates was recorded in first year of study whereby 26 female students failed to progress to second year of study. Table 4.7 below confirms the findings:

Table 4.7: Progression Rates of Female Students at Egerton University in 2008-2013 Academic Years

STEM Discipline	1st YR	FP	2nd YR	FP	3rd YR	FP	4th YR	FP	5thYR	FP	GRD	Total FP
BS/SC	164	9	155	7	148	7	141	10	-	-	131(79%)	33
Eng	29	3	26	5	21	2	19	3	16	1	15(52%)	14
Agri	20	2	18	3	15	2	13	4	-	-	9(45%)	11
H/S	132	10	122	8	114	9	105	10	-	-	95(72%)	37
Comp/SC	8	2	6	0	6	1	5	1	-	-	45(50%)	4
Totals	352	26	327	23	304	21	283	28	16	1	254(72%)	99

Source: Compiled from Egerton University Records

KEY:

FP: Failed to Progress to the next year of study
GRD: Graduated

Low female transition to ensuing year and graduation rates is attributed to poor performance, retakes, transfer to other disciplines and dropout cases as discussed in the interviews with the registrars at Egerton, University and JKUAT as discussed below:

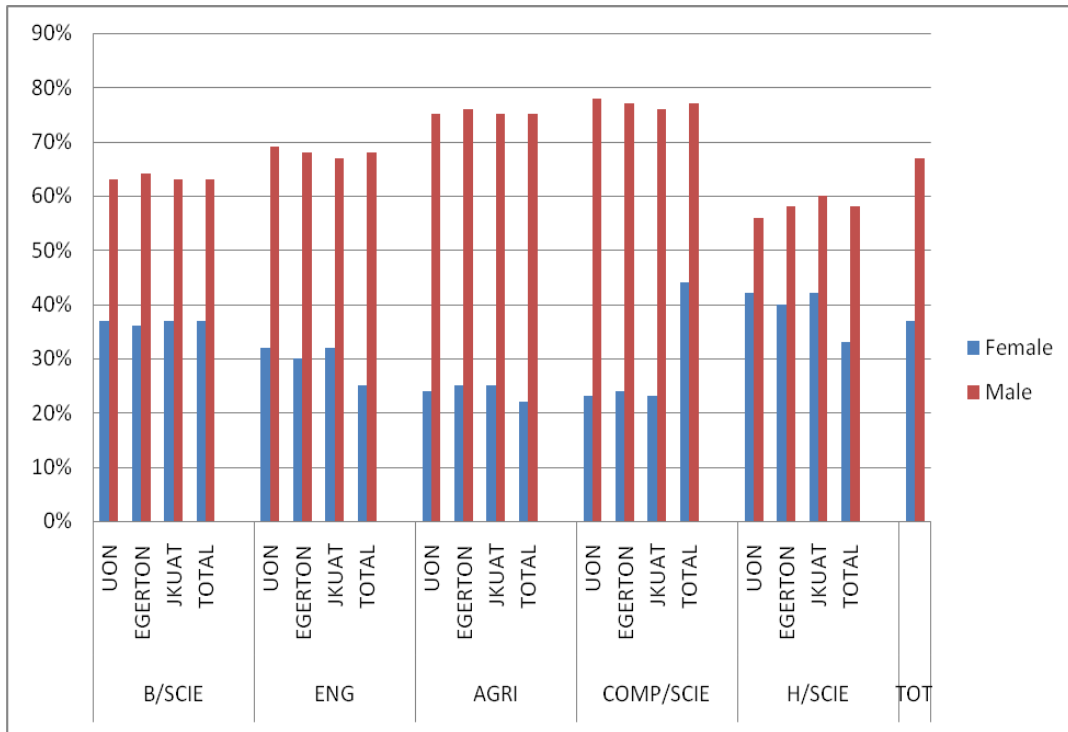
Male students pursuing STEM disciplines have lower risk of taking retakes, transfer to other disciplines and dropping out as compared to male students due to social cultural and gender roles. (Registrar, University C).

Female students have the potential to compete with the male students. They only need support and appropriate interventions to break the barriers they experience (Registrar, University B).

The implications of the findings though remotely was that female students participation trends are lower compared to male students pursuing STEM disciplines in public universities. Further, completion and progression rates for male students in the sampled universities are higher in hard sciences compared to females due to perceived masculinity of the STEM disciplines. Female students recorded higher completion and progression rates in Health Science probably due to the perceived femininity of the discipline and job attractiveness. This concurs with study by AAUW (2008) and literature review on the fact that female students' participation in STEM disciplines is influenced by STEM perceptions, societal stereotypes, interests and learning environments. This adversely affects female students' completion rates and progression rates in hard sciences.

The researcher sought to further find out participation trends of female students pursuing STEM disciplines based on graduation trends. The graduation trends were analyzed based on gender and STEM faculties between 2009-2013 academic years as shown in Figure 4.7 below:

Figure 4.7: Sampled Universities Comparative Graduation Trends between 2009-2013 academic years



Source: Compiled from the Sampled University's Graduation Booklets

Comparative graduation trends for STEM disciplines appearing in Figure 4.7 above, shows that fewer female students graduated in all STEM disciplines at 28% compared to 72% male students between 2009-2013 academic years. Agriculture discipline had the lowest female graduation trends at 18% while computer science and Bachelor of Science disciplines recorded graduation rates of 26% and 28% respectively. Female students recorded higher graduation rates in Health Sciences at 40%.

Low female graduation rates can be attributed to low STEM enrolments in the universities, the institutional barriers, the job market and challenges STEM female students encounter at the universities. The researcher's deduction is that the masculinisation of STEM disciplines coupled with STEM stereotypes and lack of STEM policies and interventions hinder equal participation of female students in STEM disciplines. As shown in the literature review and confirmed from the study findings in Objective Three, Eccles (2007) notes that females are socialized into feminine and occupational fields such as teaching, nursing rather than hard sciences.

4.5.1 STEM Students Performance Based on Degree Classification

The researcher sought to find out performance of students pursuing STEM disciplines based on grades attained in graduation classification. To address this, the researcher used documentary analysis on the graduation booklets in the three selected universities between year 2009 to 2013. The classification of students pursuing STEM disciplines was based on gender and performance. The following Table 4.8 shows the findings:

Table: 4.8: STEM Students performance between 2009-2013 Academic years

STEM	1 st Class		2 nd Upper		2 nd Lower		Pass		TOTALS		
	F	M	F	M	F	M	F	M	TF	TM	TOT
B/SC	146(3)	215(5)	750(14)	1387(29)	374(6)	1731(37)	64(1)	45(0)	1334(28)	3378(72)	4712
ENG	15(0)	87(2)	179(4)	988(27)	68(1)	1345(34)	979(24)	350(8)	1241(30)	2770(70)	4011
AGRI	22(0)	49(3)	237(9)	1008(43)	100(5)	842(35)	80(3)	59(2)	439(18)	1958(82)	2397
C/SCI	18(1)	108(6)	227(14)	471(28)	135(8)	507(32)	50(3)	140(8)	430(26)	1226(74)	1656
TOT	201(2)	459(4)	1393(11)	3854(30)	677(5)	4425(35)	1173(10)	594(5)	3444(27)	9332(63)	12776
H/S	322(40)	475(60)							322(40)	475(60)	797
TOTAL GRADUANDS									3766(28)	9807(72)	13573

Source: Data Compiled from the Sampled Universities Graduation Booklets

KEY

B/SC: Bachelor of Science

ENG: Engineering

AGR: Agriculture

C/ SCI: Computer Science

H/S: Health Science

From Table 4.8, 72% male students graduated compared to the females at 28% in all STEM disciplines. Bachelor of Science had the highest male and female graduation at 4712 with 28% female students graduating. The STEM discipline with the lowest female and graduation rate was Agriculture discipline at 18% whereas health Science discipline had the highest female graduation rates at 40%.

The study further sought to compare the performance of male and female students based on graduation classifications. Over half of the students who scored first class honours were males (4%) and females at (2%). Three per cent of female students had a first class honours in Bachelor of Science compared to 5% males. Five per cent of male students in Engineering and Agriculture disciplines recorded first class honours compared to 0%

females students. Similar trend was noted in the second upper division whereby male students recorded the highest score at 30% compared to 11% females. The highest second class upper obtained by female students was in Bachelor of Science and Computer Science disciplines at 14% whereas male students led at 28% and 29% respectively. In engineering and agriculture, female students recorded 4% and 9% compared to male students at 27% and 28%. The second lower category had a similar pattern with 35% males and 5% female students. Engineering discipline had the lowest females at 1% followed by Agriculture at 5%.

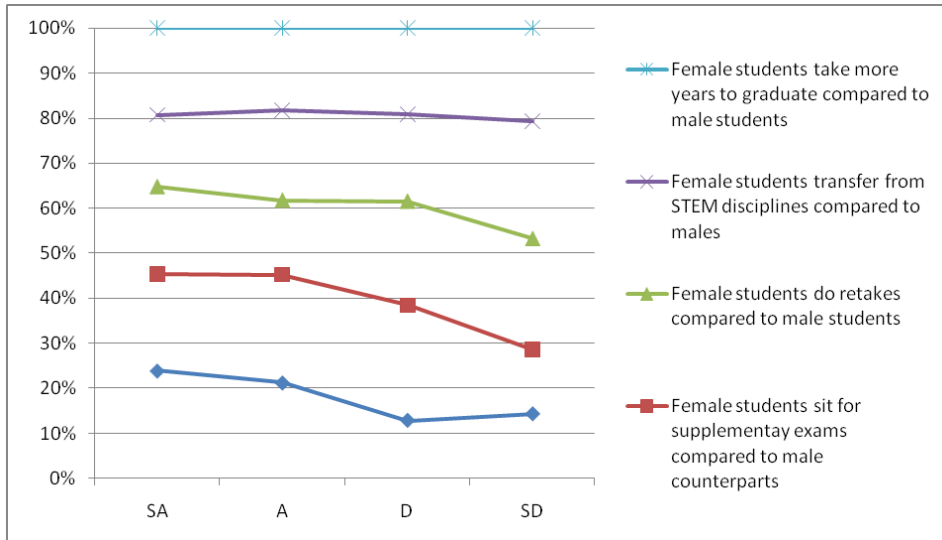
The last category of classification was pass whereby more females (10%) had passes as compared to males (5%). Agriculture had the highest female students scoring passes at 24%. Female students recorded fewer passes at 3% whereas male students had 8% in computer science. Fair competition was noted in Agriculture with 3% females and 2% males whereas in Bachelor of Science female students with passes were at 1% and 0% males. The Health Science disciplines had one category of pass with male students scoring more passes at 60%, compared to females at 40%, a range of 20%. This indicates that there was fair competition between male and female students in health sciences. High enrolment and graduation rates for female students in health sciences courses can be attributed to feminisation of the discipline as a nurturing discipline, the available job market due to the societal expectations and the gender roles ascribed to women.

Further, these findings represent low graduation rates of female students in all STEM disciplines as compared to male students. The graduation performance is also a reflection

of low enrolment rates of female students in STEM disciplines as discussed earlier in Objective One. Analysis from the STEM graduation performance indicates that the few females are able to compete with the male students and attain good grades. Few female students scored passes as compared to male students and competition in health sciences is an indication of good performance of female students. The low performance of female students in 1st and 2nd class honours is of great concern and can be associated with the barriers and challenges STEM female students encounter, the masculinity of the STEM disciplines and need for policy review existing government and university gender policies and interventions to achieve gender parity in STEM disciplines in Kenyan public universities. The female respondents in the questionnaires, FGDs and interviews with registrars and STEM deans confirmed low participation rate of female students pursuing STEM disciplines. Further, female students had higher retakes, repetition, dropouts, poor performance and low attrition compared to male students.

The findings from the questionnaires on perceptions of female respondents on female participation in STEM disciplines revealed the following: First, 78% of the respondents agreed that female students pursuing STEM disciplines perform poorly in exams as compared to males counterparts. Second, 79% concurred that female students pursuing STEM disciplines sit for supplementary exams as compared to male counterparts. Third, female students have more retakes as compared to male counterparts as confirmed by 62% of the respondents. Finally, 62% of respondents felt that female students transfer from STEM disciplines to other STEM or non-STEM disciplines as shown in Figure 4.8 from the female questionnaire below:

Figure 4.8: Perceptions of Female Respondents on Female Students Participation in STEM Disciplines



Source: Researcher, (2013)

The above findings on participation of female students in STEM disciplines were confirmed by the voices of registrars and FGDs as follow:

Female students perform poorly and take longer periods to complete their studies as compared to male students...I know of a lady who called off the semester to take care of her baby...(Female FGD, UoN).

Female students face many challenges as compared to male students such as family burdens....my sister missed last year's graduation due to supplementary as she failed to attend classes due to pregnancy complications. (Male FGD, Egerton).

Due to sex roles female students are burdened and overwhelmed by family responsibilities. This affects their participation leading to poor performance in STEM disciplines...At times their completion and progression rates are lower compared to male students (Registrar, University B).

The societal stereotypes on masculinity of STEM disciplines, job market and societal expectations affect female students' participation in STEM disciplines. Cases of change from engineering...Agriculture...Medicine and surgery to Nursing and education are many (Registrar, University A).

Considering that female enrolment is lower in STEM disciplines and especially hard sciences...the situation is worse with the completion and graduation trends...not because female students are weak academically...but due to socio cultural, institutional barriers and family responsibilities... (STEM Dean, University B).

The above responses were confirmed during the interviews with the registrar Egerton, female STEM faculty UoN, and director gender and affirmative action JKUAT who observed that: Female students are able to compete with male students in health sciences. Second, there are few females who graduated compared to males. Fourth, fewer female students score first class and second class upper honours as compared to male students. Finally, in the graduation records in the sampled universities, few female students scored pass as compared to males as noted below by the discussants:

Female students pursuing STEM disciplines are able to compete with the male students...they also score first class honours...they face many challenges making few graduate as compared to their male counterparts. (Registrar, University C).

The female students pursuing STEM disciplines do not perform as well as the male students. We have few scoring first class, second upper and second lower (STEM Female Faculty University A).

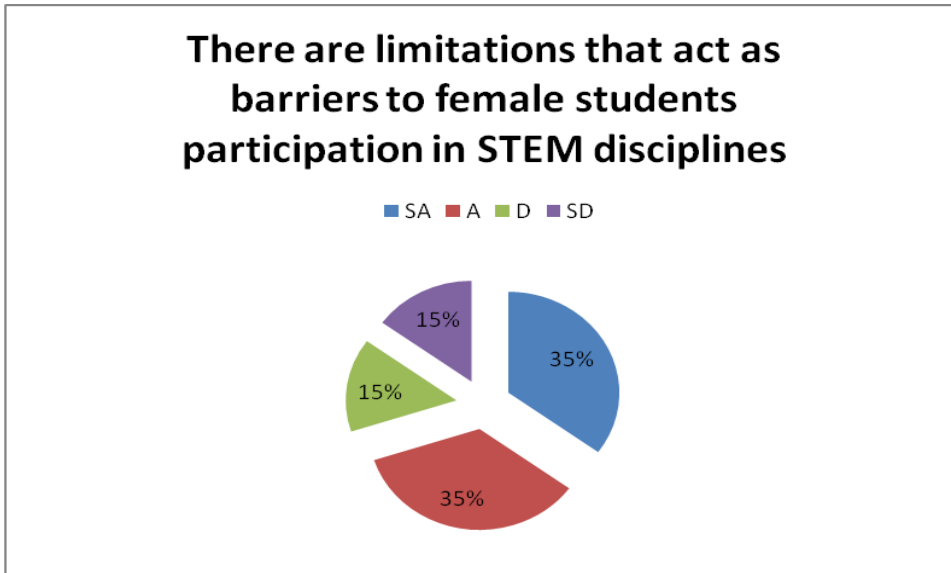
The findings above are indicative of low female graduation rates and poor performance in STEM disciplines. This can be attributed to the perceived societal masculinity on STEM disciplines, lack of STEM policies, challenges and institutional-based barriers female students face in their pursuance of STEM disciplines as discussed below in Objectives 3, 4 and 5. Unfortunately, aggregated data mask the attrition of women at every phase of the educational and career STEM pipeline. Despite grades and other academic attainments equal to or surpassing those of the men who remain in STEM fields, more women than

men quick STEM disciplines. As a result, few women are in senior or leadership positions in the STEM workforce (NSF, 2008).

4.6 Institutional-Based Limitations to Female Students Participation in STEM Disciplines

In research Objective Three, the researcher sought to investigate limitations that act as barriers to female student participation in STEM disciplines. To address the objective, the researcher collected primary data using questionnaires from the female students pursuing STEM disciplines. FGDs were used to obtain data from male and female students pursuing STEM disciplines. Interviews were conducted from university administrators and STEM faculty on female students participation in STEM disciplines. The study sought to establish the following: importance of STEM female role models, category of secondary schools attended, effectiveness of secondary school attended, career guide of female students at the university, challenges facing STEM female students, effect of dropping Physics subject at Form Two and the effects of venturing in STEM discipline to future life of the female students pursuing STEM disciplines. From the questionnaire, 70.0% female students pursuing STEM disciplines indicated that there are limitations that act as barriers to their participation in STEM disciplines in Kenyan public universities while 30.0% disagreed as shown in Figure 4.9 below:

Figure 4.9: Female Respondents Perceptions on Limitations to Participation of Female Students in STEM Disciplines



Source: Researcher (2013)

During FGDs with female students and interview with female faculty from JKUAT, the study confirmed that female students pursuing STEM disciplines have limitations that act as barriers to participation in STEM disciplines as expressed below:

We face a lot of challenges in our academic life at the university that affect our participation in STEM disciplines. (Female FGD, UoN).

I am more disadvantaged as compared to the male students in my class. My challenges started in high school having attended a District school without enough science facilities, societal stereotypes and the masculine STEM learning environment. (Female, FGD University B).

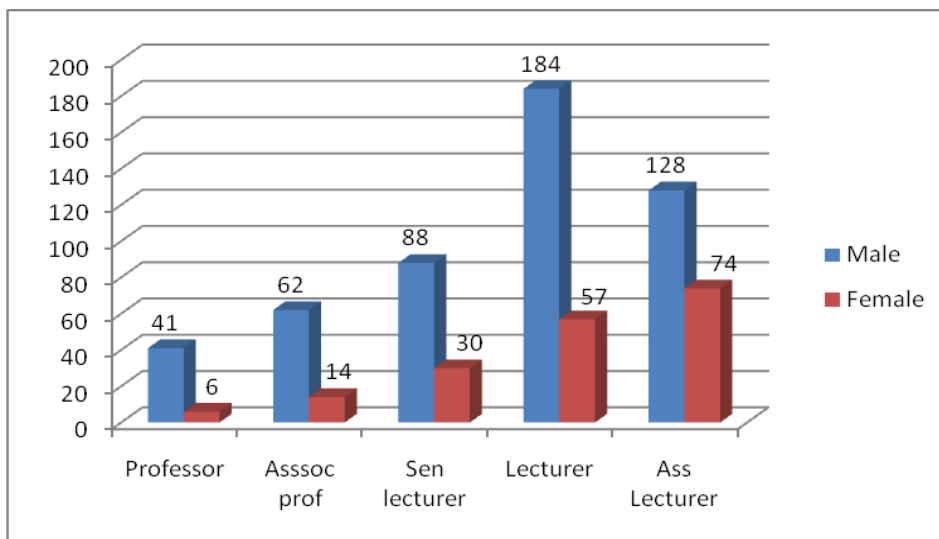
Female students pursuing STEM disciplines have many limitations and they have to work extra hard to be able to participate in STEM disciplines (STEM Female Faculty University B).

