

Participation of Women in Science Education

Trends and Issues in Higher Education in Tanzania

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Abstract

This study investigated the nature and extent of the science gender gap in higher education institutions in Tanzania (Mainland) focusing on the enrolment and employment of the students and faculty members. The study examined in detail the factors that militate against women's participation in science education in three institutions of higher learning. It also explored the strategies that have been adopted by the government and institutions under study, to promote science education for females, having as a reference affirmative actions and policies.

In the theoretical part, various paradigms and perspectives behind the science gender differences are presented. These include social learning theories, Feminist critiques of science, the pedagogy of difference and environmental perspective.

The nature and extent of the gender gap in science in higher education is illustrated using some quantitative data and discussing enrolment and employment trends in three cases. Based on qualitative methods, semi-structured personal and focus group interviews were employed to staff and students respectively, while analysis of data occurred throughout the research period.

The study demonstrated that a gender gap in science exists in all three universities. Female students and female faculty are outnumbered by their male counterparts in enrolment and employment respectively. Majority of the students and staff were observed to be concentrated in the biological science field. The study also revealed that women possess lower academic qualifications which lead to their concentration in the lower academic ranks. Women are seriously underrepresented as administrators in all three universities to the extent that to some posts they are invisible.

The study also demonstrated that women experienced institutional and societal barriers. The institutional barriers were related to financial shortfalls, inadequate facilities and science teachers while the societal barriers were linked to cultural expectations and societal influences regarding women's roles; including early marriages, little societal support and the lack of role models to emulate.

Dedication

This work is dedicated to my beloved parents Darius Shija Bipa and Hellen Silas Bipa, and to my siblings James, Patrick, Josephine and Leonard.

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I thank my Almighty God who has been my helper, comforter, counselor and strength throughout the time I worked on this thesis.

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List of Abbreviations and Acronyms

ACSEE	Advanced Certificate for Secondary Education Examination
ADEA	Association for the Development of Education in Africa
CONAS	College of Natural and Applied Sciences
CSEE	Certificate of Secondary Education Examination
DAPHEA	Declaration and Action Plan on Higher Education
DUCE	Dar-es-salaam University College of Education
EFA	Education for All
ETAN	European Technology Assessment Network
FAWE	Forum for African Women Educationalist
FEMSA	Female Education in Mathematics and Science in Africa
HESLB	Higher Education Student's Loan Board
IAU	International Association of Universities
INSA	Indian National Science Academy
ISCED	International Standard Classification of Education
MDGs	Millennium Development Goals
MIT	Massachusetts Institute of Technology
MoEVT	Ministry of Education and Vocational Training
MSTHE	Ministry of Science, Technology and Higher Education
NACTE	National Council for Technical Education
NGO's	Non-governmental Organization
NSF	National Science Foundation
NSGRP	National Strategy for Growth and Reduction of Poverty
OUT	Open University of Tanzania
PEDP	Primary Education Development Programme
PEP	Pre-Entry Programme
PRSP	Poverty Reduction Strategy Paper
PSLE	Primary School Leaving Examination
SEDP	Secondary Education Development Programme
SICT	School of Informatics and Communication Technologies
TADREG	Tanzania Development Research Group
TCU	Tanzania Commission for Universities

TEA	Tanzania Education Authority
TEAMS	Teacher Education Assistance in Mathematics and Science
UPE	Universal Primary Education
UDSM	University of Dar-es-salaam
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
URT	United Republic of Tanzania

1 INTRODUCTION

1.1 Back ground to the study

Education has long been identified as the key means to the advancement of the developing world. It is widely acknowledged that without the transfer of skills, without the creation of knowledge or without the systematic training that is obtained through higher levels of education, the national well being will be adversely affected. (Griffin, 2007: V)

Education is said to be instrumental in promoting tolerance, democratic values, political awareness and respect for the human person. It is also said to remain the most powerful tool for the social, economic and political integration of women.

Higher education in particular is positioned by the international community as a central site for facilitating the skills, knowledge and expertise that are essential to economic and social development. Even the World Bank which had previously argued that higher education in Africa is a luxury as noted by Brock- Utne (2003), no longer nurtures the view as there is a shift in paradigm towards higher education. Brock- Utne further argues that the bank has been rethinking its stance on higher education in Africa and is now actually giving some emphasis to the higher education sector across the continent. It acknowledges the role of higher education as the engine of development in the new knowledge economy whereby the new modes of economic growth are dependant of knowledge and information technology.

As the demand for highly skilled workers increases, especially in the context of globalization, there is no doubt that it has a direct influence on the demand for higher education as a whole. All African countries still consider and will continue to consider the role of higher education as critical in actualizing their respective national development agendas as it is the highest level of education that produces graduates with the requisite human relations, critical thinking and technical skills to participate in national and international decision making and problem solving.

Tanzania like any other Sub-Saharan country has been grappling for a long time with gender inequity in higher education. Statistics from many African countries show that at the primary school level, there are nearly equal number of boys and girls. Despite the considerable increment in enrolment ratios in primary education, this nearly equal representation is seen to

change significantly at the secondary level and it is even more pronounced in higher education especially in Mathematics and Science (UNESCO, 2000; Andam and Glitho, 1999).