4.6.1 Existence of STEM Role Models in Secondary School and University

The study established that female students pursuing STEM disciplines require STEM female faculty role models and mentors at secondary and university levels of education.

Female faculties in the sampled universities are less thirty per cent compared to male faculties. Further, female lecturers are underrepresented in all academic levels with the lowest representation at senior administrative positions, professor and associate professor levels. The highest STEM female faculty representation was at assistant lecturer levels at 37%. The baseline data on gender and academic level of STEM lecturers at JKUAT and Egerton University revealed that out of 684 STEM lecturers, there were only 181(26.5%) female STEM lecturers. Female lecturers were under represented in all academic levels with the lowest representation at professor and associate professor levels at 13% and 18% respectively. The low STEM female faculty representation may negatively affect participation in the universities but not enrolments. Figure 4.8 below presents the gender and academic levels of JKUAT and Egerton University STEM lecturers' distribution by gender and grade.

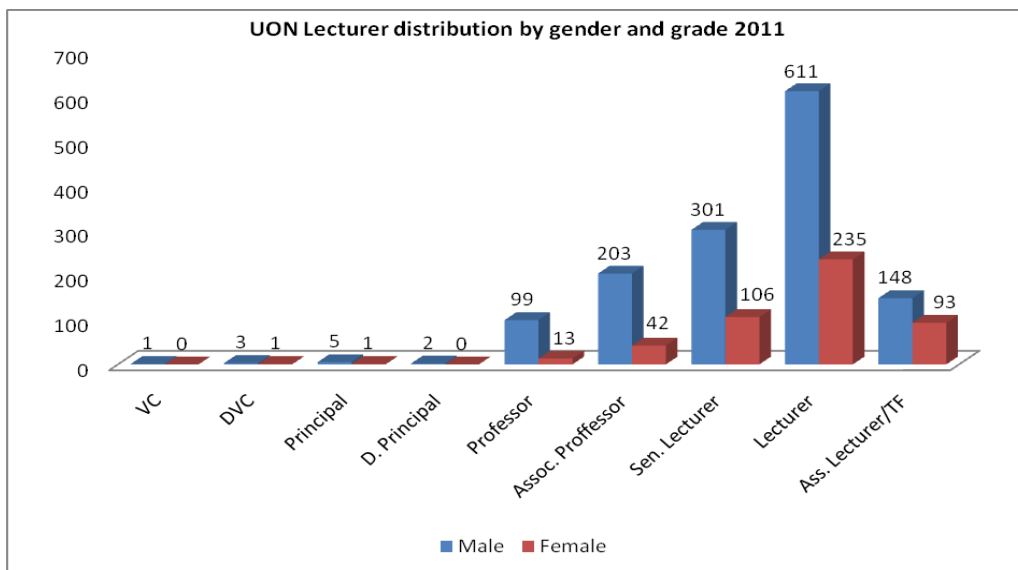
Figure 4.10: Distribution of JKUAT and Egerton STEM Lecturers by Gender and Grade in 2014/2015 Academic Year



Source: JKUAT and Egerton Universities Records

The study further sought to establish the gender, administrative positions and academic levels of the university lecturers from UoN. The trends were important to show the representation of female faculty in universities who are mentors to female students pursuing STEM disciplines. Low female lecturer representation was observed in UoN where female faculty consisted less than thirty per cent (26%) with the senior administrative positions of Vice-Chancellor, Deputy Vice-Chancellor, Principal and Deputy Principal are male-dominated with a representation of 2 females out of 11 males. The same trend was established at the professor and associate professor levels where there STEM female faculty was at less than 20%. The highest STEM female lecturer representation was at assistant lecturer at 38% followed by lecturer position at 27%. Figure 4.11 below presents the gender, administrative position and academic levels of UoN lecturers:

Figure 4.11: Academic level of University of Nairobi Lecturers by Gender



Source: University of Nairobi Records

Interview with STEM HoD, Engineering in UoN confirmed the above findings that there are few STEM female faculty in STEM disciplines and especially in hard science as noted below:

In Engineering there are very few female lecturers...in mechanical engineering for instance...we do not have any female lecturer (HoD, Engineering, UoN)

The researcher further used FGD to solicit information from the participants on the existence of science teachers as role models in secondary school (probing for the gender role model, areas mentored on, example: universities' selection, career guidance). During an FGD in JKUAT, six of the respondents indicated that they had male science teachers as their role models, two respondents had female science teachers as their role models and four respondents had no science role models as exemplified in the excerpts below:

My physics teacher was my role model...he mentored me so well that I scored an A in Physics (Female, FGD, JKUAT).

The biology teacher was my role model. She made us work hard and excel in Biology. Am now pursuing Medicine and attribute my good performance to her guidance (Female, FGD, UoN).

We never had enough science teachers in our school...I really had to work on my own to excel in mathematics and sciences...if I had a science role model I would have acquired better grades at forth form than I did. (Female, FGD, Egerton).

From the above quotations, the female faculties in STEM disciplines are fewer in comparison to male STEM faculties and which stands at less than 30%. In administrative and senior positions, female faculties are underrepresented too. The role of female science teachers and female STEM faculties is important to female students pursuing STEM disciplines as they act as their mentors. As noted by UNESCO (2013), there is

need for more role models, and female teachers in STEM related disciplines at secondary schools and universities. This will enable girls and female students to develop confidence and independence as they pursue STEM disciplines.

FGD discussants also confirmed that other science role models included parents, siblings and neighbours. The role models mentioned were majorly males as few females venture in science careers as confirmed in the literature review. One male FGD discussant, intimated that his uncle, an Engineer by profession influenced him into taking Engineering course at the university. The other discussants confirmed the presence of male role models during the interview and FGD as follows:

My mathematics teacher was a female...I had no faith in her. I felt like she was not as competent as the male teachers. I preferred consulting the science male teacher whenever I needed academic guidance (Female FGD, Egerton).

My physics teacher was a female. She was an approachable and very strict...we didn't like her... (STEM Female Faculty, UoN).

Due to socio-cultural orientation and expectations, female students pursuing STEM disciplines tend to be biased towards the STEM female faculty. At first they tend to have more preference on STEM male faculty...they form negative opinions but with time they appreciate the competence of the female STEM faculty (STEM Female Faculty, University C).

During the FGD with female and male students pursuing STEM disciplines, there were mixed reactions on the importance of female STEM faculty role models. Five of the discussants expressed the importance of more STEM female role models to emulate and share their academic and personal problems, whereas some of the discussants felt that the sex of the role model did not matter. Some of the female participants had this to say:

Having female teachers as role models is very important. Being a female I need a female I can emulate and associate with (Female, FGD, JKUAT).

At times I need a female Science teacher to share my personal problems with...during my menses...am not as active in class and in the laboratories...how do i share such personal information with a male teacher (Female, FGD, UoN).

“It doesn’t matter...the sex...a male or female STEM role model. What counts is the competence (Female FGD, Egerton)

A male respondent confirmed the above narrative and had this to say:

Science subjects seem a preserve for males as all my Science teachers were males. (Male, FGD Egerton).

Interviews were conducted with the academic registrar, directors of gender and affirmative action, the STEM deans of schools and STEM female faculty on the number of STEM female faculties in the universities. The discussants concurred that first, female STEM faculties are not enough compared to the STEM male faculty. In JKUAT College of Engineering for instance, out of 10 male lecturers only one was female in Civil Engineering and no female in Mechanical and Electrical Engineering. Second, the need to have more female faculties to act as role models to the female students pursuing STEM disciplines was suggested as discussed in the literature review. The respondents also expressed the need to develop STEM feminist persuasion to make STEM disciplines gender responsive and attractive to female students. During the interviews, dean engineering, registrar JKUAT, female STEM faculty, director gender and AA noted as follows:

Most STEM faculties in Engineering do not have female lecturers. There is a need to encourage more female scholars in STEM disciplines (Dean, Engineering, University A).

Whenever we are appointing departmental chairpersons of STEM disciplines we often face challenges as we lack STEM female faculties. We therefore recommend and encourage more female students to register in STEM disciplines (Registrar, University B).

Am the only female faculty in the department and therefore sometimes i feel out of place. There is need to bring on board more STEM female faculty (Female STEM Faculty, University C).

There are few STEM female faculty not only in the university but also in the university leadership ... majority of them majored in Social Sciences. Female students need more STEM role models (Director, Gender and Affirmative Action, University A).

Female students pursuing STEM disciplines from UoN and JKUAT expressed the view that the gender of the STEM faculty has much impact on performance in the STEM disciplines as discussed below:

I did very well in my Science subjects in secondary school, and am now pursuing Telecommunication Engineering. All my Science teachers were male teachers...It doesn't matter to me whether the lecturer is male or female (Female STEM Student, UoN).

Male teachers and lecturers in my academic life have taught me. Infact I prefer male lecturers to female. They are more active and committed to their work (Female STEM Student, JKUAT).

The conclusion here is that the gender of the lecturer has an impact on female participation in STEM disciplines. Some of the female respondents reported having had male science and mathematics teachers in high school as their role models. There was a mixed group at the universities, who felt that the gender of the lecturer matters while the rest expressed that it did not. The mixed reaction from the respondents does not change the fact that there is a need for female lecturers in STEM disciplines. The study established that the existence of female STEM role models plays a vital role in female students participation in STEM disciplines.

On the other hand, due to social cultural conditioning, some female students do not take female teachers as role models even where they are available. The societal stereotypes and the masculinity of the STEM disciplines make the female students not to associate STEM female faculty with STEM disciplines. When women believe that mathematics is a masculine discipline, they are more likely to believe the stereotype, lose confidence and disengage from STEM disciplines as noted by Good, Rattan, and Dweck (2010). Further studies have confirmed that a female teacher/lecturer can have a positive impact on female students as working side by side and respecting one another's abilities, demonstrates that there is a place for girls/women in this industry, and will help to change mindsets that still exist around male-dominant industries (NSF, 2009a). STEM disciplines are often associated with independence, a characteristic frequently linked with masculinity. That stereotype is one of the key contributors to the gender disparity. Stereotypes have far-ranging effects and become self-reinforcing as they shape the career goals, performance and interests of women and men in ways that are consistent with stereotypes (AAUW, 2008).

4.6.2 Category of Secondary Schools Attended

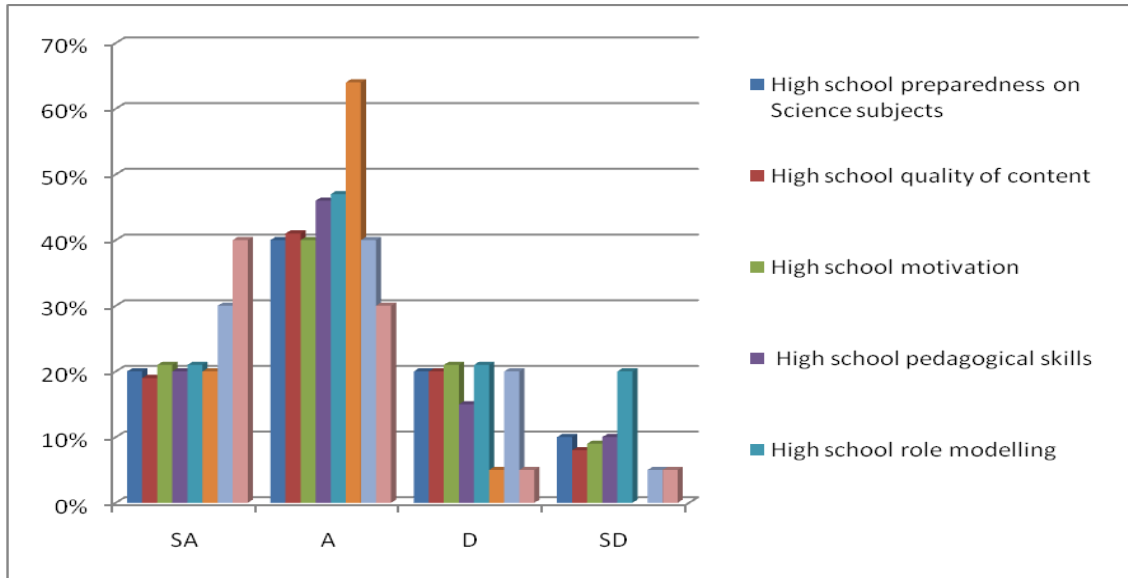
To further establish the institutional-based barriers to female students participation in STEM disciplines, the students were asked to indicate the categories of secondary schools attended. This enabled the researcher to show the relationship between the category of the school attended and KCSE performance, which affects access and participation in STEM disciplines. The sampled respondents were 360 and consisted of 173 from University of Nairobi, 147 from JKUAT and 40 from Egerton University.

Findings from the questionnaire indicate that 140(40%) of the female STEM students were from national schools, 175(50%) were from county schools whereas only 35 (10%) were from district schools. The findings on the category of the school attended revealed that educational outcomes are related to the category of secondary schools girls have attended. This was confirmed by 70.0% of the STEM female student who attained a mean grade of B plain and above was from national and county schools while 30.0% from district schools. National and county schools are better equipped in terms of adequate learning resources and facilities as compared to the day and district schools. They also tend to admit students with higher grades at Kenya Certificate of Primary Education (KCPE).

4.6.3 STEM Students Perceptions of the Effectiveness of the Former Secondary School Resources in Relation to Performance in Mathematics and Science Subjects

To further establish institutional-based limitations that act as barriers to female students' participation in STEM disciplines, the study sought for perceptual information on the effectiveness of the former secondary schools attended by the female students from the questionnaire administered to the female students pursuing STEM disciplines. This was in terms of course preparedness, science teacher effectiveness, adequacy of science textbooks and science laboratories in secondary schools. Figure 4.12 presents the findings.

Figure 4.12: Female Respondents Perceptions of the Effect of the Former Secondary Schools Preparedness to Science Subjects



Source: Researcher (2013)

Figure 4.12 was generated from questionnaire administered to female students pursuing STEM disciplines whereby 60.0% agreed that their former high school adequately prepared them on science subjects, content was well taught and the respondents were motivated to learn while 30.0% were not adequately prepared. In terms of the numbers of science teachers, majority (85.0%) agreed that they had enough teachers in terms of teacher-learner ratio whereas only 5.0% disagreed; 70.0% agreed on the science text books adequacy in terms of quantity while only 25.0% disagreed. Seventy per cent (70.0%) agreed that their secondary schools had equipped science laboratories whereas 10.0% disagreed.

The members of FGD were asked on the existence and appropriateness of career guidance at secondary schools on the disciplines to pursue at the universities. The study established that the nature and preparedness of female students pursuing STEM disciplines on STEM career guidance by former secondary school contributes to participation in STEM disciplines. Six out of eight female FGD discussants reported that there was no career guidance in their schools whereas two had career guidance. Five out of eight female participants reported that it was not appropriate, while one agreed it was appropriate.

Those who affirmed said that the high schools `administration organized and invited different professionals and peer counsellors from universities who guided them on the disciplines to pursue the university requirements in order to qualify for the STEM disciplines and the job market. Those who disagreed reported lack of mentoring programme, motivational talks centred on encouraging them to academic performance without clear guidance on cluster subject requirements and the disciplines to be taken at the university. The enormity of the high school syllabus was cited as a hindrance to proper guidance as well as lack of teachers' conversance with university programmes and the university admission requirements. The high schools concentrated on covering the syllabus at the expense of guiding their students on what disciplines to take at the university. The following are examples of the sentiments during the FGDS:

The mentoring programme was not adequate...the career teachers were not conversant with the university programmes and job opportunities...we just selected courses blindly... (Female FGD, UoN).

The teachers were more concerned with passing the exam to join university...we never had time for career guidance. It was all about performance (Female FGD, Egerton).

I wanted to be an Engineer but my school did not offer Physics which is a prerequisite for Engineering disciplines...i scored mean grade of an A but could not qualify to pursue Engineering (Female FGD, JKUAT).

My parent are illiterate...they have no idea of the courses offered at the university leave alone the location...my dad told me choose any course and go to the university...university is university...that is all we need...(Female FGD, Egerton).

Some FGD participants felt the career guidance they received at secondary school was appropriate as illustrated in the voices below:

I studied in a National school and career guidance was emphasized. We had special sessions with invited professional to guide us on university courses and programmes (Female FGD, UoN).

University students visited us and we had sessions with them on academic excellence and university programmes and cluster requirements. They mentored me so much and were my role models (Female FGD, JKUAT).

From the above discussions, there is a relationship between career guidance in secondary schools and participation in STEM disciplines. Career guidance at secondary schools prepares female students for the STEM disciplines they pursue at the universities. The secondary schools form the foundation of the STEM disciplines in terms of offering science and mathematics subjects and good performance. They are prerequisite for STEM disciplines in the universities whereby female students are prepared and made conversant with STEM curriculum and its expectations. This in return contributes to participation in STEM disciplines.

According to the study findings, performance in science subjects can be linked to secondary schools having adequate science teachers and science resources in terms of teacher-learner ratio. This was confirmed through FGDs where nine out of twelve

respondents agreed they had equipped science facilities. They attributed their good performance in science subjects to the equipped laboratories, assistance from laboratory technicians, textbooks and committed teachers. Participants argued as follows:

I studied in a national school that had well equipped laboratories. We had Science teachers who were available for academic guidance. We could go to the laboratories to perform our practical during our free time. The lab technicians were very helpful and provided us with all the guidance that we needed. (Female FGD, JKUAT).

We had three well equipped laboratories, Physics, Chemistry and Biology. Our library had enough Science text books and the school provided enough class text... my parents provided me enough text books whenever I needed... (Female FGD, Egerton).

Our Science teachers were committed and ensured we understood all Science topics well. We performed the science practical lessons in groups and if one had difficulties, we assisted one another (Female FGD, Egerton).

I was in a day school and we did not have enough science facilities...we would go to our neighbouring school for the practical lessons...luckily my science teacher was my role model and she encouraged and mentored me a lot... (Female FGD, UoN).

The above discussions can generate several arguments: Majority of female students pursuing STEM disciplines are likely to have studied in national and county secondary schools. The study concurs with the research findings that good performance in science subjects can be linked to human and science resources in secondary schools. The national and county schools have effective and sufficient science resources compared to district schools that contribute to good performance in science subjects and high enrolment in STEM disciplines. Students who studied in district schools are likely to lack science teachers and science facilities or depend on neighbouring national and county schools for the science facilities.

The study further established that participation and performance of girls in physics subject at KCSE is a key factor to their access to STEM disciplines and more so in hard sciences in universities. The number of girls taking physics is comparatively lower than that of boys at secondary school level. Physics subject ultimately determines the STEM disciplines a student will pursue at the university and it is critical for pursuance of any technological discipline especially Engineering disciplines (Lubinski & Benbow, 2006). UoN registrar and FGD discussants informed the study that girls in schools drop physics subject at Form Two due to the perceived masculinity of the subject, perceptions that girls are likely to perform poorly in the subject which affects general school performance and lack of interest in STEM careers. During the FGDs with the female respondents, 6 out of the 8 discussants confirmed that they dropped physics at form two. One of the discussants expressed that most girls are scared of physics and regard it as hard and masculine subject as noted below:

Most girls schools drop Physics at form two due to the perceived masculinity of the subject, poor performance and lack of facilities especially in district and day schools (Registrar, University C).

The fact that most girls do not take Physics to the subject contributes few female students in engineering disciplines (Registrar, University B).

Girls do no pursue Physics because they have other preferences to it. They just find it more interesting to do other subjects due to feminine career prevalence's. (Registrar, University A).

I dropped Physics in Form Two...in my school we took Biology and Chemistry...Physics is a hard subject and I was not interested in a career in Engineering (Female FGD, JKUAT).

I performed well in all the other science and mathematics subjects but failed in Physics. In my class most girls performed poorly in Physics. I wanted to pursue a degree in nursing and Physics is not a requirement...(Female FGD, UoN).

I hated physics...there's too much maths, it's not relevant to life, and, above all, it's boring... (Female FGD, UoN).

I got grade A in Physics but I was not interested in Engineering due to the lengthy period of study, I imagine it's a hard discipline and the fear of getting a job (Female FGD, Egerton).

The above findings are confirmed by the 2012 KCSE results whereby female students who sat for physics examination were 26.9% compared to male students at 72.9% (Republic of Kenya, 2012). Female students perform poorly in physics subject compared to males. Rosser (2004) contends that the key determinants of students attitudes to physics subject are how they relate themselves to the subject, their experience in physics learning environments, the Job market and the societal expectations. Thomas (2009) identifies three main reasons that influence students' choice of physics. These are mathematical phobia, beliefs and attitudes towards learning physics, and the students' personal experience and advice they get in schools.

Onsongo (2009), provided arguments that the decision of many students about whether to choose physics or not depends on the nature of the students (their abilities), their background (especially their families), and the value physics is considered to have in a certain career in the country in which the student resides. Low enrolment numbers in physics due to the fact that students consider physics to be too extensive, too mathematical and too abstract and greatly dependent on textbooks. Due to the perceived masculinity of physics subject, girls are constructed to have a negative attitude towards

the subject compared to boys. This is not surprising, since the traditional teaching of physics hasn't been modified to better suit girls, nor has it managed to improve attitudes towards physics as a possible profession (Lubinski & Benbow, 2006).

4.6.4 Career Guidance of Female Students at the University

In the questionnaire with female students pursuing STEM disciplines, respondents were asked to indicate their career guide on the disciplines they were pursuing in the university. Career guidance at the university prepares students pursuing STEM disciplines on STEM disciplines participation. The following frequency Table 4.9 shows their responses.

Table 4.9: Key Career Guidance for Female Students in the Three Selected Universities

Career guide	Frequency	UoN	JKUAT	Egerton	%
Parents/Guardian	29	14	11	4	8
Teachers/university administration	43	21	16	6	12.5
University peers	59	26	22	11	16
Others-neighbours, mass media	29	15	11	3	8
No career guidance	200	97	87	16	55.5
Total	360	173	147	40	100

Source: Researcher (2013)

Table 4.9 shows that more than half of female respondents reported to have no career guidance for the disciplines they were pursuing at the universities. This is indicative of how female students pursuing STEM disciplines in the universities are not adequately guided and prepared for the disciplines they pursue. This finding also explains the

dissatisfaction expressed by female students pursuing STEM disciplines on the STEM learning environments as discussed later in Objective Four. This finding can be attributed to low access and participation of female students in STEM disciplines as discussed earlier in Objectives One and Two. Findings from Table 4.9 indicate that career guidance provided by university administrators were at 12.5% whereas university peers were at 16%. Parents/guardians and others offered the least sources of career guidance for female respondents at 8 % respectively.

The opinions and perceptions of FGD female students and STEM female faculty concurred on lack of career guidance on university programmes. Most of the female students end up succumbing to peer influence in making their choices while 55.5% have no career guidance as presented in Table 4.9 above. The FGDs and interview with female faculty from Egerton University voices confirmed lack of career guidance as expressed below:

Here at the university it is survival for the fittest...everyone is busy with his/her on business...we learn the hard way...I never knew whom to consult for career guidance... I just followed my peers (Female FGD, UoN).

I didn't know I could apply for inter-faculty transfers until the deadline had passed... (Female FGD, Egerton).

I wanted to pursue Engineering but thought it was too hard to pursue despite the fact that I had qualified...I had no one to consult (Female FGD, JKUAT).

The lecturers are too busy, you hardly get them for consultation in their offices... (Female FGD, Egerton).

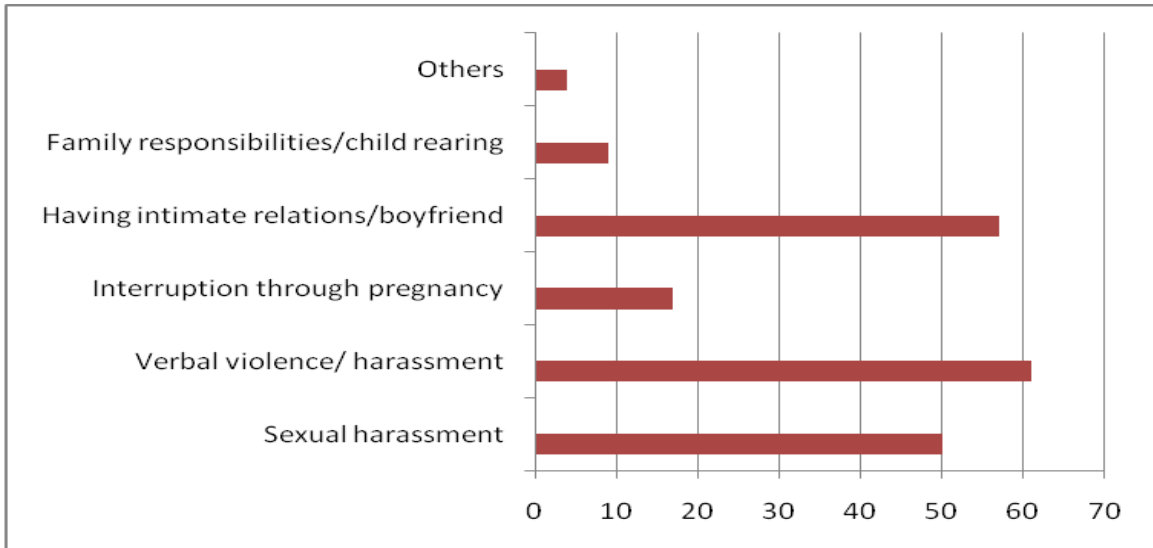
My uncle who is an Engineer is my role model...he is my guardian and I emulate him (SSP Female FGD, UoN).

There is need to strengthen career guidance and mentoring on subject choices and job opportunities in secondary schools...Most girl's schools drop key Science subjects like Physics and Chemistry at Form two. The subjects are prerequisite for Engineering and other professional STEM careers. (STEM Female Faculty, University C).

4.6.5 Other Institutional Challenges Affecting Female Students Participation in STEM Disciplines

Respondents were asked in the questionnaire to indicate the challenges they faced in the process of their academic lives at the university. The challenges faced by female students pursuing STEM disciplines affect female students participation in STEM disciplines negatively as some female students dropout, perform poorly and others take time to complete their STEM disciplines compared to the male students. Factors hindering female participation in STEM disciplines include higher opportunity cost for girls, higher attrition rates due to domestic work, sexual harassment and family responsibilities (AAUW, 2007). Gender biases are not only revealed in inequality and gender tracking but also in policies that favour male students compared to female students. Female students who get pregnant are subjected to penalties like losing boarding house privileges. The institutions do not have policies for ensuring nursing female students are retained within campus residence (FAWE, 2014). Figure 4.13 below presents the findings from the questionnaire:

Figure 4.13: Challenges Facing Female Students Pursuing STEM Disciplines at the University



Source: Researcher (2013)

The above findings on challenges at universities certainly affect all female students in the universities; however, those in STEM disciplines appear to be more affected than their counterparts in other disciplines, owing to the highly interactive and collaborative nature of the STEM discipline. In a civil Engineering class in JKUAT for instance, a female confirmed there were only two female students compared to fifteen male students. The nature of engineering discipline is interactive, practical oriented and it involves collaborative practical lessons where students work in groups. Besides STEM disciplines being traditionally male-dominated nearly two thirds of the respondents indicated they experience verbal violence/harassment, over 50% had expressed that having intimate relationship affects their participation in STEM and less than 50% experienced sexual harassment from male lecturers, fellow male students and sometimes male technicians. This was also confirmed during the FGDs in which the challenges were verbalized by

both male and female discussants to capture aspects such as sexual/ verbal harassment and interruptions due to family responsibilities as exemplified in the excerpts below:

During my life in campus I have been abused verbally a lot of times by male lecturers, male staff and male students, insults such “ngumu, spanner boy or iron lady “among other demeaning names (Female FGD, Egerton).

We normally tease the female students during the Engineering practical’s...particularly when they struggle in performing some masculine tasks like lifting and fixing oily engine parts (Male FGD, JKUAT).

The male students make annoying gestures to show how inadequate, time wasting and feminine we are when we ask a lot of question during lectures (Female FGD, UoN).

This study was further informed by over fifty per cent of STEM female respondents that having intimate relations or boyfriends were another challenge female STEM students faced. The intimate relationships were timewasters and the female students would have to balance their studies with family responsibilities such as childbearing and family chores leaving little time for their studies that involve many working hours in the workshops and laboratories as compared to other university disciplines and affected their participation in STEM disciplines. Trower (2008) concurs with the findings and explains that the ability to balance studies and family responsibilities due to the nature of scientific research may make work family balance particularly challenging for female students pursuing STEM disciplines. “The lab knows no official stop time it’s an unrelenting 24/7. It is difficult to just pack up and go home. Stopping for any period of time, to take advantage of stop the tenure clock, could be deadly to your research project.” Universities do not offer child care programmes to nursing mothers who are students. Trower (2008), explains that child care is a huge issue and most universities do not offer adequate, if any, childcare as exemplified in the excerpts below by the FGD respondents:

The nursing and married female students pursuing STEM disciplines have many family responsibilities... where as they should be working on the projects...they have family duties (Female FGD, UoN).

Some female students are abused verbally and physically whenever they disagree on relationship...they both miss classes and also perform very poorly in their exams as their attention is divided... (Female FGD, JKUAT).

From the study, 17.4% of female STEM students respondents stated that they encountered interruptions through pregnancy; 8.7% faced challenges of family responsibilities like child rearing while less than five per cent faced other challenges. These include interruptions through illness and lack of access to reproductive health facilities (family planning), lack of access to gender sensitive sanitary service (Sanitary towels, clean toilets) and stress related issues. Nursing mothers live outside campus and live in insecure areas and fall prey to gender-based violence (GBV). Moreover, they are unable to utilize the university facilities during odd hours especially at night. Those who stay within campus are housed far from academic facilities like the library and laboratories. These students cannot use these facilities at night without fearing for their safety due to distance and poor lighting systems (FAWE, 2014). The challenges hinder female students from participating well in STEM disciplines and others take longer time to complete their university studies as compared to male students as expressed below:

I got expectant in first year...had a lot of pregnancy complications...after the caesarean section I had to remain home for some time...I called off the semester and missed out a lot on my academics that time... I should have graduated last year... (Female FGD, Egerton).

I am married with two kids...I have a lot of responsibilities and family burdens..at times I miss my classes when the children are unwell...at times I do not have a house help...I go through so much in my marriage...my academic performance is not impressive but I must balance all this (Female FGD, UoN).

Life in campus is very difficult. I am an orphan...my uncle pays my fees. I have to do odd jobs to sustain myself here in campus...at times I can hardly afford a meal leave alone sanitary towels...most ladies end up to prostitution to make ends meet, and therefore very stressful (Female FGD, JKUAT).

During the interviews with STEM female faculty on the challenges facing female students, the discussants confirmed that sexual and verbal harassment and family responsibilities affect participation of female students in STEM disciplines in the universities. The study acknowledges that the challenges may also affect other university female students in other disciplines. Female students pursuing STEM disciplines are likely to be more affected due to the STEM curriculum, which is practical-oriented, and students tend to spend more time in the laboratories unlike other disciplines. More contact with male lecturers, staff and male students makes them more prone to sexual and verbal harassments. They also experience interruptions due to family burdens and pregnancy among other challenges. Sexual harassment, which is a manifestation of unequal power relations between men and women, is rampant in STEM discipline which is termed as sexual corruption (Hill et al., 2013).

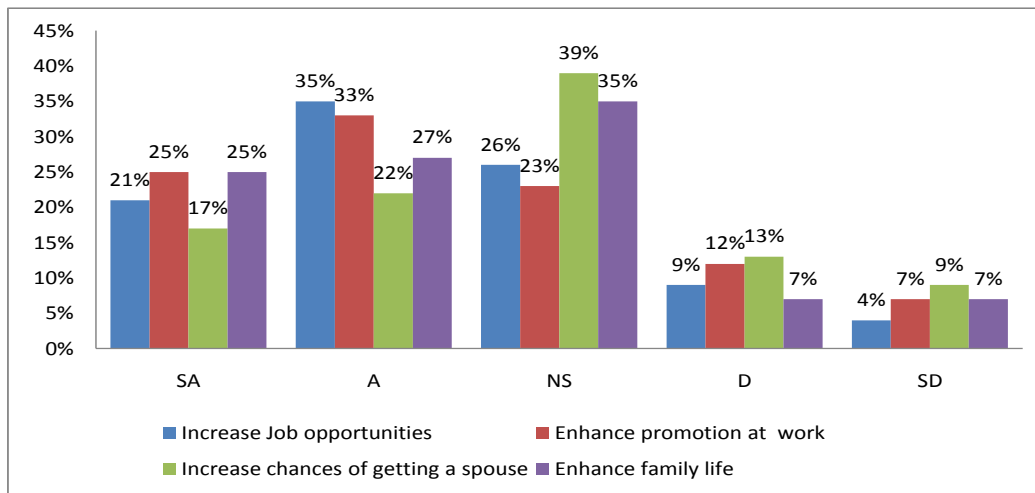
Bennett (2013) notes that other forms of sexual harassment against female students pursuing STEM disciplines include physical and psychological abuse without their consent or engagement. They include indecent touching, teasing, bullying, lewd jokes, threats and insults in the STEM learning environments. This non-friendly STEM learning environment for the female students results to mental social and physical torture and it interferes with their participation in STEM disciplines. The morale, confidence and determination of the female students pursuing STEM disciplines in an overall context are

interfered with (Thomas, 2009). These challenges hinder the female students from participation in STEM disciplines compared to male students as the STEM disciplines are more involving and require more time and concentration in the workshops and laboratories.

4.6.6 Opinion on the effects of venturing into STEM Disciplines on the future lives of Female Students Pursuing STEM Disciplines

To explore how female students enrolled in STEM perceived the implications of this choice to their future careers, the students were asked to indicate if they agreed with four statements in the questionnaire as captured on Figure 4.14:

Figure 4.14: Perceptions of Respondents on Implications of Venturing into STEM Disciplines on Future Life



Source: Researcher (2013)

Majority (56%) of the female respondents agreed that venturing into STEM disciplines would negatively affect their increase in job opportunities whereas 13.0% disagreed. The

same trend was noted when asked about females pursuing STEM disciplines being promoted at work where 58% agreed that pursuing STEM disciplines would hinder promotions at work due to the perceived stereotypes on masculinisation of STEM careers. The sentiments were confirmed during the interviews and FGDs where 6 out of 8 discussants agreed that venturing into STEM disciplines negatively affected their future life in terms of job opportunities, promotion at work, getting a spouse and family life. The study further established that the FGD male students pursuing STEM disciplines had mixed reactions concerning the effect of female students venturing into STEM disciplines in their future life. The following explanations from male and female FGDs exemplify this observation:

There are many stereotypes that I will never get a job as an Engineer...my grandma say there cannot be competent female Engineers... (Female FGD, JKUAT).

The few female students who meet the requirements for STEM disciplines often pull out due to stigma, societal stereotypes and peer influence (Female STEM, Faculty).

My friend said she can't stand wearing aprons in rusty, oily and greasy environment...others said it's tedious and exhausting (Female FGD, JKUAT).

How can a female Architect compete with a male architect? How will you climb on top of tall buildings...it is an African... women are supposed to be soft and tender... (Male FGD, UoN).

Why should somebody work for women during maternity leave simply because they cannot lift heavy objects during pregnancy and after delivery? (Male FGD, EGERTON).

It is hard for women to be promoted when competing with men in our Kenyan society...if anything promotions come with more responsibilities...when they will work extra hours and take care of their families... (Male FGD, JKUAT).

Further, the study established that some FGD male and female respondents were comfortable with female students pursuing STEM disciplines.

I chose to pursue telecommunication engineering...my mom is an engineer and highly respected in the society...am sure I will not be discriminated in any way (SSP Female FGD, JKUAT).

Female students can venture into STEM disciplines and have normal lives and compete for same opportunities as the men. My sister is an architect and happily married with three children (Male FGD, Egerton).

The foregoing examples of discussions draw several arguments; first, career guidance at secondary schools does not adequately prepare female students pursuing STEM disciplines on the expectations and the nature of STEM disciplines in the universities. This may explain mixed reactions from female discussants on the STEM learning environments and expectations of STEM careers on future lives. Second, the existing societal stereotypes on the masculinity of the STEM disciplines and lack of STEM female role models contribute to the mixed reactions on female students pursuing STEM disciplines.

The respondents in the questionnaire were asked to confirm if pursuing STEM disciplines affected them from getting a spouse. There were mixed reactions as (39.1%) agreed while (39.1%) were not sure, and 21.7% disagreed. The same sentiments were confirmed during the FGDs where both male and female respondents agreed female students have difficulties in getting spouses due to masculinity of the STEM disciplines and negative societal stereotypes:

My high school boyfriend left me when I was admitted to study Engineering claiming I am competing with him...he felt I should have studied Medicine or Education (KUCCPS Female FGD, JKUAT).

I cannot date a fellow architect...they are boring and too authoritative (Male FGD, UoN)

I had been admitted to do medicine in orthopaedic surgery but I had to change to paediatrics and child health...my parents felt it was too complicated and involving...my peers made fun of me...I wish I had people to support me... (KUCCPS Female FGD, UoN)

I am proud to be the only female pursuing Mechanical Engineering...when we joined were three but the other two female students transferred to other courses. They complained of too much work and were afraid they may not have time to socialize... (KUCCPS Female FGD, UoN).

In the questionnaire, the study sought to find out whether pursuing STEM disciplines negatively affects female students' family life. Majority of the respondents 53.1% agreed whereas 34.8% were not sure and only 13.7% disagreed. This was confirmed during the FGDs and the respondents expressed concerns about their families regarding STEM profession. The quotes below demonstrate the sentiments expressed:

Engineers are too busy for family...imagine how masculine and manly women can be in those aprons and oily or greasy hands... (Male FGD, Egerton).

When will a female doctor spend time with her family...she is on call all day and night...what will happen to her small family? (Male FGD, UoN).