Various scholars, feminists and international agreements have viewed that the gender inequality in science education as an obstacle to development and they therefore urged that measures should be taken to fight it (Makame, 2008). The 1999 World Conference on Science (Budapest) emphasized the need to eliminate the effects of gender bias in all aspects, including the bias that exists in Science education. Science Agenda-Framework for Action, paragraph 43 requested among others that, new curricula, teaching methodologies and resources taking into account gender and cultural diversity should be developed by national education systems in response to the changing educational needs of societies (ibid).

The Declaration and Action Plan on Higher Education in Africa (DAPHEA) recommends that women in Africa should be oriented towards scientific and technological disciplines (UNESCO, 1998 cited in Makame, 2008:4). DAPHEA points out that challenges facing Africa, such as imbalance in student enrolments between science and technology based programmes and the humanities, make the structural problems of higher education institutions even more critical. It urged international organizations, member states and higher education institutions to develop well articulated policies and remove gender inequity in education and to double the number of women as students, teachers and decision makers in higher education. Over the years, African universities have produced mainly male managers (Andam and Glitho, 1999). More than 90% of staff of African universities, 80% of teachers and 75% of students are men (ibid). Hence there is a global movement to encourage more women to enter higher education and specifically science education.

The findings of many studies conducted worldwide on gender gaps within the science discipline, have clearly demonstrated that women are highly under-represented in scientific education (Sinnes, 1998; Kabeer and Magnus, 2004)

In Tanzania the gender gap in science related fields of study is still very wide with females lagging far behind males (Masanja, 2004.) and this is a cause for concern. In Higher and Technical education in particular, gender equity is a serious constraint in science and technology related academic programmes (Msolla, 2007). A gendered analysis of enrolments in science reflects that the number of enrolled females at the undergraduate level is generally lower than that of males in Tanzanian public universities. For example, data from the College

of Natural and Applied Sciences at the University of Dar-es -salaam Tanzania, shows that from 2005/06 to 2007/09 academic years the total number of males enrolled in various science degree programmes was 1188 while that of females was 265 which is considerably low .

It appears that women's choice of science field in Tanzanian higher learning institutions is not just a matter of academic ability, rather there appears to be a complex constellation of factors that constrain women's participation in the field. This argument is supported by Oakes (1990) and Hanson (1996) that the low participation rates and the paucity of women in science majors are attributable to factors affecting girls and women during the elementary and secondary school years. Mkude and Cooksey (2003) assert that most problems confronting quality female participation stem from deep-rooted cultural and psychological factors.

Masanja (2004) and Msolla (2007) have identified one among the factors for the under-representation of females in sciences in Tanzania as the low participation rates in advanced secondary courses such that the pool from which qualifying female students are drawn is too small. Data from the Ministry of Education shows that in 2002, out of 4056 Advanced level students' enrolment in public secondary schools science combination, females were 1236 (Lwinda, 2009). It has also been observed that in the years 2003 and 2004, the total number of boys admitted to science A- level public schools were 3379 and 3710 respectively while that of girls were 1450 and 1622 respectively (URT, 2004a and URT,2004b cited in Lihamba et al., 2006). Hence gender disparity in science in higher education is part and parcel of gender disparity in provision of primary and secondary education. Indeed, in view of these imbalances in secondary schools and higher education institutions, calls one to study in depth the factors that contribute to the existence of such wider gender gaps.

Significant but not quite remarkable progress has been made by African higher education institutions to address the science gender parity issue. In Tanzania, there were funded pre-entry programmes for women to enter Science and Engineering. These programmes demonstrated that it is possible to change the situation and make science subjects as amenable for females as for males. They indicate ways in which the participation and performance of females in Science subjects can be improved

It is clear that improving science education for women is crucial to the long-term health of the Tanzanian economy. Science education must begin with a firm base in primary school but it

must continue into secondary school, university and beyond. In this era of lifelong learning, Tanzanians must be ready and able to adapt themselves to new skills and technologies at many different points in their career; otherwise, they will find it extremely difficult to compete in the global economy

1.2 Rationale for the study

The importance of Science and Technology in society has grown enormously over the past two decades. Science, Technology and Mathematics are today known to be very central to the development of any nation (Aguale and Agwagah, 2007). There can be no doubt that the rich and industrialized countries of the world are those with high levels of science and technology while the non-industrialized countries are those with comparatively low levels of science and technology. At the present time, scientists are needed more and more by our society, not only to face the challenges resulting from new developments in technology but also to face the challenges of sustainable development. Ukeje (1997) observes that the development of a nation is properly assessed by the level of the education of its citizens in science, technology and mathematics. Uhlig (cited in Aguele and Agwagah, 2007) supported this view when he stated that:

In the theory and policy of development it has been accepted from the beginning of the debate that one of the essential pre-conditions for the development and transformation of a national economy is the factor of education in the broadest sense and science and technology in the particular sense.

Globally, more women students are entering higher education than a decade ago. However, they tend to cluster in certain disciplinary locations (Gunawardena et al., 2004). The science world appears to be greatly affected with gender barriers disadvantaging women scientists in their educational and career development. The under-representation of women in science and technology raises an issue of serious concern since it has practical implication on the technological growth of a nation especially in developing regions.