My cousins made fun of me and said that they could not imagine an expectant Civil Engineer...doing bridge construction... (KUCCPS Female FGD, Egerton).

During the interview session with the registrars, STEM deans and faculty, they expressed great concern on the existence of stereotypes and prejudices on female students pursuing STEM disciplines. The respondents during the interviews confirmed that the stereotypes are transmitted through verbal language, content of curriculum and general organization of teaching space. Most societies see female STEM students as intruders into male domain. They are treated like outsiders, masculine, misplaced and are at times rejected by their family and friends.

Many STEM female students felt alone and misplaced... they opt to transfer to feminine disciplines (Registrar, University C).

Some parents do not want their daughters to take disciplines taking long duration ...some STEM disciplines for example Engineering take more than four years (Female STEM Faculty, University A).

Some STEM female students fear that this will affect future family responsibilities like marriage and childbearing (STEM HOD, JKUAT).

The few female students in STEM disciplines are focussed and are able to cope well despite the challenges especially with the faculty and parents support (Female STEM Faculty, University A).

Findings from FGDs and questionnaire confirmed that they were aware of 10.0% of STEM female students have dropped out of STEM disciplines as a result of institution-based barriers discussed above and in the theoretical framework and literature review. From the respondents narratives, it can be concluded that perceptions of respondents on the implications of female students venturing into STEM disciplines on their future lives was negative and this perception affects the participation of female students in STEM disciplines. The society activates the stereotype that women are poor at Math and Science and makes female students to passively conform to that view in order to fit with societal norms thereby reduce their achievement and enjoyment within these disciplines (Cialdini, & Goldstein, 2004). In conclusion, there exist a lot of social cultural and institutional barriers, stereotypes and prejudices that affect female students from pursuing STEM disciplines in universities. These barriers also affect female students pursuing STEM disciplines personalities and make them feel like outcast and inferior in their pursuit to STEM related discipline (Correll, 2001, FAWE, 2014). The need to address these barriers for more participation in female students in STEM disciplines was emphasized in this study.

From the questionnaire findings, FGDs and interviews are indicative of the institution-based barriers that are manifested from lower levels of education especially the secondary level. Hill et al, (2013), concurs that the foundation for a STEM career is laid early in life, but scientists and engineers are made in colleges and universities. Institutional based barriers also contribute to poor performance of female students in Science and Mathematics subjects which are prerequisite requirement in STEM disciplines admission in the universities as further noted by Andreescu et al (2008). It would therefore appear as established in the study and from the views of the respondents that science orientation at secondary schools, adequate science facilities and resources at both secondary and university levels of education enhance participation of female students STEM in the university. Further, Margolis et al (2002), confirms the study findings that most female students consider a range of factors when deciding what fields to pursue. Personal family choice appears to be a much more significant factor in the decision to pursue high STEM careers. The literature further indicates that high ability women have more options than do high ability men. “Women are far more likely to be equally talented in both math and verbal domains simultaneously, giving them more options to enter non-math fields than are available to men.”

4.7 Gender Responsiveness of STEM Curriculum in Universities

To discuss findings based on Objective Four on gender responsiveness of STEM curriculum, the researcher sought information using questionnaires, interviews, FGD, content analysis and observation. The aspects that were discussed were gender

responsiveness of the STEM textbooks and the STEM teaching and learning environments in the universities.

4.7.1 Gender Responsiveness of the STEM Resources

To address the issue of gender responsiveness of the STEM resources in Objective Four, the researcher conducted interviews with deans of STEM faculties/schools and female lecturers teaching STEM disciplines on gender responsiveness of STEM resources and curriculum. Content Analysis and observation were also used to analyze gender responsiveness of the STEM textbooks and learning environments. The STEM text books were sampled from the five STEM disciplines under study, whereby the researcher obtained information from the five STEM deans and the reading lists. Content analysis of STEM textbooks was used to identify gender biases in terms of gender coverage used in the textbooks; gender appropriate illustrations and roles assigned to each gender. Other indicators analysed included STEM equipment used for male and female gender, location of each gender in the diagrams and the dominating gender.

To establish the effect of gender biases in STEM textbooks on the participation of female students in STEM disciplines, interviews were conducted on STEM faculty. From the interviews, there were mixed reactions as some discussants felt that lack of female illustrations in STEM textbooks might affect female students participation in STEM disciplines, as they may feel unrepresented. Other discussants felt that the textbooks were gender neutral and had no negative effect on female students participation in STEM disciplines. The following excerpts exemplify sentiments that discussants expressed:

The textbooks are masculine, historically the Engineering disciplines were tailored for the male students...the female students may feel left out (Male STEM Faculty, UoN).

Most STEM illustrations are not gender sensitive. They have male pictures demonstrating scientific procedures (HOD STEM, JKUAT).

Most inventors are men as shown in the diagrams, so they cannot have female illustrations (Female STEM Faculty, Egerton).

Other discussants indicated that most text books were gender neutral and do not affect female students participation in STEM disciplines as narrated below:

Most STEM text books are not descriptive...there is no use of noun, pronouns...we have calculations and illustrations which do not denote any gender whatsoever (Male STEM HOD, UON)

The text books are gender neutral; there are factual information and a lot of gender neutral information (Male STEM HOD, JKUAT).

To further probe for gender biases in STEM textbooks, the researcher used content analysis tool to sample textbooks from the five STEM faculties of General Science, Engineering, Agriculture, Computer science and Health Sciences as indicated in item 3.6.4 in chapter three. The sampled textbooks were among the textbooks that were frequently listed on the reading lists in the STEM disciplines and therefore, the biases portrayed may disadvantage the female students and affect their participation in STEM disciplines. The STEM textbooks analysed were picked from the STEM course outlines and Table 4.10 presents sample matrix of female, male, and mixed illustrations in STEM discipline textbooks.

Table 4.10: Matrix of Selected STEM Text Books

Textbook Title	Discipline	Publication Details	Total Illustrations	Female Illustrations	Male Illustrations	Mixed Illustrations
Practical Fractures treatment	Medicine	Ronald M & Max Esser(2008), Elseviour Churchill Livingstone: Endingurg	18(100%)	2(11%)	14(78%)	2(11%)
Guide to Microsoft Windows	Information Technology	Levin,R (2000), Dorling Kindersley, London	82(100%)	23(28%)	50(61%)	7(11%)
Electrochemistry past and present	Chemistry	Orna, M. (1989),ACS Washington DC	52(100%)	5(9%)	43(83%)	4(8%)
Construction Materials Methods and Techniques.	Engineering	Spencer, W. (2006). Thomson Delmar learning. USA, NY.	98(100%)	6 (6%)	90(92%)	2(2%)

Source: STEM Textbooks

Report from Table 4.10 shows that illustrations analyzed in STEM textbooks were male-dominated at 79% whereas female illustrations were at 14%. For instance, in Medicine out of eighteen illustrations, only two had pictures of females, two with mixed illustration and others with male illustrations. From pages 120-131 on the topic on Fractures of the clavicle for instance, the illustrations depicted male doctors attending to patients who had suffered fractures with no illustrations of the doctors being depicted as females (Ronald et al., 2008). The same trend was noted in Information Technology, Chemistry, and Engineering textbooks with over three quarters of illustrations being male.

In the construction materials methods and techniques engineering textbook, as noted earlier in Table 4.10, male pictures dominate compared to female and mixed pictures. On page 170 on the topic on work and motor, men are portrayed as the key performers of the tasks whereas on the topic on pivot point, weight lifting page 127 women a depicted performing a feminine role of fishing. Similarly, on page xvii on an energy topic, there is

a picture of two male and two female students conducting the experiment. Gender unresponsiveness is demonstrated as the male students are performing the tasks whereas the female students are onlookers. The computer science textbook, guide to Microsoft windows on page (ii) on computing golden Rule, depicts a gender responsive illustration in the mixed picture whereby both the male and females are taking active participatory roles in the operating the computer (Levin, 2000). The study also noted the existence of gender biases of STEM textbooks on the illustration of pictures in favour of male students, a manifestation of gender unresponsive STEM textbook.

From this analysis, the researcher deduces that under-representation of female pictures in STEM text books may affect female students participation in STEM disciplines. This is because female students may feel alienated, outcasts and in the male world as discussed below by FGDs:

Most of the Engineering text books have male images... I have not come across a picture of a female engineer...this makes me feel like am in man's world (Female FGD, JKUAT).

Whenever I use the Agriculture text books...I wonder whether this course was designed for male students only. It makes me feel out of place and alienated. (Female FGD, Egerton).

The text books in Mechanical engineering have only male pictures and diagrams. After all in my class there are no female students... (Male FGD, UoN).

These findings confirm Sadker and Sadker (2008), who argue that STEM textbooks are perpetrators of gender stereotypes as a result of male images and languages portrayed. In Australia, Rosser (2004) indicated that review of science textbooks contained minimal information regarding women accomplishment in science topics. The above content analysis of the sampled STEM textbooks qualified as examples of gender unresponsive

curriculum as it leads to discrimination of female students pursuing STEM disciplines. Lack of women representation in STEM textbooks may lead to female students to develop low self-esteem, feeling misplaced, unrepresented and outcasts in the STEM disciplines. In all the STEM textbooks analyzed, the roles and technologies assigned to men and women were gendered.

The study sought to find out the effect of gendered roles in STEM textbooks on female students participation in STEM disciplines. Content analysis of the four sampled textbooks revealed evidence of gendered depictions of roles such as those of men performing masculine roles in an electrical laboratory and operating machines. The researcher sampled two pictures from STEM textbooks that depict gender roles and technologies as illustrated below depicting male engineers performing a fibre glass project.

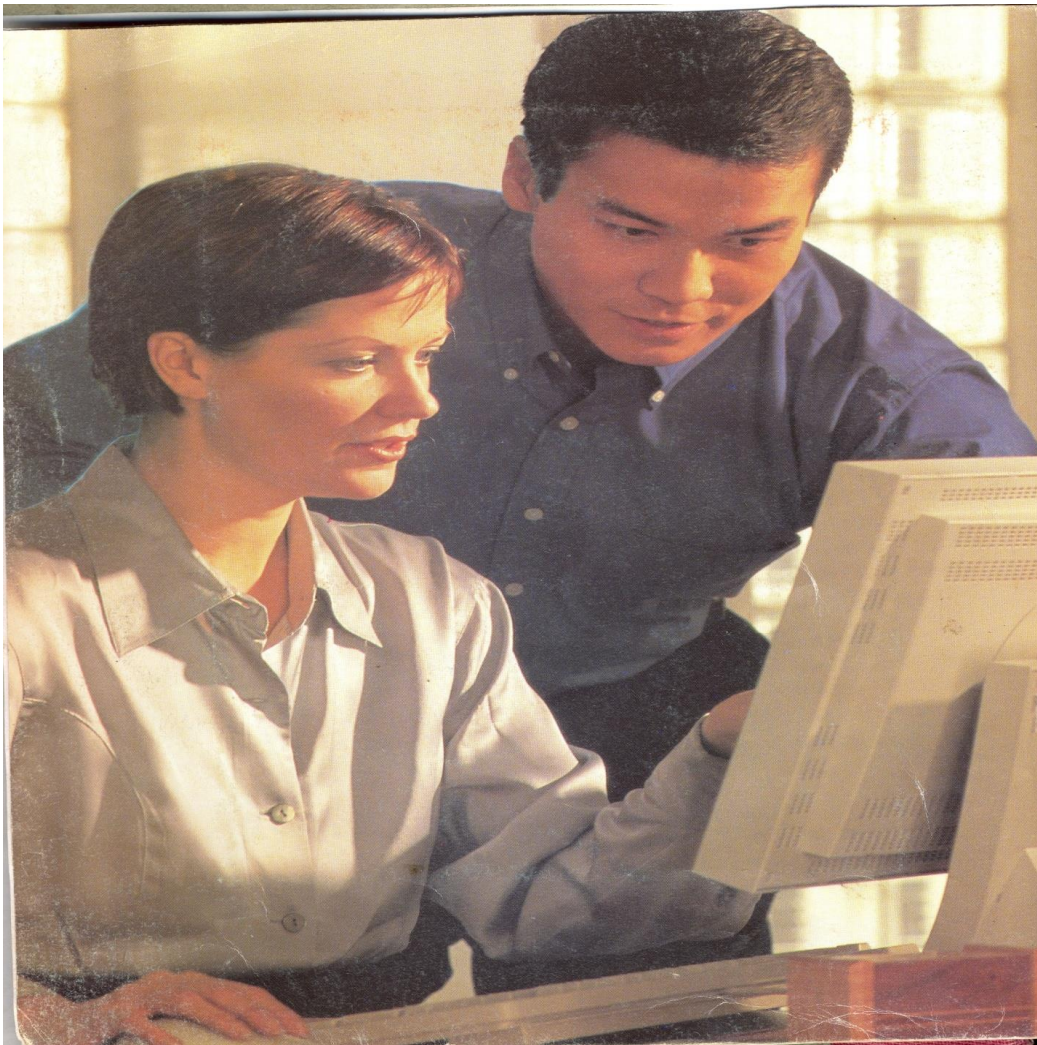
Plate 4.1: Male Engineers Performing Civil Engineering Fibre Glass Project

Source: Spencer, W. (2006, P.155), Construction Materials Methods and Techniques

Further, in a computer science text book in computer Engineering discipline (Guide to Microsoft Windows), a woman is depicted performing a computer programme under male supervision. This only serves to further reinforce gender stereotypes being feminine while supervisory roles are masculine. This concurs with Obura (1991) who argues that female students are not represented in Mathematics and Science textbooks. Participation in STEM disciplines do not seem to promote the awareness in the female students about

their participation in STEM disciplines but rather leads them to feminine disciplines such as humanities and languages. Below is Plate 4.2 from a key textbook used in Computer science discipline:

Plate 4.2: Man Demonstrating to a Woman the Application of a Computer Programme



Source: Levin. R. (2000, P. 259) Guide to Microsoft Windows

Feminine roles assigned to the female students may have negative effect on female students leading to low participation in STEM disciplines (Settles, 2006). This implies that different cultures of engagement of the disciplines may either attract or repel students from enrolling in a given discipline. Hogben and Waterman (1997) found that men are portrayed as dominant and with higher status than women in STEM textbooks. Women are likely to be portrayed as passive actors merely reacting to their environment, while men are shown in active roles by directly engaging in and initiating activity. Men are, therefore, depicted as being active agents, managing and controlling the environment. Conversely, women are likely to be depicted as passive, reactive to their environment and the recipients of others actions as noted by Woodzicka and Wingfield (2010). The study further established that students are recruited into a field and undergo a socialization in which they discover and adopt the attributes that are recognized within that field and feel represented and part of the activity. The importance of creating a gender-responsive environment through site selection, staff selection, programme development, content, and material that reflect an understanding of the realities of women's lives and address the issues of the participants should be emphasized.

4.7.2: Location of Diagram's of Male/Female in the Sampled STEM Textbooks

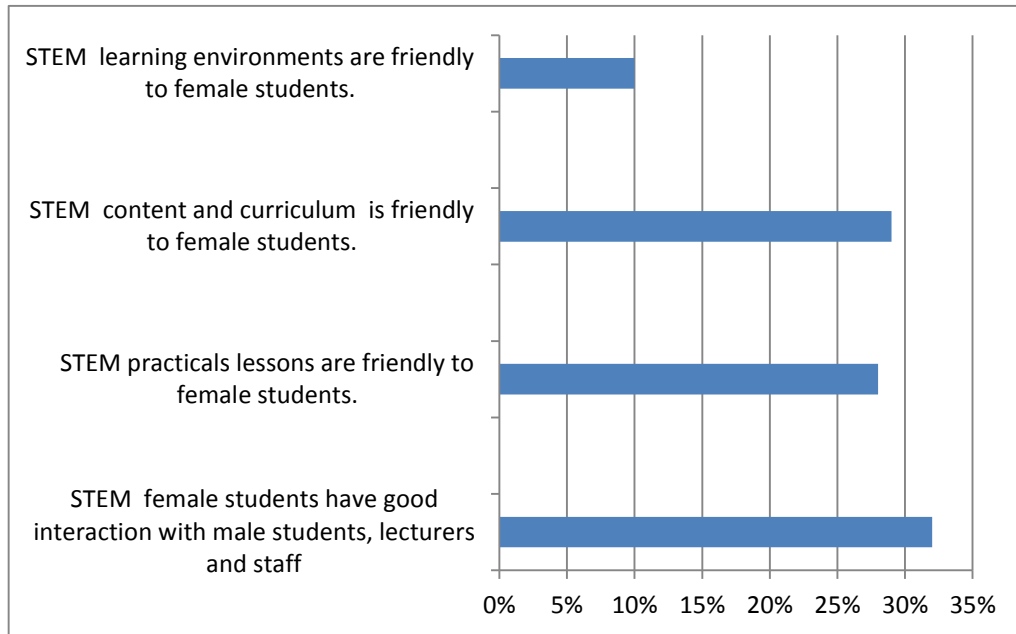
From the analysis of sampled STEM textbooks, male pictures received more focus and attention. Men were found to be located in public places like factories, building houses and workshops whereas women were depicted performing feminine roles. This implies that STEM textbooks are not gender-sensitive and therefore may influence negatively female students' participation in STEM disciplines, as they may feel alienated and

unrepresented. The findings were confirmed during the interviews with STEM female faculty as follows:

The illustrations in the textbooks are largely gendered where most pictures manifest gendered roles. Men in engineering textbooks are given masculine roles and women feminine roles...this is discouraging to female students pursuing STEM disciplines (Engineering Female Faculty, Egerton).

To further explore the gender responsiveness of STEM curriculum, the researcher used both questionnaire and observation to collect data from female students pursuing STEM disciplines and STEM teaching and learning environments. The questionnaire was administered to the female students pursuing STEM disciplines and the researcher observed the STEM teaching and learning environments. The information sought was concerning gender responsiveness of STEM content and curriculum to the female students participating in STEM disciplines, its conduciveness, STEM learning environments and male-female interactions. Figure 4.15 presents the responses from the questionnaire:

Figure 4.15: Perceptions of Female STEM Students towards STEM Learning Environment



Source: Researcher (2013)

The findings from Figure 4.15 show that (37) 10% of the female respondents confirmed that the STEM learning environment were friendly to female students. This implies that 90% of the respondents were of the opinion that learning environments were not gender friendly to female students. In terms of STEM content and curriculum, less than (108) 30% of the students reported that it was gender friendly to female students; (100) 28% indicated that STEM practical lessons are friendly to female and less than (115) 32% of the respondents agreed that there was good female students' interaction with male students, staff and lecturers were good. In summary, 65% of respondents indicated that learning environment is not gender friendly on all the four aspects under investigation. Hill et al., (2013) concurs with the study that classroom and extracurricular settings

should provide a more relaxed, less stressing, less competitive learning environment for students, including girls. Extremely high expectations, selective and result-driven preparation can interfere with female students excelling in STEM disciplines. High STEM disciplines expectation can also affect the development of self-esteem and self-efficacy needed for STEM performance. If this is paired with a fixed mindset approach, most female students get discouraged. Inclusive learning environments, without threatening of failure, and allowing female students pursuing STEM disciplines make mistakes so as to learn from them (Bennett, 2013).

The study further sought to find out the suitability of the STEM learning environment in terms of STEM facilities, equipment and the STEM environment in terms of location and security of female students. There were mixed reactions from respondents on the implication of the STEM learning environments on participation of female students. The findings were that the 6 out of 8 FGD female respondents indicated that the learning materials are not friendly to the female students and are male dominated whereas 2 respondents were comfortable. This was confirmed during interviews and observations sessions with the STEM faculty who had mixed reactions as follows:

The STEM disciplines are Masculine historically the Engineering disciplines are stereotypically male dominated (STEM Dean, University C).

A FGD female participant from UON indicated that she was comfortable with the learning environment as discussed below:

It does not matter. My passion was to study Engineering and it doesn't matter how the learning environment is (Female FGD UoN).

felt comfortable with the STEM learning environments. Other respondents felt that the learning environments were masculine, rusty, oily and dusty and this affected their participation in STEM disciplines. The following plate 4.4 illustrates the STEM learning environments:

Plate 4.4: A Picture of a University STEM Woodwork Workshop



Source: Researcher 12.07.2013

The researcher shared the above plates 4.3 and 4.4 with the discussants during FGDs and received divergent views on the suitability of STEM learning environments to female students. From the discussion, 5 out of 8 female discussants depicted the learning environments as dusty and unsuitable for learning while the others were comfortable as narrated below.

The Labs are oily, full of wood, dusty and noisy. Too masculine for me... but I have no choice as that is the nature of STEM disciplines (Female FGD, UoN).

The instruments are too masculine and manual... (Female FGD, Egerton)

It does affect some female students' participation especially the dusty, oily and unventilated rooms (Female STEM Faculty, JKUAT).

Some FGD female students' discussants students pursuing STEM disciplines were comfortable with the learning environment as narrated below:

The wood work workshop has to be dusty...am comfortable and i dress appropriately for the class (Female FGD, UON).

The learning environments are okay. There cannot be masculine or feminine machines... if anything machines are to be operated on by both male and female students (Female FGD, UON).

The researcher sought for opinion from the FGD discussants on mitigation measures to make STEM learning environments gender sensitive. Discussants noted that the STEM learning environment cannot change so female students must learn to cope. This is an indication that the gender sensitive campaigns at the universities, including gender and affirmative action directorates have not adequately prepared female students on the requirements and expectations of STEM disciplines. Other discussants suggested that universities should adopt new technology particularly the use of ICT instead of operating workshop devices and machines manually. They had the following opinions:

Why do female students imagine that they can have their own machines yet we are conducting the same practical? They should harden up if they are to compete with males students (Male FGD, JKUAT).

Let the universities adopt technology...this will improve the learning environments in the laboratories and workshops. (Female FGD, JKUAT).

The researcher further probed the female respondents pursuing STEM disciplines on their preparedness and expectations of the STEM learning environment and STEM careers. 6 out of 8 female FGD respondents expressed lack of prior awareness of the STEM learning environments. They expressed that there was lack of proper preparedness and

exposure on what to expect from STEM disciplines at the universities as more emphasis was on syllabus coverage and some secondary schools lacked science facilities as expressed below:

My high school teachers never prepared me on the STEM learning environment. As much as I knew the Engineering laboratory was full of machines... I never expected such huge and scaring machines...my first day in the laboratory was terrifying (Female FGD, JKUAT).

The science subjects taught in high schools are very different from the STEM disciplines in the universities. I expected the same laboratories and equipments...but that is not the case...here they are complex (Female FGD, UoN).

I studied in a day school. We did not have a laboratory...we would use our neighbouring school labs...I lacked proper guidance on the STEM equipments and this affected my performance. Luckily my Biology lecturer and the laboratory technicians were of great assistance. (Female FGD, Egerton).

The female FGD concurred that they were not conversant with STEM learning environments as the equipments were sophisticated and a new experience for the respondents. The respondent agreed that nothing could be done about the oily, rusty and noisy learning environments and the STEM curriculum. Both female and male FGD respondents felt the need to enlighten students was paramount on the disciplines offered at the university and what they pertain. The career guidance should be started from lower levels of education to make the female students pursuing STEM disciplines aware of the STEM curriculum and STEM learning environments. This too will enable the students make enlightened choices as expressed below:

No one told me that the Engineering lab is this messy...but I realize it has to be this way...I now cope very well (Female FGD, JKUAT).

Some female students were so scared the first time we had a practical in the morgue...some dropped the course and others had interfaculty transfers...at first I was traumatised...but I now cope very well.(Female FGD, UoN).

The first impression I received in the workshop was disappointing. But I really wanted to pursue electrical engineering. I got a lot of support from then my lecturers... now I like it as it is all about determination (Female FGD, Egerton).

The female students have stereotypes about the STEM laboratories and workshops. Secondary schools should prepare the students well on what to expect of the STEM disciplines learning environments (Male FGD, UoN).

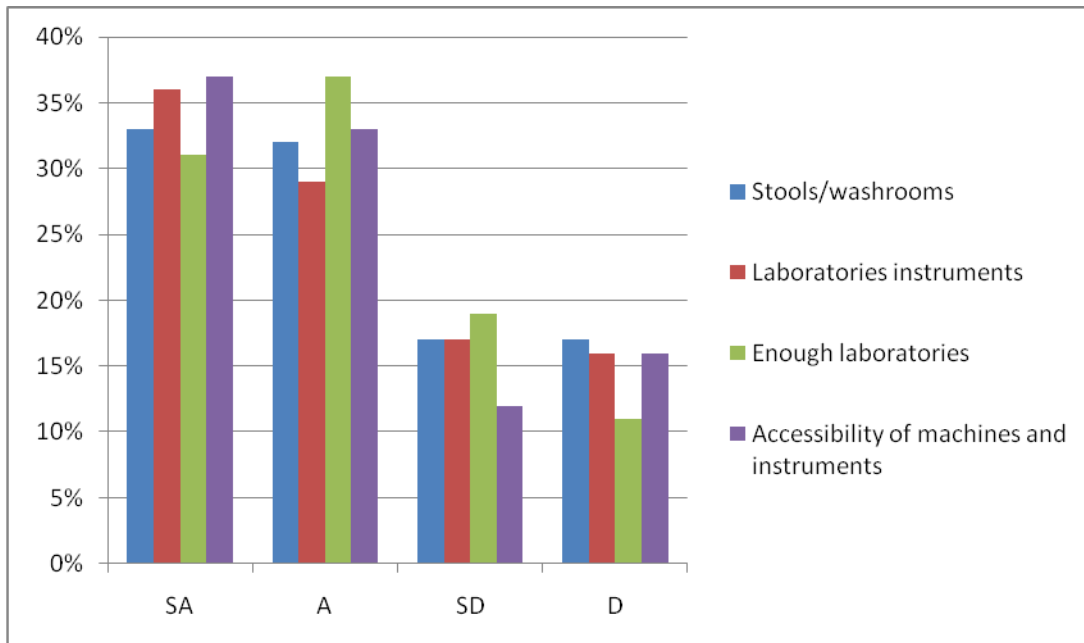
STEM learning environments are perceived masculine and unattractive to the female students and this affects female participation in STEM disciplines. Pajeres (2005) confirms that gender differences in performance in sciences is caused by lack of confidence, culturally prescribed gender roles unsupportive learning environments and poor career guidance and preparations at all educational levels. There is need to make the STEM learning environments more gender-friendly by including feminine figures, illustrations and modern computerized equipments and equip students with necessary information on the expectations of each STEM discipline.

Mentoring and socialization are statistically significant predictors of academic experience for the female students pursuing STEM disciplines, and academic experience is highly correlated to overall experience at the university. Hill et al (2013), emphasises the importance of mentoring, socialization and unbiased faculty and peers. STEM fields provide fertile ground for bias in two reasons. First, studies of tokenism document that bias tends to occur more often when women make up less than 15% to 20% of a given field, which is common in many STEM disciplines (Kanter, 2014). Second, biases are more common in STEM fields that are highly meritocratic,

4.7.3 STEM Physical Facilities

To establish the status of physical facilities in the universities, the questionnaires, interviews, FGDS and observations were used to collect data on the adequacy of the physical facilities. These included laboratory facilities. In terms of adequacy of STEM physical facilities, findings from the questionnaires revealed that 65% were of the opinion that the STEM physical facilities such as stools and washrooms were not adequate whereas 34.5% felt that they met the needs of the female students. In terms of laboratory instruments 66% felt that they were inadequate. In terms of accessibility of STEM machines and equipment by female students in the laboratories and workshops, 70% expressed dissatisfaction whereas 28% felt they were enough and sufficient. The above discussions are shown in Figure 4.16 below:

Figure 4.16: Perception of Respondents on Inadequacy STEM Physical Facilities



Source: Researcher (2013)

Respondents were of the opinion that the inadequacy of the physical facilities affects the equal participation of female students in STEM disciplines. This was further confirmed during the interviews and the FGD as follows:

The practical instruments in my university are old and non-functional, masculine, scary, oily and noisy especially in the engineering laboratories. (STEM Female FGD, UoN).

Learning facilities including the washrooms were designed for male students but a few have been customized to fit female students (STEM Dean, UoN).

In Engineering some machines are too high and heavy for accessibility by female students. (STEM HoD, Egerton).

The study established that male and female students tended to specialize in different disciplines due to gender stereotyping, perceived masculinity of the STEM disciplines and learning environments. This also seemed to steer females to enrol in feminine courses where they feel more appreciated and represented. Cialdini and Goldstein (2004) confirm the findings and indicate that people tend to passively comply and conform to societal ideals or stereotypes to fit within the norm. According to NSB (2010), female students are underrepresented in STEM disciplines because they are uninspired by pedagogical processes and techniques that potentially influence their performance negatively. The students develop subject loyalty and develop gender identities (Thomas, 2009).

The researcher further observed that teaching and learning environments were not friendly to female students as laboratories and workshops were far from the hostels and residential areas. This made it difficult for the female students to study during the late hours due to insecurity. The researcher also observed poor lighting within the universities

thus making female students to be afraid. Notably, insecurity within universities affects all female students but the STEM students are more affected as they spend more hours in the laboratories till late in the night carrying out STEM practical and experiments: this is because STEM disciplines curriculum involves more practical work compared to other non-STEM disciplines hence they are at greater risks of being attacked at night. This was informed during the interview with Egerton director of gender and affirmative actions as follows:

There are many reported cases of insecurity for the commuting female students from their campus to their residence at night (Director Gender and Affirmative Action, University C).

FGD participants confirmed the status of insecurity in the university as follows:

Walking from the library at night to the hostels alone is scaring. We walk in groups or organize with male students to escort us (Female STEM, JKUAT).

We have to perform the experiments in the laboratories unlike other students who can study in their rooms. The laboratories are far from halls of residence...it is very insecure (FEMALE STEM, UoN).

Nursing and married female students stay out of campus and some in the slums where there are high cases of insecurity. They were not able to finish their assignments and projects in time due to family responsibilities. (Female STEM, Egerton).

Am a mother and I stay in the neighbouring slum...it's very insecure our here... walking from campus at night is very risky...cases of sexual harassment are the order of the day...the living conditions are unbearable...(Female STEM, UoN).

We normally stay in the university carrying out foundry work in structural engineering which requires us to stay in workshops after normal study time to accomplish the projects assignments. (Female Mechanical Engineering Student, UoN).

The differences in choice of disciplines are as a result of socialization and gendered societal expectations which are the limiting factors to the female students pursuing STEM disciplines. Discussants expressed the need of a gender responsive STEM curriculum and gender-friendly learning environment is paramount for more female student participation in STEM disciplines. Masculinisation and feminisation of the disciplines pursued at the university is as result of the social construction and stereotypes that are determined by the society that affect female participation in STEM disciplines as discussed in the theoretical framework and literature review.

4.7.4 STEM Classroom Teaching and Learning Process

During the process of STEM teaching and learning, the researcher observed three STEM classes one from each of the sampled universities. The STEM disciplines and topics observed were purposively sampled to establish STEM classroom teaching and learning process. In the three lessons observed, there was the presence of one STEM female and two STEM male lecturers teaching. The classroom teaching and learning observation confirm the previous findings in Objective One which showed under representation of female students in STEM disciplines and under representation of female faculty in STEM disciplines as reported in Objective Three.

In JKUAT for instance, the researcher observed third year students during Agriculture lesson on the agro-ecology topic, which is a common unit for students pursuing Bachelor of Science in Agriculture. The Agriculture class, consisted of twenty students out of which 3 were female students with a STEM male lecturer. It was also observed

that when explaining some content within the Agro-ecology topic, the lecturer used masculine terminologies and stereotypes, for example, when a female student faced difficulties in explaining a concept, a male student made the following comments:

I told you she cannot make it...softie...wasting our time...let ladies take courses they can manage like teaching...Agriculture is a male world... (Male STEM, JKUAT).

The above comment during the lecture informs the study of ridicule and laughter when a female student gave wrong answers and failed to respond to some practical aspects as compared to the male students. This negatively affected their participation in the lesson. The lecturer in the Agro-ecology lesson intervened and discouraged the remark.

At the UoN, the researcher observed a third year engineering practical lesson doing Automation and Robotics topic; the class comprised of 15 male and 3 female students taught by male lecturer. During the session under observation, the researcher noted gender biases exhibited by both male students and lecturers towards the female students. While teaching course concepts and ideas, more interactions of lecturers with male students compared to female students were noted. Interestingly it was reported by the lecturer that female students understood and performed tasks better than their male counter parts. During the practical lesson, there were stereotypes exhibited by the male students when they resorted to work in groups. This happened specifically when male students were called upon to work together. Below male STEM lecturer seemed surprised that female students were performing better than male students made comments:

You see men of today you are being overtaken by women... it is interesting that the ladies are active and acquiring high grades that you men...(Male STEM Faculty, University A).

Let the gentlemen help our ladies lift that heavy object (engine)...too heavy for them...we might not finish this practical soon (Male STEM Lecturer, University A).

At Egerton University, the researcher attended a biochemistry (Science) practical lesson where third year students were taught macro molecular biochemistry on DNA isolation. This class was facilitated by female faculty and comprised 18 students where only 4 were female students. During the learning process, all students were actively involved in the learning process, although male students were more dominant during the practical lesson. In some instances female students were passive and merely observed and recorded the results as male students performed the tasks. The researcher observed that the female lecturer ensured there was active involvement by all students. Concerning lecturer/learner interaction during STEM lessons observed, the researcher using an observation checklist noted that both male and female students were given equal opportunities in answering questions, providing answers and performing tasks.

In summary, the STEM teaching and learning environment and process are not friendly to female students and are male-dominated by both the STEM faculty and students. This disadvantages the female students pursuing STEM disciplines and affects their participation. The STEM teaching and learning is interactive for both male and female students pursuing STEM disciplines. Teaching skills and techniques that are gender responsive encourage female students to access and participate in STEM disciplines in the universities as discussed in Chapter One in the literature review.

4.8 Existing Institutional Interventions to Increase Female Participation in STEM disciplines in Universities

To respond to Objective Five, the researcher sought to evaluate the appropriateness, soundness and the impact of existing educational policy interventions that influence female students' participation in STEM disciplines in Kenyan public universities. The existing institutional interventions include SSP or Module Two programme, financial Aid for the needy female students pursuing STEM discipline, Affirmative Action policy by GoK (1995); Wango (2012). Objective Five finally discusses the interventions that can be implemented to increase female participation in STEM disciplines.

4.8.1 Self Sponsored Programme (SSP)

The study established that one of the major institutional interventions that has increased female students participation in STEM disciplines in Kenyan public universities, is SSP. This policy is income-generating driven and the needy female students cannot afford as they have to pay more of higher education within and outside STEM. The admission criteria involve low university cut-off point as compared to KUCCPS admission. Due to higher cost, SSP admits more financially able students who meet the university requirements. It was established that enrolment trends in STEM discipline are higher through the SSP mode of admission compared to the KUCCPS. For instance the study established that in 2013/2014 academic year JKUAT had over 55.8% female students were enrolled in SSP compared to 44.2% KUCCPS. Data obtained from Economic Survey 2015 indicate that there were more female students in Bachelor of nursing at 66% compared to males at 34%. Fewer females were recorded in dental surgery,

Biochemistry, Pharmacy and Medicine and Surgery at an average of 45%. As discussed earlier in Objective One, female students were attracted to soft sciences as compared to hard sciences despite the low university requirements.

For example, at JKUAT, there was an enrolment rate of 88.6% for SSP students and 11.4% for KUCCPS students in Health Sciences, 81.8% for SSP and 18.2% for KUCCPS students in Computer Science which are perceived as soft sciences. On the other hand, there was an enrolment rate of 21.2% for SSP students and 78.8% for KUCCPS students in Agriculture while 45.9% for SSP students and 54.1% for KUCCPS students were enrolled in Engineering. These findings were confirmed through interviews with the university registrars. The study further established that SSP students have the opportunity of selecting the STEM disciplines they wish to enrol in and the mode of study as long as they qualify. The following are opinions from the discussants on the same:

The universities have high female enrolments in STEM disciplines due to the introduction of SSP... More SSP students are in Computer Science and in nursing compared to KUCCPS... especially those who did not qualify under KUCCPS (Registrar, University A).

The cut point requirements for SSP are lower compared to KUCCPS and therefore more students qualify. KUCCPS requirements for engineering are grade A and for SSP are grade B in the cluster subjects (Registrar, University B).

SSP are open and flexible depending on the performance and the mode of study as compared to the KUCCPS students who are restricted by the KUCCPS requirements... (Registrar, University C).

The study noted an increment of enrolment in soft science for SSP students was due to low cluster requirements, perceived femininity, job market and financial ability to cater

for the cost. The discussants who included the JKUAT registrar and female SSP students pursuing STEM disciplines confirmed the findings as follows:

Female students are not attracted to Engineering and Agriculture compared to Computer Science and health Science...they perceive them as masculine... (Registrar, University B).

I had qualified to take Mechanical Engineering but I was scared...imagined it is very hard and I also felt it was too masculine...I opted to take a degree in Medicine. (Female STEM SSP, UoN).

My parents pay 200,000 Ksh per year as compared to KUCCPS students who pay 35,000 Ksh. Accommodation is not automatically provided by the universities...times seek private accommodation outside campus when the hostels are fully booked by KUCCPS students (STEM FGD SSP Female, UoN).

I got an A Minus in KCSE and due to high KUCCPS requirements I could not have qualified to pursue Engineering. Luckily my parents can afford the SSP programme and am glad my dreams have come true. (STEM FGD SSP Female, JKUAT).

From the on-going discussions, it is evident that SSP has increased female students admission in soft sciences in STEM disciplines in universities. This is because SSP female students pursuing STEM disciplines can afford to pay the fees as opposed to students admitted through KUCCPS. The needy female students are not able to raise the required fees and are left out. Female students pursuing STEM through SSP are attracted towards soft sciences due to perceived femininity of the soft sciences and the job market.

4.8.2 Financial Aid for Needy Female Students Pursuing STEM Disciplines.

As previously discussed in Objective Four on institutional-based limitations to female student participation in STEM disciplines, the study established that female students pursuing STEM disciplines face many challenges in pursuit of their studies. Among these challenges is a financial constraint. The respondents reported financial aid as another

institutional intervention that has increased female students participation in STEM disciplines in Kenyan public universities. As much as SSP increases female students enrolment in STEM disciplines, through SSP students pay more tuition fees compared to KUCCPS. This disadvantages the needy students who do not meet the KUCCPS cluster requirements and cannot afford to raise the tuition fees (Onsongo, 2009, Wanyande, 2003). Moreover, the respondents advocated the need to develop financial aid programmes for the needy female students pursuing STEM disciplines.