There are a number of compelling reasons why it is important to promote girls and women in science education. The importance of science education for women cannot be underestimated as women make up more than 50% of the world population; their underrepresentation in science and technology would no doubt affect the developmental process. In Africa, the area of science and technology is the one with the highest shortfall of national human resources

and many countries are required to seek expertise from other countries (UNESCO, 1999:2). For effective industrial development, it is estimated that the developing countries of Africa need atleast 200 scientists per one million individuals (ibid).

The former UN Secretary- General, Koffi Annan, argued for the support of more science education for females in the following way:

If Africa is to surmount it's shortfall in human resources and scientific progress, it must begin by affording girls and women complete and comprehensive equality in education.

He said this while noting that brain drain of Africa's best and brightest to the industrialized world has increased (Mwaura, 1999:31). Mr Annan further pointed out that no country can afford to leave women out of these areas of education if they are to achieve a critical mass of scientists and technicians, as women not only make up 50% of the population but they also play the multiple and critical roles of mothers, producers and custodians of family health, nutrition and general well-being. They are best placed to apply the benefits of science and technology in everyday life.

Mulemwa (cited in Sinnes, 1998:12) writes about the importance of science and technology education for women in the developing world. She states that:

There is a need to specifically focus on improving the performance of girls in science, mathematics and technology subjects (SMT). Girls as future mothers and care providers for the family, are moulders of society and virtue of this, they hold the future of the nation in their own hands. Therefore in order to speed up building a scientifically literate society, the women must themselves be well grounded in SMT so that they can inculcate this SMT culture into society.

Since women in developing countries play such a major part in personal economy, food security, health care and community needs in general, providing them with education in science and technology is a good investment. Ukeje (cited in Aguele and Agwagah, 2007) observes that without science there is no modern technology and without modern technology there is no modern society. Thus women cannot be left out in matters regarding national development and matters of science and technology which is a vital tool in the development of a nation. Also an increasing number of occupations are scientific and unless women have the ability to access them, they will continue to suffer from unemployment. It is true that people with a scientific education are often recruited in positions with extensive influence on

the development of our society. Women are needed in science and engineering to help maintain and promote our knowledge societies and economies, and not simply on grounds of equity alone (Huyer and Westholm, 2007). This calls for the need of a more science and technology educated labour force.

From a western point of view, Sjøberg and Imsen (cited in Sinnes, 1998:12) set up some areas of concern that shed light on the importance of more girls choosing science. First, they argue that for industry and society the problem of low female participation is one of possible recruitment of a hitherto untapped pool of intellectual reserve, that it is high time now for a concern about the gifted girls. From this perspective the practices and underlying values of science and technology are unproblematic and given. The focus of interest lies in finding the most efficient intervention program or support system that will channel the girls into these careers. Secondly, they argue that women have different interests, perspectives, values and priorities than men. Science and technology are seen as important factors in the shaping of a new future. Access to science and technology means good career opportunities for the individual as well as access to political and economic power for women as a group. This position is critical to the uses and practices of established science and technology. The aim is to join the scientific community in order to get access to economic and political power and to use this position to change decisions and priorities.

Women of the western world as well as Africa cannot be left at the margin of the economic development of their countries, particularly during this social, cultural and political upheaval in the continent. The focus should more strongly be on identifying and removing the constraints that girls and women participating in science face as this seems to be of essential importance to improving the situation of the people in both parts of the world (Sinnes, 1998).

There are several motives behind this study. First, there is little information on women's participation in science education in developing countries (Huyer and Westholm, 2007). King and Hill (cited in Gunawardena et al., 2004) support this argument by asserting that much of the body of knowledge generated by research about the cause and consequences of women's underrepresentation in science and technology in higher education is concentrated upon higher income countries. There is lack of data about women in middle and lower income countries (ibid). Therefore this research is very relevant during this time.

Secondly, in Africa much has been written about females' participation in higher education in general but not in science education in particular. The few science studies that have been written focus mainly at the level of Primary and Secondary school with little emphasis in higher education. Thus more quantitative and qualitative information is needed in higher education to shed light on the extent of the gender gaps in sciences and their causes and in this way serve as tools for policy makers.

Third, a comparison of three universities provides a challenge to each individual university so as to assess how well or how poorly one is performing in terms of students and staff participation in science. This could serve as a motivation in future improvements.

For a long time now gender equality has been a subject of lively debate. Many declaration and resolutions have been made. These include The Beijing Declaration and Platform for Action, World Declaration of Education for All (EFA) and United Nations Millennium Development Goals (MDGs). At the national level, Education and Training Policy, Education Sector Development Programme and Tanzania Vision 2025 all aim at minimizing gender imbalance in all levels and in all disciplines in education. This aim cannot be realized unless females' participation in science education is improved.

1.3 Purpose of the study

This study explored the relative position of male and female students and staffs, focusing on their enrolment, employment and distribution in the fields of science. The study also investigated the reasons behind the science gender gap and identified steps in which the government and universities have taken to enhance the participation of women.

Specifically the study was guided by the following research questions:

1. What is the nature and extent of the gender gap in sciences in higher education in Tanzania?
2. What factors contribute to the existence of the gender gap in the field of science in Tanzanian universities?
3. What strategies are put in place by the government and universities to reduce gender imbalance in science in higher education?

1.4 Significance of the Study

Examining gender gap in science education is significant because doing so might yield some practical suggestions for improving the situation at both the secondary and higher education levels, and thus meet the work-force needs of the 21st century. The findings of this study are expected to contribute to the existing body of knowledge in terms of what needs to be done further to foster women's participation in science in Tanzania. This knowledge will assist in planning more meaningful strategies at national and university level as current initiatives translating policy into practice have been slow.

The present and future economic and social life of Tanzania depends on well educated, creative and economically productive human resource, hence improvement in education is important to empower women to realize their potentials. Men alone will not do much but it should be both men and women. Given that women lag behind in science participation, ways to help them to participate as well as men have to be sought out.

1.5 Thesis Structure

This thesis is divided into eight chapters. Chapter one introduces the study with study rationale and outlines the research questions. In chapter two I use insights derived from several theoretical frameworks as a point of departure to discuss different understandings of how sex/gender can be seen to impact students and staff participation in science education. Chapter three embarks on reviewing the literature related to this study. It looks at the position of women in science education internationally. Chapter four discusses the research methodology utilized in the study. Chapter five contextualizes factors surrounding the science gender gap in higher education in Tanzania. Chapter six presents the quantitative part of the findings whereby the relative position of women and men in Tanzania (Mainland) universities is analysed. Chapter seven presents the qualitative part of the study where interview results are analysed in detail. Chapter eight discusses the findings, provides the conclusion and recommendations for action.

2 THEORETICAL FRAMEWORK

Introduction

In this section an attempt would be made to concisely analyze the explanatory models/theories various researchers, scientists and writers have put forward in explaining gender inequity in science education.

2.1 The Pedagogy of Difference: An African Perspective

Female participation in formal education is influenced by a complex interplay between macro-level policy (both international and national) and micro-level practices, beliefs and attitudes (Wamahiu and Njau, 1995 cited in Wamahiu, 1996:46). They argue that the policy environment, whether at the international or national level, is in turn influenced by dominant ideologies including gender ideologies. As Wamahiu (1996) notes, the crucial causative factor in female disadvantage in formal education in Sub-Saharan Africa is gender ideology. The source of this disadvantage is traced to a dominant patriarchal ideology perpetuated through the pedagogy of difference, operational both at home and in school. The pedagogy of difference characterizes all African societies despite the socio-cultural and historical diversity of the region. It influences differential treatment and exposure of boys and girls in the education systems of Africa even when all other factors are seemingly equal.

The pedagogy of difference as defined by the African educational philosopher Bennars, is ‘a way of educating that stresses the differences.....rather than the similarities’ (1994 cited in Wamahiu, 1996:47) between the genders (Wamahiu, 1996). It propagates the view that males and females are not only radically different, but that females are physically, and more significantly, intellectually inferior to males. It is argued that within the African context, the pedagogy of difference reflecting a social theory of silencing, domination and subjugation, is used to rationalize the continued disadvantage of women and girls in both the informal and formal educational systems. It is believed that the pedagogy of difference is rooted in the pre-colonial era; it has been reinforced in the subsequent colonial and post-independence periods of African history.

From a feminist perspective, Wamahiu (1996:47) accentuates that the pedagogy of difference is discriminative, inequitable and therefore totally undesirable. While acknowledging the

biological differences between males and females, feminists argue that the pedagogy of difference is a socio-cultural construct which can be transformed into a pedagogy that promotes gender equity and an egalitarian ideal. The pedagogy of difference in contemporary African society seems to breed a culture of violence and discrimination that begins at home and is continued into the school and workplace. From an early age, girls are socialized into the ethics of work and discipline taking on some responsibilities of their mothers while for boys the opposite situation prevails. Boys thus play and/ or study for school as their sisters work and wait upon them. By the time children enter school, boys and girls have already begun to internalize different values and concepts of self-worth.

The differential treatment of the genders as a whole reinforces feelings of superiority in boys and inferiority in girls. This differential treatment of the genders not only appears at home but is also observed in African textbooks where women and girls are particularly absent from mathematics, science and technologically oriented textbooks. Wamahiu (1996) points out that, the pedagogy of difference is transmitted not only through textbooks (both written word and pictorial illustration) but also by the teachers themselves who act as the mediators between the curriculum developers and textbook writers, transmitting the messages through monologue. The content of the messages that are transmitted is influenced by the teachers' many years of exposure to the pedagogy of difference in both informal and formal education settings. The authoritarian climate of the African classroom thus provides the perfect breeding ground for the pedagogy of difference. It legitimizes the subordinate position of females vis-à-vis males and creates a vicious cycle of powerlessness and desperation to both boys and girls- the oppressor and oppressed respectively. Through this, an African male has greater opportunities for employment and economic empowerment.

It is argued that unless we are able to replace the pedagogy of difference with a pedagogy of empowerment, the gender gap in African education will continue to widen (Wamahiu, 1996:46). She further points out that the pedagogy of empowerment will make girls aware of their potential and allow them to realize their abilities to full. Bennars (cited in Wamahiu, 1996) asserts that, "it will equally change the attitudes and values of boys and make both genders socially responsible".