The study established that there are a variety of financial aid programmes but most of these are neither gender nor discipline specific. Most of these financial aid programmes (Alumni Association, Ratansi Education Fund, Needy Students Fund programme, Babaroa prize awards, Higher Education Loans Board (HELB) and School of Architecture and Building Sciences (SABS) benefit both male and female students. The study established only two financial aids programmes, namely; the South Face Scholarships in UoN and Dr. Wanjui Education Fund which benefits female students pursuing STEM disciplines. The study was informed of two categories of financial aid: designed for female beneficiaries and aid accessible to female students but not designed for female students only. A brief description of the financial aides in universities is provided in the subsequent paragraphs.

Aid Designed for Female Beneficiaries

One of the aid designed for female beneficiaries is Dr. Joe Wanjui Educational Trust Fund that was launched in the 2005/06 academic year. Applications are made through Catholic University of Eastern Africa (CUEA) with the selection and awards being done by Dr. Joe Wanjui Education Trust Board. The fund supports academically gifted but financially deserving KUCCPS female students studying STEM disciplines. The amount of financial aid awarded varies yearly depending on the number of applicants and the funds available. For example in 2014/2015 academic year, seven universities out of which five UON female students pursuing STEM disciplines received financial aid.

The study established another UoN financial aid programme designed for female beneficiaries for the needy female students pursuing STEM disciplines is the South Face Scholarship. The female beneficiaries these Scholarships are selected from school of Engineering, Environmental and Biological disciplines. In 2014/2015 academic year, South Face Scholarship benefited 8 needy female KUCCPS students.

Aid Accessible to Female Students but not Designed for Female Students Only

Alumni Association is another financial aid provider accessible to female students but not designed for female students only in UoN which awards both male and female KUCCPS needy students. In 2014/2015 academic year there were 178 beneficiaries out of which only 18 were female students in STEM disciplines. In Architecture, out of 52 beneficiaries, only 5 female students benefited. In Agriculture, 2 female students benefited out of 57 beneficiaries, in Bachelor of Science, 5 female students benefited out

of 34 beneficiaries whereas in health science, 14 males and 3 females benefited from the grants.

The study was further informed of organizations, non-governmental organisations and individuals who provide financial assistance, scholarships and bursaries to the needy university students. For instance, Ratansi Education Fund provides financial aid to both male and female students in the universities. The study established that in 2014/15 academic year in the School of Engineering, out of 69 beneficiaries there were only 6 female students by Ratansi Education Fund. In Agricultural discipline Ksh out of 52 students, 12 female students benefited. In Bachelor of Science the fund allocated and 9 male students benefited with no female beneficiary. Ratansi Education Fund also benefited SSP students. For instance in 2014/2015 academic year, there were 121 beneficiaries in health Sciences out of which there were only 11 female students which is less than 10%.

UoN has a needy students fund programme for KUCCPS students which benefits male and female students in the university. The amount provided varies depending on the needs of the students and funds availability. In 2014/2015 academic year in the School of Engineering, out of the 19 beneficiaries, there were only 4 females, in Agriculture there were 29 beneficiaries with only 7 female students. In health sciences, there were only 2 females out of 8 beneficiaries whereas in Bachelor of Science there, were 27 beneficiaries whereby 20 were males and 7 females. Other beneficiaries included 2 female out of 8

male students in Health Sciences. Proportionately none of the funds complied to constitutional requirement of minimum 30% for either gender (GoK, 2010).

In JKUAT there are scholarships offered by Babaroa Prize Awards to both male and female needy students pursuing STEM disciplines. Babaroa prize award is an annual academic event that was incepted 12 years ago. The award was initiated by over 180 pioneering Japanese Professional under the Technical Cooperation Agreement between the Government of Kenya and Japan International Cooperation. In 2014, the financial aid programme benefited 117 STEM students out of which only 32 were female students.

Other financial aid providers at JKUAT include School of Architecture and Building Sciences (SABS) funded by BASCO Products Kenya Limited to the best three final year students in the departments of architecture, landscape architecture, construction management and civil engineering Kenya youth education scholarships. It benefits male and female needy students. At Egerton University, there are financial aid programmes for needy students regardless of gender and area of study. They include Ratansi Education Fund and Egerton University Bursaries and Scholarships. The study could not obtain the amount availed to the needy students because of non-responses from respondents.

The Government of Kenya, through the Higher Education Loans Board (HELB), provides financial assistance to needy Kenyan students who have achieved annually predetermined cut-off points at the Kenya Certificate of Secondary Education for university entrance. The study noted that HELB was established in 2004 and started operations in 2005 and has led to increased participation of female students in STEM

disciplines. Notably, HELB benefits all categories of needy university students joining tertiary education. In 2013/14 academic year, out of 31,647 applicants 29,754(94%) qualified for the loans.

Further, the study sought to establish the significance of the financial aids to the needy female students pursuing STEM disciplines. The fund benefits very few female students pursuing STEM disciplines and was sufficient. These findings were confirmed by registrar UoN and a female students pursuing STEM discipline who expressed the need for more financial aid to meet the needs of the female students pursuing STEM disciplines as discussed below:

Dr Joe Wanjui education fund provides scholarships to the needy bright female students pursuing STEM disciplines. The university recommends the needy cases and forwards the names to the fund for their consideration...the fund benefits very few female students yet we have many disadvantaged students (Registrar, University A).

Am lucky I benefited from the fund this year. I was awarded Ksh 20,000 ...part of my fees balance was paid. I hope I will get assistance next year. (KUCCPS Female FGD, UoN).

We are glad that South Face Scholarships provides scholarships to only female students pursuing STEM disciplines...unfortunately they are very few female students pursuing STEM disciplines who benefit and we have many needy female students...we need more financial aid providers to assist the disadvantaged students(Registrar, University A).

Am a needy SSP student and have never received any financial aid...the scholarships are extremely competitive and it is difficult for me to pay my tuition fees and upkeep...am likely to drop out of university if I don't get a scholarship (SSP Female FGD, UoN).

The study found that JKUAT does not have a financial aid programmes for female students pursuing STEM disciplines as confirmed below by the Academic Registrar during the interview:

The Babaroa and Vice Chancellors awards are open to competition to both male and female students and only those who meet the requirements benefit...we do not have financial aid for female students pursuing STEM disciplines...maybe in future we shall develop the programme.. (Registrar, University B).

The study investigated the perception of the respondents on the efficiency of the financial aids and scholarships to the needy female students pursuing STEM disciplines. The discussants confirmed that there are very few financial aids for the female students pursuing STEM disciplines. The existing financial aids have little significance to the financial needs of the female students as they are not able to cater for all the needy students pursuing STEM disciplines. Second, the respondents expressed that the financial aid programmes in some instances have been abused by some universities authorities through support of undeserving students as expressed below during the interviews with female FGD registrars:

I come from a peasant background. I have not benefited from any financial aid programmes... I had to call off some semesters due to financial problems ...this has negatively affected my participation in my studies (Female FGD, UoN).

We have many needy students in need of financial aid but only a few benefits due to financial constraints. We need more funding to provide finances to the female students pursuing STEM disciplines (Registrar, University C).

Selecting the female student to benefit from the few financial aid providers is difficult since they all qualify and they are extremely needy (Registrar, University A).

Cases of favours and corruption are common whereby the financial aid programmes beneficiaries are the financially able students leaving out the needy (Female FGD, JKUAT).

The study established that female students pursuing STEM disciplines required more financial aid compared to male students pursuing STEM disciplines since tuition fees for STEM disciplines are higher compared to other disciplines and female students who have

more financial needs. Apart from the academic financial expenses, there are nursing mothers who require financial assistance. The study established that some STEM students end up dropping out of university, performing poorly and indulging in odd jobs to earn a living to enable female students pay the university tuition fees and accommodation as expressed below by the female discussants from UoN and JKUAT:

I spend a lot of money purchasing learning materials such as text books for my medicine programme. Most times my parents cannot afford...I work in town a chemist after classes to meet my financial needs (Female FGD, Pharmacy, UoN).

After classes I work in a supermarket to enable me pay for my tuition and my basic need. (Female FGD, JKUAT).

From the ongoing discussion, the study established that there are few financial aid programmes for female students pursuing STEM disciplines. Second, the existing financial aid programmes in the sampled universities benefit both male and female students and are open to competition. Third, the grants are not able to meet the needs of the needy female students pursuing STEM disciplines due to financial constraints and high competition by the needy male and female students. Fourth, the female students pursuing STEM disciplines end up indulging in odd jobs to meet their financial needs in the university. There is need to develop and improve the existing financial aid programmes for female students pursuing STEM discipline since they have more financial needs as compared to the male students. Financial aid interventions will increase female participation in STEM disciplines.

4.8.3 Affirmative Action Policy

As discussed in Objective One in this study on STEM enrolments, Kenyan public universities have less than 30% of female students in all STEM disciplines and more so

in hard sciences. This low enrolment is despite the Kenyan governments, universities gender equity policies, and interventions put in place on equalizing the opportunities of women in universities in terms of access and participation. The existing affirmative action (AA) only lowers the general KCSE mean grade and does not consider the science and mathematics cluster subjects that are prerequisite requirement for STEM disciplines (Wanyande (2003). Previous analysis by KNEC (2012) shows poor performance of female students in Mathematics, Physics, Chemistry and Biology. This limits female students' ability to qualify for STEM disciplines at the universities under KUCCPS due to the higher cluster requirements for STEM subjects. The researcher confirmed this by analysing the female beneficiaries from the AA intake in different disciplines in the selected three public universities from 2009 to 2013 as shown in Table 4.11.

Table 4.11: Female Beneficiaries of the AA by Various Programmes Cumulatively Between 2009-2013 Academic Years

Faculties	Female beneficiaries(N)	%
Bachelor of Science	240	16
Bachelor of Arts	489	34
Bachelor of Education	412	28
Bachelor of Commerce	269	18
Engineering	15	1
Agriculture	40	3
Health sciences	0	0
Computer Science	0	0
Total	1465	100

Source: Data Compiled from the Sampled Universities Records

The findings in table 4.11 are indicative of how existing AA policy has brought about little impact on female students access to STEM disciplines. Over half of the

beneficiaries of the AA between 2009 and 2013 are from Bachelor of Arts and Bachelor of Education degrees at 61.5%. Engineering and Agriculture have the lowest number of beneficiaries at less than 4.0% cumulatively. This was observed by Onsongo (2009) who argued that during the Beijing Conference, most countries among them Kenya included adopted affirmative action programmes so as to increase women access to university education. Wanyande (2003) also observed that lowering female students university intake by 1 or 2 points depending on KCSE performance is a temporary measure aimed at enabling more female students to join universities. Despite the global efforts to increase female students' enrolment in the Universities, they remain underrepresented in STEM disciplines.

To further address Objective Five, the researcher interviewed the university administrators (registrars, STEM faculties/schools, directors of gender and affirmative action) from the sampled universities who confirmed that few or no female students pursuing STEM disciplines benefit from the AA. All respondents expressed the need to develop complementary educational policy interventions for STEM disciplines arguing that the implementation of AA had not been successful in increasing female student participation in STEM disciplines in the universities.

To validate claims made by various university officers regarding the AA ineffectiveness in enhancing STEM intake for female students, the study further compared the KUCCPS female admission and female beneficiaries of AA in 2011/2012 academic year for the three sampled universities as shown below in Table 4.12.

Table 4.12: Female Enrolment and Proportion of Female Beneficiaries of AA by the Various Programmes in UON, Egerton and JKUAT (Year 2011/2012)

Discipline	AA Beneficiaries(N)
Engineering	0
Agriculture	11 (3.7%)
Health sciences	0
Bachelor of Science	68 (7.5%)
Computer Science	0
Bed(Science)	0
Bed(Arts)	32 (12.7%)
BA	256 (22.8)
Total	367 (11.4%)

Source: Data Compiled from the Sampled Universities Records

The study established that only 11.4% of female students benefited from the AA action. There were no beneficiaries of AA from Engineering, Health sciences, Computer Science disciplines. The greatest beneficiaries were from Bachelor of Education and Bachelor of Arts degrees at over 35%, Bachelor of Science at less than 10% and Agriculture at less than 5% as shown in Table 4.12. The study further established that male students are not beneficiaries of the gender AA and therefore, their figures were not included in the above findings. These reports, confirm the need for a STEM gender policy to increase female participation in STEM disciplines. These findings were supported during the interviews from university administration as follows:

The AA action should be strengthened by introducing STEM policies and interventions to bring more female students on board. These policies should be implemented starting at lower levels of education especially at secondary level (Registrar, University C).

Poor performance of girls in Mathematics and Sciences starts early and is reflected by the KCSE performance. Complimentary policies should be adopted to address other socio cultural and institutional barriers (STEM Dean, University A).

Yes, a few student benefit from the AA...but they just join the university to pursue general courses... they don't qualify in the STEM disciplines due to their poor performance in Sciences and Mathematics at KCSE. The AA should lower the Science and Mathematics subjects to enable female students qualify for STEM disciplines (Registrar, University B).

AA action should be re-evaluated... it is not adequate. STEM disciplines should be made more attractive to female students (STEM, HOD, University A).

AA has been in place for over the last fifteen years. It is only concerned with lowering the general university cut points. There is no STEM policy at the university ...the universities have interfaculty transfers with the same cut points so most female students do not qualify. (Director Gender AA, University B).

The researcher further probed on how STEM gender policies are covered in universities strategic plans, university gender policies and Ministry of Education gender policy. The study established that STEM policies and interventions were not covered in all the sampled universities in the stated policy documents. Instead, the government gender policy and the universities have general strategies such as gender advocacy and sensitization, bursaries and scholarships for the needy students. Universities are also involved in secondary schools career guidance, mentoring programmes and secondary school science congress programmes. Similarly, they have mobilized resources to conduct research with special focus on gender issues in education and providing gender responsive STEM facilities and equipment. This was further confirmed during the interviews as follows:

We do not have STEM gender policy in place. We have interfaculty transfer but most girls do not qualify for STEM disciplines due to their poor performance in high school in Mathematics and Sciences (Registrar, University C).

We are yet to develop a STEM policy. We do organise mentoring and career programmes where we create awareness on the university programmes we offer. We also offer career guidance to interested secondary schools (Registrar, University A).

We only have the general gender policy and hence we are looking forward to develop a STEM gender policy in due course to increase more females in STEM disciplines (Registrar, University B).

The study further sought to find out the implication of universities developing STEM gender policies and interventions to the female beneficiaries. There were mixed reactions from the respondents whereby some were of the view that STEM gender policy will encourage female enrolment in STEM disciplines while others felt that the STEM gender policy would compromise quality and may lead to stigmatization of the female students benefiting from the programme. Some of the views are captured in the interviews excerpts as follows:

It is a good policy, as we shall have more female on board in STEM disciplines where they are under presented (Registrar, University C).

The policy should have been implemented together with the AA...this will reduce the gender imbalance in the universities and in STEM disciplines (Director, Gender AA, University B).

Female students do not need special consideration...this is discrimination because both sexes are endowed equally. The fact that someone is a lady does not mean she is should be given special treatment (STEM FGD, Male, Egerton).

It is argued that encouraging preferential treatment in university admission and hiring or appointing women to STEM positions perpetuates the myth that women are inferior (STEM FGD, UoN).

Women who enter university through AA are considered inferior to other students and sometimes called names suggesting they are below standard.

Some students are opposed to affirmative action on the basis of the stigmatisation of beneficiaries (STEM Faculty, JKUAT).

It has put a majority of us women into a very bad spot. Once in a while a male student will tease you that you only joined the university courtesy of the AA (STEM FGD Female, Egerton).

During the interviews, the respondents also confirmed that universities have mentoring programmes and interfaculty transfers that support AA policy on addressing policy on gender equality as noted below by discussants:

We do not have a STEM gender interventions, the university has a mentoring programme that provides guidance and counselling to the students. Unfortunately it does give special attention to STEM students (Gender AA Director, University B).

We have introduced Science clubs and mentoring programmes at universities and in secondary schools. The university visits neighbouring secondary schools and organise career and mentoring programmes on STEM disciplines in and out of universities (Registrar, University C).

We provide financial aid to the needy students through work study programmes in the university (Director, Gender AA, University C).

The study noted that female students continue to be underrepresented in STEM disciplines, as there are no STEM interventions in the universities. Respondents expressed the need for complementary STEM interventions so as to address low female enrolment in STEM disciplines. They had this to say:

We are yet to develop a STEM intervention programme in our university. This is a good idea and may enhance more female students in STEM disciplines (Registrar, University B).

The female under representation requires a holistic approach. Interventions will be vital to curb the gender imbalance in STEM disciplines (Director Gender, AA, University C).

Female students face a lot of challenges in pursuit of university education. They are ignored...it is important that interventions be implemented to make STEM learning environment gender sensitive to female students (STEM Dean, University A).

According to the JKUAT strategic plan (2012), gender mainstreaming policies and interventions are internationally accepted measures to promote sensitive integration of gender issues and concerns. They aim at bridging the gap of participation of male and female students in STEM disciplines in universities. Equal participation in STEM disciplines of male and female students will maximize innovation, creativity and development (NSB, 2010). Therefore, there is a need to develop and adopt multifaceted approaches in STEM policies and interventions that will bring about gender equality in STEM disciplines. The existing gender policy interventions in Kenya have minimal impact on female access and participation in STEM disciplines (Kapinga, 2010). Therefore, the development of educational policy interventions that can increase the access and participation of female students in STEM disciplines is paramount.

4.8.4 Proposed Interventions to Increase Female Participation in STEM Disciplines

Further in Objective Five, the study sought the perception of registrars, directors of gender and AA, the STEM deans HODs and STEM female faculty on institutional policies interventions that can be implemented to increase female participation in STEM disciplines. Interviews with the above mentioned respondents indicate that there is need to adopt complementary policies and interventions to increase female participation in STEM disciplines as summarised below:

First, the respondents expressed the need to develop complementary policies and interventions to widen female participation in STEM disciplines. The existing policies and interventions such SSP, financial aid for the needy STEM students and AA are not

adequate in meeting the needs of female students pursuing STEM disciplines. The Affirmative Action should not only include lowering of university entry points for girls but also lower the entry points in mathematics and science subjects. Girls score low grades in Mathematics and Sciences at KCSE and therefore only a few qualify to pursue STEM disciplines at the university as captured in objective one. Therefore, the development of a STEM gender policy will increase access and participation of female students in STEM disciplines in public Universities.

Secondly, discussants noted that incorporation of gender policies and interventions should start at low levels of education. Girls perform poorly in Mathematics and Sciences at secondary level and are not attracted to STEM disciplines especially hard sciences. This limits female students from pursuing STEM disciplines at the universities. The views of the Registrars, Director Gender AA, STEM Deans and female faculty supported this by making the following comments:

As much the AA increases female students in the university, they get admitted to humanities and Languages...they do not qualify for the STEM disciplines... (Registrar, University A).