2.2 Feminist critiques of Science

Feminism is an effort to bring insights from various female experiences together with research and data gathering to produce new approaches to understanding and ending female oppression (Bunch, 1983). Feminist scientists have developed powerful critiques of scientific theories used to justify the oppression of women in western society (Howes, 2002:26) which also apply to other societies elsewhere in the world. Males and sometimes female scientists have produced theories about women and men that are based in sexist attitudes; theories that put women below men in an intellectual hierarchy (Fausto-sterling, 1992 cited in Howes, 2002), theories that split the human brain and assign women whichever half is considered less powerful and important (Tavris, 1992, cited in Howes, 2002). Feminist scholars therefore developed critiques of specific theories in the biological sciences ranging from models of human evolution to deterministic explanations of differences between the sexes to endocrinological construction of ontogeny (Birke, 1986; Bleier, 1984; Fausto-sterling, 1985; Haraway, 1981; Keller, 1992 cited in Fedigan, 2001).

These critiques sought to expose the androcentric language and concepts seen as inherent in the theories and offered an alternative explanation from the female point of view. Feminist scholars critiqued the entire scientific enterprise as it has been traditionally conceptualized and conducted on assumptions of male patriarchal power (Harding, 1986; Keller, 1992; Longino; 1990; Tuana, 1993 cited in Fedigan, 2001). Harding (1986) has also noted that the ultimate objective of feminist critiques should be to bring an end to androcentrism, not to systematic inquiry even though an end to androcentrism will require far reaching transformations of that inquiry. The concern in feminist science literature has been the extent to which women and others are underrepresented in science and to look at why that has come about.

Feminist critiques of science do not speak in one voice. The critique raised is varied and rich and reflects different academic perspectives and fields of interest, each providing a distinct of how sex/gender is seen to impact scientific inquiry or practices within scientific communities. The perspectives of feminist critiques of science are overwhelmingly designed not to diminish the presence of women and other minorities in the sciences, but to argue that traditionally marginalized people have had to adopt characteristics of the people in power in order to have a place at the table in science. Some of these arguments typically do not make a claim that

there are fundamental differences between women and men, but the differences are a result of socialization.

Fedigan (2001:242) has observed that even though the feminist critiques of science are diverse, they share two fundamental communalities: The assertion that the inferior status of women in science is related to the inferior status of women in society at large, and one will not change without reform to the other; and the attempt to document and bring an end to androcentric bias in science.

Recently, feminist critiques of science have moved from a primary concern with exposing sexist practice and content in sciences, to including a broader concern with scientific knowledge (Barr and Birke, 1998).

2.2.1 Equality feminist perspective

Equality feminist perspective is a critique of science that seeks to achieve equality and equal opportunities for the sexes and create a research practice that is dealt equally with women's problems. In feminist literature such kind of an approach to scientific inquiry has been referred to as feminist empiricism (Harding, 1986), Liberal feminist critique (Howes, 2002), First wave feminism (Barton, 1998) and first generation feminism (Noddings, 1990). It concentrates on the exclusion of women from science and what they could contribute if they were included (Turner, 1995:4). It also looks on the obstacles that women face in obtaining the educational and employment opportunities available to similarly talented men (Harding, 1986). It argues that sexism and androcentrism are social biases and feminist scientists, men as well as women, are more likely than non feminist scientists to notice this bias (Turner, 1995). According to Turner, this perspective assumes that the lens and methodologies of science are correct, but if attention is paid to the inequities of participation the problems that have arisen in the conduct of science will start to be resolved. Liberal feminists recognize that women have largely been barred from practicing science because of political and social forces external to science. These forces will be discussed later in chapter six and seven.

Sinnes (2006) describes equality feminist perspective as focusing on similarities between males and females approaches to science, in that there is no difference in how males and females engage in science education. She asserts that the basic assumption within these critiques is that men and women are equal and should therefore have equal opportunities in

education. This would benefit women as they would have their possibilities and equity rights extended and these benefits will also be realized to the society as there would be more women contributing to the development of scientific knowledge. Adherents to this position further argue that the ability of creating valid scientific knowledge is not determined by gender or sex but by one's scientific training, thus women and men are equally capable of contributing to scientific development. Sex/gender of the individual should not impact on the production of scientific knowledge. In this manner scientific knowledge is not regarded as discriminating against females since any competent observer in scientifically controlled observations will understand phenomena in precisely the same way as another. Girls and boys should be encouraged to develop similarly without emphasizing their sex.

Barton (1998) and Harding (1986) point out that equality feminists have played a major role in eliminating the formal barriers against women's equality in science by advocating females' abilities to advance science inquiry on equal terms as males. Educational Reform efforts in science are based in this perspective (Howes, 2002). The consequences of this position for science education initiatives as interpreted by Sinnes (2006) is that the key to improving female participation in science would be to address and change the political, educational and social factors that keep females away from science. A central goal of equality feminist is therefore to recruit more girls into Science by finding ways to make it more attractive to female students. To recruit more women into the sciences, feminist empiricists regarded it as necessary that all obstacles be removed that prevent girls from choosing science in school (Barton, 1998 cited in Sinnes, 2006). This theoretical position is said to have been the dominating feminist philosophy of science in the 1960s and 70s. Several people engaged in questions of females and science still adhere to this understanding of the role of females in science (Sinnes, 2006). Howes (2002) asserts that most initiatives currently addressing gender issues in science education operates under the premises of equality feminism.

2.3 Socialization Theories

Explanations for girls/women underrepresentation in science which do look to the social sphere suggest a complex of factors in operation. Socialization is defined as 'The process by which an individual learns to be a member of his or her society (Berger, 1976 cited in Measor and Sikes, 1992). It is the transmission of behavior, roles, attitudes and beliefs to the next generation (Kelly, 1981). It is also the way we learn the patterns of thought and behavior

considered acceptable in our society. Early socialization lays down rules about and provides role models for sex appropriate behavior and actions. Most societies especially in Africa have patterns of socialization which encourage males to become masculine and females to become feminine.

2.3.1 Social learning theories

The main thrust of the conglomerate of social learning theories suggest that children learn about appropriate attitudes and behavior from their parents, peers and teachers. They all play a dominant part in the moulding of children's behavior and in establishing habits and roles (Kelly, 1981). By the triple socializing agents mentioned above, girls learn to conform to a stereotype of femininity, a learnt role of such attributes as passivity, dependence and sentimentality (Olurundare, 1989). The social learning theories are differentiated into Reinforcement theories and Observational theories.

Reinforcement theories emphasize the importance of rewards and punishment. Children learn that appropriate behavior is rewarded, and hence reinforced, while inappropriate behavior is discouraged or even punished and it is therefore to be avoided. It is argued that rewards for sex appropriate behavior are the main mechanisms by which sex roles are acquired. The essence of this theory is that the child learns which behavior is approved and which has been disapproved. In order to gain approval, repeats that which has been favored until it becomes second nature. In the context of gender difference studies, children tend to imitate people who they see as being like themselves. Hence observational theory suggests that it is important for the learning of sex roles. The more sex-typed behavior the child observes, the more sex-typed the child's own behavior and attitudes are likely to become.

The relevance of the reinforcement theory in explaining the gender differences in science is that differential moulding would take place through parents, teachers and peers indicating that science is more suitable for boys and not girls. Assumptions are that boys might be strongly rewarded for success in terms of science learning and strongly criticized for failure while the reaction to girls performance could be more neutral or sometimes hostile if a girl does well in science. The reinforcement theory would also suggest that parental approval and disapproval are important in ensuring that boys and girls play with different toys. This will eventually affect performance in science because boys' toys (mechanical building kits, electric trains

e.t.c) are efficacious in developing scientific skills than are girls' toys (dolls, prams, kitchen sets).

2.3.2 Cognitive developmental theories

With these theories, the child is motivated to achieve competence rather than reward. The theory suggests that children are concerned to develop ways of understanding the world as a means to gaining competence. They develop a number of categories into which they fit their world, and they form rules about the categories, sex being one of the significant categories they use (Measor and Sikes, 1992:10). As part of their attempt to make sense of the world, children develop and put together a cluster of attributes which they label male and female, and then they try and copy the appropriate cluster.

The cognitive developmental theory can be applied to the question of sex differences in science by way of the image of science. If the image of science to male and female members of the society is different from childhood, this image does not seem to improve as the child of either sex grows up and is capable of making sense of the world by his/her own accord. If science has a masculine image in any society, then boys will be motivated to achieve competence in science as part of their developing masculinity. Conversely girls will see success in science as not being compatible with their developing femininity and so avoid it.

2.4 Environmental Perspective

There is consistent documentation that indicates the major contributors to the gender gap in science and mathematics are environmental in nature, influenced by society (Keller, 1985; Giddens, 2001; Mhehe, 2002)

Environmental forces have been categorized into Socio-cultural, educational and attitudinal factors (Makame, 2008). Socio-cultural factors include issues of female societal roles and society stereotyping. Attitudinal factors include internal or self imposed restraints in learning on women. Educational factors include general concerns of teaching and learning, curriculum, textbooks, lack of teaching materials and equipment and inadequate student teacher interaction as well as nature of academic institutions (ibid).

2.4.1 Socio-cultural factors

The social and cultural influences on gender differences have been explained to have greater consequences on women's participation in science education. The impact of socio-cultural expectations of females and females' education seems to be particularly evident in science education since science has maintained its image as a special masculine domain (UNESCO, 1999b cited in Sinnes, 2004). Most African societies place higher value on the traditional male role and undervalue the role of women. Thus at a very early age girls and women receive conflicting messages about their worth and place in African cultures from schools, home and the community. Such socio-cultural values, beliefs and practices coupled with existing school influences affect women's choice of study, careers and aspirations.

The early childhood environment has been identified as one major obstacle that is attributable to gender disequilibrium in science education. The way children are reared is important in developing children's self image. In most societies, masculinity is associated with independence, self reliance, strength and leadership while femininity is associated with conformity, passivity, nurturance and concern for people (Chonjo, 1994). Boys, therefore tend to be brought up to be independent while there is a tendency to call on girls to be subservient and affectionate (Mulemwa, 1999 cited in Lewis, 2006).

Lewis argues that learning tools in science classroom which include discussion, laboratory exercises, problem solving tend to be more in line with the environment in which boys are used to. Very early on boys are involved with many of the principles inherent in science while girls often lack experiences, so they enter science classrooms feeling insecure about their abilities. There is the tendency to have an environmentally induced head start for boys in science even before they are introduced to the subject in school (Jovanovic and Drovos, 1995). Children's at home experiences when they are very young can affect future learning outcomes in science and mathematics (Harlen, 1992; Kahle, 1990 cited in Clewell and Campbell, 2002).