Let the STEM policies be introduced at secondary levels. We need to address the root cause of the problem. Girls form negative opinion on Sciences and Mathematics at low levels of education (Director Gender AA, University B).

During the interviews with the STEM HOD, Egerton and FGDs with female students the discussants expressed that there are few female mathematics and science teachers at secondary schools and same case applies to the female STEM faculty in the universities. Therefore, the discussants suggested the inclusion of more female Science teachers in secondary schools and more female STEM faculty to be trained to act as role models and

to mentor the female students. They emphasized the importance of female STEM mentors who can understand the female students and share their personal views and concerns that affect their academic participation. Female students in STEM disciplines felt out of place as the STEM disciplines were male-dominated. In this regard, there is a need to create awareness by bringing more STEM females on board and development of gender policies and interventions that reward STEM females faculty and students through internship, exchange programmes and scholarships as expressed below:

I feel out of place as all lecturers are male in my Engineering class, it is worse in the laboratories and workshops where there is no single female... (Female FGD, UoN).

When a lady teaches me in Mathematics and Sciences I realise I too can make it ... I will emulate her and she will be my role model...It is easier for me to share my personal problems with a female teacher/ lecturer (Female FGD, Egerton).

Let the STEM female faculty be promoted and rewarded...give them more opportunities and awards so that the world can know and recognise them...this will demystify the STEM disciplines (STEM HOD, University C).

The need to strengthen Science Career guidance and mentoring programmes in both secondary schools and Universities was noted. The study established that career guidance should be enhanced at lower levels of education, this is because female students develop negative attitude; stereotypes on masculinity of STEM disciplines at the lower levels of education and peer influence also affect their participation in STEM disciplines as confirmed below:

I had done very well in math at KCPE...but in Form 2 we started hating mathematics... Mentors from UoN talked to us and made us realise that it was not hard to excel in Maths...we realised the importance of excelling in mathematics and Sciences to qualify for STEM disciplines in university...few of us passed well...(Female FGD, JKUAT).

Appropriate career guidance training for the high school teachers may contribute to more female participation in STEM disciplines as expressed by the discussants. The principals/teachers/career masters were found to be not conversant with the courses offered at the universities and the cluster requirements which made the students to apply for university courses without proper guidance. Most parents/guardians had no idea on the university programmes and the requirements. For instance, it was reported that girls drop physics subject at form two which is a prerequisite for most STEM disciplines, which make them, miss out. The students who qualify for STEM disciplines get discouraged and demoralised by their peers and family members due to the masculinity of STEM disciplines. Therefore, there is need to create awareness and reduce stereotypes and prejudices that dominate masculinity of the STEM disciplines.

Secondary schools science learning facilities and textbooks are paramount for academic excellence in Mathematics and Science subjects. The respondents revealed that the students from national and county schools performed well due to availability of adequate facilities like enough text books, well equipped laboratories and enough qualified science teachers in schools. The discussants suggested provision of adequate science facilities in all categories of schools as confirmed by the following comments:

Adequate Science facilities in all schools should be provided for good performance for STEM female students (STEM Female Faculty, University B).

The government should allocate enough funds for this...most schools lack qualified Maths and Science teachers. The government should train enough manpower in Mathematics and Science subject. (Director Gender & AA, university A).

Making STEM curriculum and learning environment gender friendly was suggested as this will make the STEM disciplines more attractive to the female students. The physical facilities and learning environment were masculine and this discouraged female students participation in STEM disciplines. The respondents therefore recommended that gender neutral learning environments with a feminist persuasion should be put in place.

The need for career guidance and proper preparation of female students on the STEM disciplines and their expectations was recommended to prepare the students on the STEM learning environments. Students interested in STEM disciplines should be enlightened to avoid disappointments and dropout of female students pursuing STEM disciplines as confirmed below:

I didn't know the learning environments were like this...dressing in aprons...gloves...dusty, oily and noisy labs...but I have a passion for this course and am coping well and will pursue it to the end. (Female FGD, JKUAT).

My first day in my medicine class was a nightmare...I was traumatised by the bad accident cases and injuries I attended to...worse still was in morgue...I know of my girlfriends who opted out...but I was well prepared by my uncle who is a surgeon...my lecturers too were of great support... (Female FGD, UoN).

Some female students pursuing STEM disciplines have difficulties in coping with the STEM learning environments and their expectations. During orientation week we prepare them well...a few opt for interfaculty transfers to feminine disciplines (Registrar, University B).

The secondary schools should prepare the learners well on the universities programmes and their requirements. At the beginning of the practical's some female students are very particular on their dress code especially during practical's...but they must adhere to the code and the regulations of the STEM disciplines...there are no shortcuts to the STEM disciplines expectations...they apply to all students..(STEM Dean, University C).

The discussants felt that government and universities should develop a STEM policy and interventions that can encourage female students' participation in STEM disciplines.

Financial aid and scholarships should be provided to the needy female students pursuing STEM disciplines. Another intervention includes work study, merit awards to the female students pursuing STEM disciplines. The study noted that the needy female students who often drop out of university and are burdened by doing odd jobs while others take long time to complete their studies. Hostels for nursing mothers should also be provided and family planning services should be readily available to the in the universities to minimise unwanted pregnancies as narrated below:

The work study would reduce my fees balance...i would also have money for my daily expenses instead of doing odd jobs like doing laundry and hawking for the other rich students (FGD, Female UoN).

The respondents reported gender-based violence by male lecturers and male students. Most cases go unreported as there is lack of proper mechanism to address GBV in the universities. Security within the campus and its environs should also be strengthened as cases of insecurity were on increase in campuses. Female students are not able to walk freely at night from the library to the halls of residence due to insecurity as narrated below:

I wish there were hostels for nursing mothers... i stay in the neighbouring slum with my son and maid...the living conditions are horrible with a lot of insecurity. I cannot stay late in the library due to insecurity to and from campus (FGD, Female JKUAT).

4.9 Summary Conclusions

Despite the existing educational gender policies and interventions, female students' pursuing STEM disciplines in Kenyan public universities have remained less than 30% in public universities as compared to males. SSP mode of admission has increased female enrolment in STEM disciplines by 55% compared to KUCCPS but female students are

attracted to soft sciences as compared to hard sciences. 31% of female students graduate and perform poorly compared to male in STEM disciplines in 2012/2013 academic year. There are institutional-based barriers at all educational levels that contribute to poor performance of female students in STEM disciplines.

The study also established that STEM curriculum is not gender responsive to female students and negatively affects their participation in STEM disciplines. The existing educational gender policies and interventions are not adequate as they only increase the general enrolment in humanities and social sciences and not in STEM disciplines. This is due to the high cluster requirements for female students in KUCCPS and perceived masculinity of STEM disciplines for SSP female students. Finally, respondents advocated for complementary educational STEM policies and interventions, SSP, gender friendly STEM curriculum and learning environment, financial aid for needy female students pursuing STEM disciplines and elimination of STEM stereotypes and prejudices on the masculinity of STEM disciplines so as to increase female participation in STEM disciplines in Kenyan public universities.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes research findings, presents the conclusions and makes policy recommendations. Lastly, the chapter presents suggestions where further research could be carried out from emergent issues. Lastly is an outline of contribution that this study has made to knowledge.

5.2 Summary

5.2.1 Trends in Female Student's Access in STEM Disciplines

Objective One focussed on trends in female students access in STEM disciplines in Kenyan public universities and trends in female students access in STEM disciplines in the sampled public universities between 2009 to 2013. Female students are underrepresented in STEM disciplines in Kenyan public universities at less than 30% of STEM enrolments with lower enrolments in hard sciences. Higher enrolments were recorded in SSP mode of admission especially in soft sciences compared to hard sciences at 55.8% at JKUAT as a case institution. The above findings show that female students in SSP are more attracted to health sciences and computer disciplines compared to KUCCPS students. High enrolments in soft sciences are as a result of perceived stereotypes on the femininity of the disciplines and attractiveness to the job market. Hard sciences attract few female SSP STEM students despite the low cut-off point requirement by universities.

5.2.2 Participation Trends in UON, JKUAT and Egerton Universities in the Years Between 2009 - 2013

Objective Two sought to establish trends in female students participation in STEM disciplines in Kenyan public universities. Female students had lower completion (66%) and progression rates (49%). Similarly, only a third of female students in STEM disciplines graduated from the three sampled universities compared to males in all STEM disciplines. Hard sciences had the lowest female graduation trends compared to soft sciences. Low female graduation rates especially in hard sciences can be attributed to low STEM enrolments in the universities, the institutional barriers and challenges STEM female students encounter in their academic pursuits. High enrolment and graduation rates for female students in health sciences can be attributed to femininity of the discipline as a nurturing discipline, the job market, the societal expectations and the gender roles and lack of STEM policies, challenges and institutional-based barriers female students face in their pursuance of STEM disciplines.

5.2.3 Institutional-Based Limitations of Female Students to Participation in STEM Disciplines

In research objective three, the study established that there are institutional based limitations that continue to act as barriers to female student participation in STEM disciplines. First, female students had few female science and mathematics teachers role models as Science and Mathematics teachers in secondary are male dominated. Second, national schools have adequate facilities compared to day schools and effectiveness of the secondary schools can be linked to good performance in science subjects. Institutional based barriers that are manifested from lower levels of education especially the secondary

level contribute to poor performance of female students in Science and Mathematics subjects which are mandatory requirement in STEM disciplines qualification in the universities.

Other institutional based limitations included lack of career guidance for the STEM disciplines female students were pursuing at the Universities. Female respondents indicated they experience verbal violence/harassment and sexual harassment from male lecturers, fellow male students and sometimes male technicians. Fourth, intimate relationships were too demanding and the female students would have to balance their studies with other responsibilities affecting their participation in STEM disciplines.

Fifth, societal perceptions and stereotypes on female students venturing into STEM disciplines affect their future life. The perceptions and stereotypes were on job opportunities, promotions at work, getting a spouse and family life. Stereotypes are transmitted through verbal interaction, content of curriculum and general organization of teaching space.

5.2.4 Gender Responsiveness of STEM Curriculum

There are gender biases in the STEM curriculum that affect female participation in STEM disciplines. Content analysis on STEM text books indicated perceived masculinity of the STEM textbooks that affected female students participation in STEM disciplines. STEM learning environment were not gender friendly to female students. The interaction of STEM lecturers, male and female students pursuing STEM disciplines in STEM classes was mutual.

5.2.5 Existing Educational Policy for Gender Equality Interventions in Universities

Despite the Kenyan governments and universities gender equity policies and interventions there is still low participation of female students in STEM disciplines. The existing educational policy interventions included SSP, financial aid, Affirmative Action policy, mentoring programmes and interfaculty transfers.

The study further **established that the existing AA policy and financial aid** have brought about minimal impact in female students access to STEM disciplines. The study further established that there are no educational STEM policy interventions in all the sampled universities and complementary educational policies and interventions. Third, there are few female Mathematics and Science teachers at secondary schools and same case applies to the female STEM faculty in the universities. For better performance in STEM the study established the need more female Science teachers in secondary schools and female STEM faculty to act as role models and to mentor the female students pursuing STEM disciplines.

Fourth, there is need to strengthen Science Career guidance and mentoring programmes in both secondary schools and Universities. Negative attitude developed by female students and societal stereotypes on masculinity of STEM disciplines begins at lower levels of education. Fifth, appropriate career guidance training programmes for the high school teachers are important. Sixth, secondary schools Science learning facilities and text books are paramount for academic excellence in Mathematics and Science subjects. Seventh, gender friendly STEM curriculum and learning environment will make the

STEM disciplines more attractive to the female students. The respondents recommended that gender neutral learning environments with a feminist persuasion should be put in place. The eighth finding was that female students face many challenges such as sexual harassment, interruption through pregnancy and family responsibilities at the universities. Government and universities should develop STEM policies and interventions for the needy female STEM students who often drop out of university. Provision of hostels for nursing mothers and family planning services to female student in the universities are crucial. GBV by male lecturers and male students were reported by the respondents. Finally, universities should strengthen legal action against perpetrators and mechanism to address GBV in the universities and security within the campus and its environs.

5.3 Conclusions

The study draws seven conclusions from its findings. First, the considerably high under-representation of female students in the STEM disciplines implies that despite the existence of educational gender equity policies in the sampled universities, the implementation of such policies should be strengthened. Therefore, low participation rates of female students pursuing STEM disciplines is linked to perceived societal stereotypes, institutional based challenges and masculinity of the STEM discipline. Third, there exist many institutional barriers that affect STEM female students participation in STEM disciplines. Hence the few STEM female faculty role models for guidance and counselling on academic and personal matters for female students pursuing STEM disciplines do not make notable impact. Consequently, societal stereotypes and

prejudices on perceived masculinity of the STEM disciplines continue to affect the STEM female students' participation and performance in STEM disciplines.

Fourth, because the STEM curriculum is not gender responsive to the female students pursuing STEM disciplines, it is not surprising that the STEM learning resources and environments including STEM textbooks have continued to affect participation of female students in STEM disciplines. Fifth, the lack of adequate and modern STEM laboratories and facilities affects female students participation in STEM disciplines and has resulted in STEM teaching and learning process that is not gender-friendly and is mainly male dominated. Sixth, the existing educational interventions such as the financial aids do not make significant impact and hence were consequently insufficient in responding to the needy female students. SSP programme increases female enrolments in soft sciences as compared to hard sciences, thus explaining why few female students who qualify and are admitted through the AA only join schools/faculties of Humanities and Languages.

Further female students' participation in STEM disciplines can be encouraged by STEM policies and adequate career guidance from lower levels of education to the university levels. Finally, it is clear that unless there is change of negative social cultural stereotypes and prejudices on the masculinity of the STEM disciplines and careers, female participation in STEM disciplines may continue to stagnate in the Kenyan universities. Based on the above conclusions, this study presents the following recommendations.

5.4 Recommendations

The study dichotomized recommendations into those related to policy and practice and those related to further research.

5.4.1 Policy Recommendations

(a) Enhancing Existing Policies

- i. Universities should strengthen mentoring and role modelling of female students pursuing STEM disciplines.
- ii. Universities should provide security to female students pursuing STEM disciplines who have to work late at night in the laboratories.
- iii. Government should provide of adequate Science and Mathematics learning facilities and resources in all categories of secondary schools

(b) Recommendation for New Policies

- iv. The government of Kenya through MOEST should develop a gender STEM policy to complement existing policies to encourage and support female students access and participation in STEM disciplines.
- v. The government through the MOE should also develop gender responsive Mathematics and Science policies at basic level of education. The policies should aim at improving girls performance at KCSE for access and participation in STEM disciplines in the universities.
- vi. Government and universities need to enhance specific financial aid programmes with clear policies that support needy female students in STEM disciplines.

- vii. Universities need to develop STEM gender friendly learning environment, adequate and modern STEM facilities and equipments.
- viii. Government of Kenya should develop clear policies on proportional increase of STEM female lecturers in universities and female Mathematics and Science teachers in lower levels of education.

5.4.2 Recommendations for Further Research

The following general areas related to the concerns of this study were proposed for further research:

- i. This study focussed on interventions to increase female students' participation in STEM disciplines. Findings of the study were that females' students were concentrated in some areas of specialisations in soft sciences.
- ii. An in depth study on why some STEM disciplines are preferred and attractive to SSP female students compared to others should be conducted.
- iii. There is need to carry out a study on implications of family burdens and responsibilities on female students pursuing STEM disciplines at the university. A study on magnitude and effects of GBV on female students pursuing STEM disciplines compared with non-STEM female in universities should be conducted.
- iv. Finally, a study on inequalities of female students pursuing STEM disciplines at postgraduate levels is proposed by this study.

5.4.3 Study Contributions to Knowledge

- i. The study established the absence of STEM policies in the universities with focus to increasing female participation in STEM disciplines.
- ii. The study established a need for development of Mathematics and Science policies at basic education level to improve girls' performance in the subjects to enable them qualify for STEM disciplines in the universities.
- iii. Relatively few STEM female students benefited from financial Aid Policy thus calling for a review of the policy.

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APPENDIX I: STEM STUDENTS QUESTIONNAIRE

Dear Respondent,

This questionnaire is part of my Ph.D research that is designed to gain a better understanding on the interventions that encourage female students participation in Science, Technology, Engineering and Mathematics (STEM) disciplines in Kenyan public universities. Your contribution to this research work will be highly appreciated. This because you are in a unique position to provide information that will enable me to understand the nature, role and state of gender policies to increasing female students participation in science-oriented disciplines. This will help me draw appropriate conclusions and recommendations for the betterment of an equitable society. By completing this questionnaire you will help to identify the barriers and interventions that are pertinent in encouraging female students to prosper in STEM disciplines in Kenyan public universities.

The information you will provide will be handled in a confidential manner. Answers to all questions will be used only in combination with the responses from other participants whose identity will remain anonymous. For these reasons, if need be, I will only use pseudonyms so that no names or any information will be used to identify particular respondents in reporting the research findings. The results will be disseminated through a publication available to the public and through other channels such as seminars and journals.

Finally, please note that though participation in this study is voluntary, you are at liberty to withdraw at any stage. However, I would strongly encourage you to participate because the study is for educational purpose and you will be contributing to the production of new knowledge.

Request for further clarifications can be channelled to:

Lucy Wandiri Mbirianjau,
Kenyatta University,
Department of Educational Foundations,
P.O.43844-00100,
NAIROBI, Tel.0722 299 123

SECTION A
STUDENTS PROFILE

Name of the institution.....

School /Faculty.....

Department.....

Course of study (e.g. Bed (Science/Arts), Computer Science, Actuarial Science.....

Mode of Sponsorship:

Government Sponsored (KUCCPS/REGULARS) []

Self Sponsored Program (SSP) []

Category of the secondary school attended:

National []

County []

District boarding []

District day []

KCSE Mean Grade and Points.....

SECTION B

Institutional-based barriers to female student participation in STEM disciplines.

Tick the most appropriate response about former secondary school attended

	My former high school prepared me for course I am pursuing?	My former high school had effective science teachers	My former high school had enough science text books	My former high school had equipped science laboratories
Strongly Agree (SA)				
Agree (A)				
Not sure				
Disagree (D)				
Strongly Disagree (SD)				

a) Briefly describe the STEM facilities your department provides to your course.....

b) Which STEM facilities do you find lacking in your department for the course you are taking.....

.....

Tick the challenges that you have faced in the process of your academic life at the university

Sexual harassment

Verbal violence/harassment

Interruptions through (pregnancy)

Interruptions through illness

Family responsibilities of (child rearing)

Having intimate relations/ boyfriend (cooking, doing laundry, cleaning for the boyfriend

Access to reproductive health facilities (family planning)

Access to gender sensitive sanitary service (Sanitary towels, clean toilets)

Stress related issues

Any other (Specify).....

(a) Are the STEM lecturers languages gender sensitive?

Yes No

(b) Briefly explain your answer

.....

(a) Do you find the learning environment sensitive to the needs of each gender?

Yes No

(b) Briefly explain your answer.....

In your opinion, is the language used in STEM text books gender sensitive

Yes [] No []

(a) Do you know of any STEM female students who dropped out of the discipline before completion?

Yes [] No []

(b) If your answer is Yes,

(i) State the number.....

(ii) State the reason(s).....

Briefly explain your view on what should be done to improve the following:

(i) Making the lecturers' language more gender sensitive.....

.....

(ii) Making the learning environment more gender sensitive.....

.....

(iii) Reducing drop out rates of female students in STEM discipline before completion

SECTION C

Gender responsiveness of the STEM disciplines on female students who join Kenyan public universities.

1. Tick the most appropriate on the university STEM disciplines

	Poor Performance of female students in secondary limits them from excelling in STEM disciplines in the universities	University learning environment is friendly to female STEM students	STEM lecturers are friendly to female STEM students	STEM learning materials are gender friendly	The STEM content and curriculum is friendly to female STEM students	The STEM practicals are friendly to female STEM students	Male and female students interact well during the STEM classes	Female students interact freely with lectures during STEM classes
Strongly Agree								
Agree								
Not Sure								
Disagree								
Strongly Disagree								

2. a) In your opinion does the sex of the lecturer affect the performance of female STEM student's

Yes [] No []

Give an explanation to the above response

b) To what extent would you agree that venturing in STEM disciplines will affect your life chances:

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
Job opportunities					
Promotions at work					
Getting a spouse					
Family life					

In order of priority suggest 3 ways on how female student's participation in STEM disciplines in the University can be encouraged

- (i).....
- (ii).....
- (iii).....

THANK YOU

APPENDIX II: FOCUS GROUP DISCUSSION (FGD) FOR STEM STUDENTS

INTRODUCTION SESSION AMONG STEM PARTICIPANTS

Briefly explain whether you had a science teacher role model in secondary School?
(probe for the gender of role model, areas mentored on, example: universities' selection, career guidance)

.....
.....

How appropriate was the career guidance on female students on the disciplines to pursue at the universities?

.....
.....

At the university, whom do you consider key career guide of female students of the disciplines that female students pursue in the university? (Tick appropriately)

Parents/Guardian []

University administration []

University peers []

Probe for Others []

How appropriate did you find career guidance to the female students on the disciplines to pursue at the universities?

.....
.....

It may be argued that fewer female students than male students in STEM disciplines does not affect the female students participation and performance. What would you say to that?(Probe for the gender composition in the STEM classes and probe in what way it

affects female students-performance, group works, academic sharing and searching for academic materials, support from lecturers, laboratory assistant, male to female, female to female)

.....
.....
Some people say that there should there be more female STEM lectures to act as role models to STEM female students. What is your opinion? (probe for the importance of female role models: easy association, free to ask questions/clarification, act as role models, share personal and academic problems)

.....
.....
LEARNING ENVIRONMENT

(a) Some observers may claim that STEM classrooms and laboratories are ill-equipped. What are your views in terms of the physical facilities? (probe for toilets, stools, chairs, gender sensitive instruments-during practicals) customize the Fgd as per the areas of specialisation).

.....
.....
(b) How suitable are the physical facilities for the STEM female students? (probe for suitability of toilets, stools, chairs, gender sensitive instruments-during practical's) customize the Fgd as per the areas of specialisation.

.....
.....

There is a feeling that STEM disciplines are designed for male students. What is your opinion on this? Do both male and female students participate equally in STEM classes? What do you say to that? (Probe for support from lecturers, laboratory assistant, male to female, female to female)

.....
.....

Comment on the following:

Female STEM students cannot perform comparably to males STEM students in both practical's and theories no matter how equitable the learning environment would be.....

.....

Female STEM students find the STEM content difficult to understand compared to male STEM students.

.....

.....

CHALLENGES FACING STEM FEMALE STUDENTS

1. Female students with family responsibilities are burdened and their participation and performance STEM discipline in the universities are affected. (Probe for the implications on STEM females participation and performance due to marriage, motherhood, relationships, sexual harassments, verbal harassments, interruptions-pregnancy).

RECOMMENDATIONS

1. In your view what should be done in order to encourage more female students participation in STEM disciplines? (Probe for:

a) Government and university gender policies.....
.....

b) STEM gender policies.....

c) Interventions such as financial aid, bursaries, CDF, work study, mentoring, merit awards, internships.....

**APPENDIX III:
INTERVIEW SCHEDULE FOR UNIVERSITY ADMINISTRATORS
(REGISTRARS AND DEANS OF SCIENCE FACULTIES/SCHOOLS)
BACKGROUND INFORMATION**

From the statistics I have seen, it is clear that girls are less than one quarter of males in the STEM classes. Why do you think this is the case?

.....
.....

What do you think are the factors related to female students high school experiences influence their entry to STEM disciplines? (probe for high performance, science facilities, teachers, learning materials)

.....
.....

INSTITUTIONAL BASED LIMITATIONS AND STEM CURRICULUM

How does the STEM curriculum in your university affect participation of female students in STEM disciplines? (probe for masculine nature of the STEM curriculum)

.....
.....

How do you think facilities, classrooms, laboratories, washrooms, and other physical equipment and infrastructure in the STEM classrooms/laboratories affect female students participation?

.....
.....

There is a perception from the literature that STEM disciplines are still unresponsive to the needs of female students, what can you say about that (Probe on the STEM textbooks- how gender friendly they are? (probe for male/female images, gender biased words/remarks/statements)

.....
.....

Probe for the lecturer's genders in STEM disciplines and how it might be affecting females participation in STEM disciplines

.....
.....

EXISTING POLICIES AND INTERVENTIONS TO WIDEN FEMALE STUDENTS PARTICIPATION IN STEM

Has there been evidence that the interventions of increasing female students in universities such as the AA have worked towards increasing female enrolments unfortunately females are still underrepresented in STEM disciplines. Do you university policies to increase female participation STEM disciplines (probe for why the gender differences have persisted in STEM disciplines and what are the institutions doing about this or what should the institutions do)

.....
.....

How are issues of gender mainstreaming in STEM disciplines covered in institutional strategic plans, issues of institutional resource capacities.

.....
.....

Probe on limitations of current gender university policies.

.....
.....

Does the university have STEM gender policies/ (discuss affirmative action of lowering of grades for females pursuing STEM disciplines, funding and scholarships, merit awards, mentoring, internship).

.....
.....

Do you have a copy of the STEM policy? Probe for how he finds its responsiveness to the gender affirmative action issues mentioned above.

.....
.....

Has the implementation of affirmative action been successful to increasing female student's participation in STEM disciplines in the universities?

.....
.....

What alternative policies and interventions would you suggest to increase female students participation in STEM disciplines in the universities?

.....
.....

APPENDIX IV: STEM FEMALE FACULTY INTERVIEW SCHEDULE

STUDENTS PROFILE

Briefly explain the gender composition of your STEM classes (Probe for the male and female ratios).

.....
.....

Explain reasons for gender differences in terms of enrolment, participation and performance STEM classes.

.....
.....

What can you say about the gender composition of your class and the participation and performance of STEM female students? (probe in what way)

.....
.....

In your opinion how does the high school performance affect the placement of females in STEM disciplines in the universities? (probe for Science performance in high school and the disciplines they qualify for)

.....
.....

Kindly comment on gender composition of STEM lecturers establishment in your department (probe for the gender ratios, perceptions of effectiveness in teaching etc)

.....
.....

There is a view that the gender of STEM staff affects STEM female students performance? What do you say to this?

.....
.....

Some people say that there should there be more female STEM lectures to act as role models to STEM female students? What is your take on this? (probe for the reasons; mentoring)

.....
.....

INSTITUTIONAL BASED LIMITATIONS AND STEM

How does the STEM learning environment for the females students? (during practical and theory lessons)

.....
.....

In your opinion do female students participate and compete equally as male students (probe for female participation, cooperation, distractions, barriers....)

.....
.....

Do you think the learning environment is conducive for female students in STEM discipline classes? (probe for support from lecturers, laboratory assistant, male to female, female to female)

.....
.....

In terms of physical facilities, how suitable are they for the STEM female students? ,
(classrooms, laboratories, washrooms, equipment's)

.....
.....

STEM CURRICULUM, CONTENT

Is the language used in STEM text books affect females participation in STEM
disciplines (probe for masculinity of the text books)

YES []

NO []

If No What can be done to make the text books gender friendly

.....
.....

How does the STEM curriculum affect participation of female students in STEM
disciplines?(probe for masculinity of the STEM curriculum, what can be done?)

.....
.....

How gender friendly is the content of the STEM disciplines? (how does this affect the
female participation in STEM disciplines)?

.....
.....

Do you think STEM disciplines are still unresponsive to the needs of female students?

.....
.....

(Probe for the job market, stereotypes, family responsibilities, job promotions)

CHALLENGES FACING STEM FEMALE STUDENTS

Do family responsibilities for female students affect their participation in STEM disciplines in the universities (marriage, motherhood, Relationships, sexual harassments, verbal harassments, interruptions-pregnancy, completion)

.....

.....

In your opinion how can these challenges be addressed (probe for each and the solution)

.....

.....

EXISTING POLICIES AND INTERVENTIONS TO WIDEN FEMALE STUDENTS' PARTICIPATION IN STEM DISCIPLINES IN KENYAN PUBLIC UNIVERSITIES.

Which are the admission and placement policies?(discuss the university gender policies and interventions).

.....

.....

Has there been evidence that the interventions have worked towards increasing female enrolments (general university enrolment and STEM enrolment)

.....

.....

Probe on limitations of current gender university policies.

.....

.....

Why have the gender differences persisted and what are the institutions doing about this or what should the institutions do?

.....
.....

COMPLIMENTARY GENDER POLICIES AND INTERVENTIONS

Are you aware of university STEM gender policies? (discuss lowering of grades for females pursuing STEM disciplines, funding and scholarships, merit awards, mentoring, internship)

.....
.....

Has the implementation been successful to increasing female student's participation in STEM disciplines in the universities?

.....
.....

Suggest ways of increasing females in STEM disciplines (probe for STEM policies and interventions such as AA, financial Aid, bursaries, CDF, work study, mentoring, merit awards, internships)

.....
.....

What alternative policies and interventions would you suggest to increase female students participation in STEM disciplines in the universities?

.....
.....

**APPENDIX V: INTERVIEW SCHEDULE FOR PROGRAM DIRECTORS OF
GENDER AND AFFIRMATIVE ACTION**

What achievements has your directorate been able to achieve to date in increasing the female students participation in university in STEM disciplines? (probe for male and female ratios in university and in STEM disciplines)

.....
.....

What challenges are faced by the directorate in addressing the female students involved in STEM disciplines? (probe for the directorates role in STEM affirmative Action)

.....
.....

Are there gender STEM policies and interventions in place to increase female students participation in STEM disciplines? (probe for the existing policies)

.....
.....

In your opinion, how would improvement of the existing gender policies and interventions increase female participation in STEM disciplines in Kenyan public universities? (Probe for how the STEM programs and policies should be restructured to address the gender imbalance in participation in STEM disciplines in your university)

.....
.....

APPENDIX VI: Documents Analysis

The researcher will analyze institutional records especially on enrolment of female students in the three selected public universities for the last five years (between 2007 and 2011) to establish the associated trends for female students in STEM disciplines. This will be used as a supplementary method of gathering information especially from institutional records for the last 5 years (between 2007- 2011) including:

Admission records

Graduation records: graduation booklets: record of the kinds of disciplines in which the students enrol in and success rates.

Institutional policies such as strategic plan: gender policies,

1. ADMISSION RECORDS

JKUAT STEM DISCIPLINE ENROLMENT FOR THE LAST 5 YEARS (2009-2013)

Year/ course	Architecture and Building Science Engineering	Information technology	Mechanical, Manufacturing and Mechatronic Engineering (SMMME)	Civil Engineering and Geomatic Engineering (SCEGE)	Electrical, Electronic & Information Engineering (SEEIE)	Science	Agriculture
Gender	M/F	M/F	M/F	M/F	M/F	M/F	M/F
2007							
2008							
2009							
2010							
2011							

**UNIVERSITY OF NAIROBI STEM DISCIPLINE ENROLMENT FOR THE
LAST 5 YEARS (2009-2013)**

YEAR/ SCHOOL	Medicine	Biological Sciences	Computing And Informatics	Dental Sciences	Engineer ing	Phar macy	Nursing Sciences	Physical Sciences	Built Environ ment
GENDER	M/F	M/F	M/F	M/F	M/F	M/F	M/F	MF	M/F
2007									
2009									
2009									
2010									
2011									

**EGERTON UNIVERSITY STEM DISCIPLINE ENROLMENT FOR THE LAST 5
YEARS (2009-2013)**

YEAR/ FACULTY	Agriculture	Engineering	Environment	Health Sciences	Science	Veterinary Medicine and Surgery
GENDER	M/F	M/F	M/F	M/F	M/F	M/F
2007						
2008						
2009						
2010						
2011						
2012						

1st class									
2nd upper									
2nd lower									
Lower									
Pass									
2011									
1st class									
2nd upper									
2nd lower									
Lower									
Pass									

**EGERTON UNIVERSITY GRADUATION TRENDS FOR THE LAST 5 YEARS
(2009-2013) FOR STEM DISCIPLINES**

FACULTY/YE AR	Agriculture	Engineering	Environment	Health Science	Veterinary Medicine and Surgery	Sciences
GENDER	M/F	M/F	M/F	M/F	M/F	M/F
1st class						
2nd upper						
2nd lower						
Lower						
Pass						
1st class						
2nd upper						
2nd lower						
Lower						
Pass						
1st class						
2nd upper						
2nd lower						

Lower Pass						
1st class 2nd upper 2nd lower Lower Pass						
1st class 2nd upper 2nd lower Lower Pass						
1st class 2nd upper 2nd lower Lower Pass						

APPENDIX VIII -CONTENT ANALYSIS

GENDER STEREOTYPES/BIASES NOTED(QUALITATIVE)	INDICATORS	FREQUENCY	SOURCE/ TEXTBOOK
1.Gender balanced coverage Indicate the frequency of usage of Nouns in the text	Common nouns, Mr/Mrs		
Indicate the frequency of usage of Pronouns in the text(he /she)	Pronouns in the text(he /she)		
2.Gender appropriate illustrations Name the roles of each gender (male and females)	- Masculine or feminine roles assigned by author - Girls portrayed as observers or amazed onlookers		
State the specific Technologies used by males and females in the text	- Indicate how they are gendered		
Describe pictures portrayed by males and females in the text	- Show how they are gendered		
Describe location of the male and female image	- Who dominates the page-males or females? -Location of the picture males or females- who receives more focus/attention)		
3.Gender fairness in content Indicate the places where each gender is located	- Private and public places- e.g. females at home while male in factories, machineries		
4.Gender fairness in language Which vocatives are used for each gender	- Demeaning names chairman, manpower, mankind)		

**APPENDIX IX: OBSERVATION OF CLASSROOM TEACHING AND
LEARNING PROCESS**

Dimensions	Indicators	Noted Behaviors (qualitative)	Noted Behaviours (Quantitative)
Content Integration	Resource utilization- diverse range of cultures and groups to illustrate course concepts and ideas in a gender neutral manner?		
Lecturer learner interaction	Indicate how the lecturer interacts with male and female students Indicate how Lecturers ask male and female students questions Indicate time allocated to male female students		
Knowledge Construction	Does the lecturer facilitate students' understanding of the assumptions and gender biases operating within a given STEM discipline?		
Prejudice Reduction	Does the lecturer create learning environments that foster students' rejection of negative gender attitudes and values?		
Equity Pedagogy (use of teaching skills and techniques)	Does the lecturer adopt, integrate, and develop a set of teaching skills and techniques that reflect consideration of the full range of cultural gender perspectives and practices?		
Male –female student interactions	Do male students often seize and use the equipment in practical sessions, while the female students merely observe and record the results		

	Do males speak up in science classrooms more than females and as a consequence receive the most attention from teachers, despite the teachers believing that they give equal attention to both males and females		
STEM language	Does the language and materials used in STEM education assume or imply that STEM is a masculine activity or profession?		
Gender Empowering/classroom/ school STEM cultures	Does the lecturer structure classroom spaces and other teaching environments to promote equity in learning and cultivate respect for students' backgrounds and cultural experiences.		

Adapted from Banks, J.A. (1996). Multicultural education: Historical development, dimensions, and practice. In J.A. Banks & C.A.M. Banks (Eds.), Handbook of research on multicultural education (pp. 3-23). San Francisco, CA: Jossey Bass.

APPENDIX X

STEM Teaching and Learning Environment (Laboratory/Workshop-Customized to STEM Discipline)

SCHOOL/FACULTY.....

DEPARTMENT.....

UNIT.....

Aspect of inclusive curriculum	Descriptions-qualitative
How would you describe the learning environment?	
(a)physical facilities? (toilets, stools, chairs, gender sensitive instruments-during practicals) (b) suitability of the physical facilities for the STEM female students?(suitability of toilets, stools, chairs, gender sensitive instruments-during practical's)	
Effect of facilities,(classrooms, laboratories, washrooms, and other physical equipment and infrastructure in the STEM classrooms/laboratories) on female student's participation	
Location of the learning facilities(position suitability, accessibility)	
Class arrangement for learning(position of male and female students in class and laboratory setting)	
Instructors (dominating lecturers, lab technicians-male or female)	
Student class composition(male and female ratio)	
General condition of the learning environment(classroom ventilation, general classroom cleanliness)	

APPENDIX XII**Budget**

No	Item	Cost (Kshs)
	Transport Expenses	80,000/=
	Printing and Binding charges	60,000/=
	Library and Internet Charges	70,000/=
	Typing and photocopy Expenses	65,000/=
	3 Research Assistants @ 35,000	105,000/=
	Sub Total	380,000/=
	Miscellaneous (10%)	60,000/=
	Grand Total	440,000/=

APPENDIX XIV

Plate 4.5: Map of Kenya Showing the Location of the Sampled Universities

**KEY:**

■ UoN: University of Nairobi

■ JKUAT: Jomo Kenyatta University of Science and Technology

■ EGERT: Egerton University

Appendix XV
Letter of Research Authorization

REPUBLIC OF KENYA



NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/14/013/1321**

Date: **23rd July, 2013**

Lucy Wandiri Mbirianjau
Kenyatta University
P.O.Box 43844-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application dated *16th July, 2013* for authority to carry out research on "*Exploring interventions to encourage female participation in Science, Technology, Engineering and Mathematics disciplines in Kenyan Public Universities,*" I am pleased to inform you that you have been authorized to undertake research in selected public Universities for a period ending **31st December, 2013.**

You are advised to report to **the Vice Chancellors of selected Universities** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report thesis to our office.


SAID HUSSEIN
FOR: SECRETARY/CEO

Copy to:

The Vice Chancellors
Selected Public Universities.

APPENDIX XVI

Permit

PAGE 2

Research Permit No. **VCS/T/RC/14/013/132**
Date of issue **23rd July 2013**
Fee received **KSh. 2,600**

THIS IS TO CERTIFY THAT:

Prof. (Dr./Mr./Mrs./Miss/Institution)
Lucy Wandiri Mbiranjau
of (Address) Kenyatta University
P.O. Box 43844-00100, Nairobi

has been permitted to conduct research in

Selected Public Universities	Location
Nairobi	District Province

on the topic: **Exploring interventions to encourage female participation in Science, Technology, Engineering and Mathematics discipline in Kenyan Public Universities**

for a period ending: **31st December 2013**

Applicant's Signature

National Council for Science & Technology