Family expectations have been identified by many scholars to be a disincentive for girls and women's participation in science education. Parents expectations for their childrens' academic abilities and success predict the childrens' self concept of their own ability and their subsequent performance (Eccles, 1994; Clewell and Campbell, 2002). Parents tend to have

low expectations for their daughters' success in science and mathematics. Parents also tend to be less worried about a girl who cannot understand science or mathematics and be more willing to let her drop the subject at the earliest opportunity but not boys; they are expected to persevere (Chonjo, 1994). Girls who perceive greater encouragement from their parents are more likely to find science and mathematics less difficult which results in higher levels of achievement (Ethington, 1992 cited in Clewell and Campbell, 2002).

The socio-economic background of parents and their attitudes about educating girls contribute to shaping decisions about schooling of daughters (Makame, 2008). Girls coming from disadvantaged families are less likely to enter and remain in schools than those who come from socio-economically advantaged families. Poverty both at a societal and a personal level has proven to have a particularly negative effect on girls' education. If parents can not afford to send all their children to school, boys are often given priority (Kwesiga, 2002; Bendera, 1999; Mulemwa, 1999). Kwesiga notes that the main explanation for this male-child preference seems to lie in the way parents view education, either as consumption or an investment. Sekwao (1998) and Malekela (1995) note that low income earning parents would rather educate a boy for old age insurance.

Another factor that militates against women's equal participation in science education is gender stereotypes. The wide spread acceptance of stereotyping of scientists as predominantly male domain from primary to university level is still persistent. The media are a good indicator of society's attitudes toward women's participation in science. Discrimination based on gender stereotypes surface in many ways in this context. It ranges from the treatment of females in textbooks, television and curriculum materials to differential treatments of males and females in the classroom. Stromquist (2005) argues that there is a tendency to present women in biased ways, primarily as mothers, homemakers and care givers, with limited role as professionals. Such stereotypes within society have helped to create 'male' or 'female' subjects so that even when options are offered pupils are likely to choose subjects which are identified with their own sex (Kwesiga, 2002). As a result females tend to opt for the arts and humanities, life sciences leaving mathematics, chemistry and Physics (physical science in general) in the hands of males. Psychologist Claude Steele (cited in Hyde, 2007:138) believes that a negative stereotype about one's group leads to self doubt and other processes which then damage academic performance.

The traditional female stereotypes emphasize dependence, personal relationships and feelings (Lewis, 2006). Schenkel (1991) argues that sex role stereotypes portray a woman as emotional, helpless and intuitive whereas men are portrayed as rational, competent and smart. She asserts that such stereotypes consider being brainy as absolute unfeminine while achievement, assertion and aggression belong squarely in the male domain. As a result this is internalized by females by conforming to the notions that their success is achieved through being well behaved and obedient (Adams, 1996 cited in Lewis, 2006). These stereotypes encourage girls to adopt self conceptions and values and they lead to a pattern of internalized helplessness with respect to science and mathematics.

Schenkel (1991 cited in Makame, 2008) asserts that learned helplessness has devastating effects on behavior as it destroys motivation, it interferes with the ability to learn and it creates emotional distress. She also argues that women in the workforce have difficulty giving orders as it is believed authority is regarded as a masculine concept. In African societies most authority figures have been males as a result many women have a gap in their concept of authority, their image and their behavior repertoire. The belief that men are supposed to lead and direct while women are supposed to follow and submit has resulted in some women feeling that there is a conflict between authority and femininity. Women regard asserting authority over men as inappropriate and a threat to their sense of femininity.

2.4.2 Educational Factors

Schools have a positive socialising effect on pupils but they can also be places where gender inequalities are perpetuated (Kwesiga, 2002 cited in Makame, 2008). Schools may exert their influences in multiple ways, including teachers' attitudes and behaviors, curriculum, textbooks and assessment. Teachers through their behaviors and interactions with students have long been considered important influences on girls' attitudes and achievement in science. Researchers have hypothesized that teachers' stereotyping of science and mathematics as 'male realms' affects their expectations, which in turn results in differential behavior toward girls and boys in science and mathematics classrooms. Many studies have suggested that within the science classroom, boys and girls receive different educations. Studies that investigated the complex area of teacher/student interaction (Koehler, 1985; Wilkinson and Marret, 1985) revealed that indeed teachers were treating males and females differently within the science and mathematics classrooms, and that usually this difference

was in favor of males. In science and mathematics classes, teachers are more likely to encourage boys than girls to ask questions and to explain (Jones and Wheatley, 1990 cited in Hyde, 2007).

It is also argued that school facilities determine the quality of the school, which in turn influences the achievements of its pupils (Makame, 2008). Many scholars have argued that the important indicators in assessing quality in education and effectiveness in school systems include the availability of textbooks, reading material, good classrooms and laboratories, school library, school furniture and numbers of qualified teachers (Omari, 2001). The lack of adequate teaching facilities for science is a strong explanation of why girls are under-represented in higher education in these subjects (Kwesiga, 2002). Quality of schools, courses offered, messages about sex roles conveyed by educational materials and by teachers influence how parents and students, make schooling decisions (Hyde, 1993 cited in Makame, 2008). Hyde argues that school-related factors can be an important determinant of whether girls enter and remain in schools.

Type of school may also hinder the participation of girls in education and what they study (Hyde, 1993, Kwesiga, 2002 cited in Makame, 2008: 28). Kwesiga contends that boarding schools are expensive to run and are therefore accessible to fewer students, although girls' parents sometimes prefer. It is believed that day schools do not always provide effective learning environment (ibid). Harding (1981) argued that females studying mathematics and science seem to be disadvantaged in a mixed school setting. The assumption is that coeducation does not signify equity or equality in policy or practice as males dominate co-educational schools as students, teachers and administrators. Researchers who experimented with single-sex settings (Fox and Cohn, 1980; Lockheed, 1985) suggest that carefully timed, organized, and implemented intervention programs may indeed lead to qualitative if not quantitative benefits in the learning of mathematics for some females.

2.4.3 Attitudinal Factors

Mednick *et al.* (cited in Makame, 2008:29) describes attitude, as 'a predisposition to act in a certain way towards some aspects of one's environment, including other people'. It is one of the strong determinants that shape individual or community actions and behavior in a particular society. Confidence is one of the most important aspect that has been studied in

relation to gender difference in science and mathematics. Koehler and Mayer (1990) assert that confidence is one part of self-concept and has to do with how sure a student is of his or her ability to learn and do well in mathematical tasks. They argue that confidence influences a student's willingness to approach new material and to persist when the material becomes difficult. Some studies (Fennema and Sherman, 1976) have shown that when a gender difference in mathematics achievement in favor of males was found, it was accompanied by a gender difference in confidence, also in favor of males. Other studies have shown that even when girls tend to perform just as well as boys, their confidence relating to their abilities of learning science is lower than what applies to the boys (Lewis, 2006). It is claimed that the low performing boys have higher self-confidence in their own abilities for learning science than the high performing girls (Sinnes, 2004).

Schenkel (cited in Makame, 2008) asserts that women lack confidence because they have doubts and fears among them. They wonder about the value of their ideas and actions and they normally question their intelligence, talent and skill (ibid). Schenkel argues that the major reason for women to lack confidence is that women learn to view their abilities in the same way that society views them. The society's prejudices against women's competence further leads to many women becoming prejudiced against their competence.

2.5 Chapter Summary

This chapter has presented the theoretical frameworks that attempt to justify and explain the contributing factors to the gender gap in science in higher education. The pedagogy of difference as an African perspective has also been described in order to comprehend the factors that keep women away from participating in science education. The environmental perspective adhered to in this study was discussed in detail. The environmental factors outlined and discussed in relation to science include socio-cultural, educational and attitudinal factors. More recently researchers have focused on the influence of the social environment in explaining gender discrepancies in science education because there is no evidence to suggest anything biological which stops females from participating and achieving high levels of science like males.

3 LITERATURE REVIEW

Introduction

This chapter contains a review of literature related to the study of womens' participation in science education. It begins with making a discussion on general concepts of gender equity in education. The chapter also contains comprehensive review of empirical findings of girls and womens' participation in science education in alignment with the theoretical framework, worldwide and in Tanzania in particular.

3.1 Rationale for Gender Equity in Education

The arguments for gender equity in education provision and labor markets have as their base in the human capital theory and human rights concerns (UNICEF, 2001 cited in Ngezi, 2005). Education is seen as an investment in human capital that lifts individuals out of poverty by increasing their returns to the labour market (World Bank, 1995). The United Nations officially called for women's equal right and access to education as a "fundamental right" (UNESCO, 2004 cited in Scantlebury and Baker, 2007). Education is the foundation of all other human rights like equal opportunity in the world of work, participation in the economic development and political empowerment. All these are central to the reduction of poverty and economic insecurity (Omari, 2001). UNESCO's policies state that female education is a key strategy to eliminating poverty and improving development.

The World Bank (1993:3) observes a symbiotic relationship between men and women in the following way:

Failure to ensure equality in education between sexes can reduce the potential benefits that educating men has on social welfare, and a nation with a large gender gap in enrolments will have lower economic productivity than another country with similar capital and labor resources but with a smaller gender gap in schooling.

The World Bank's chief economist, Lawrence Summers in 1993 argued for the support of education for girls in the following way:

An educated mother faces higher opportunity cost of time spent caring for the children. She has greater value outside the house and thus has entirely different set of choices she would have without education. She is married at later age and is better able to influence family decisions. She has fewer healthier children and can insist on the development of all of them, ensuring her daughters are given a fair chance. And the education of her daughters makes it much more likely that the next generation of girls as well as boys, will be healthy and educated as well. The vicious cycle is thus transformed to the virtuous cycle (quoted in Sinnes, n.d:3).

Hennevelde (cited in Ngezi, 2005:24) argues that girls' education has intergenerational economic and social benefits. The evidence of significant returns to female education includes reduced fertility, reduced infant mortality, enhanced family health and welfare, improved children's education and increased agricultural productivity for women and the larger economy. Hence there is a need to ensure gender balance in education and specifically in science and mathematics if Tanzania is to develop socially, economically as well as politically.

3.2 The Situation Internationally for Girls' and Womens' Participation in Science

Women and girls' participation in science in many countries is restricted by their limited access to education (Scantlebury and Baker, 2007:265). In 2002, the World Bank estimated that of the 150 million children in primary school, 100 million were girls who were expected to leave before completing their education (ibid). It is estimated that 104 million children aged 6-11, worldwide are not in school each year and that 60 million of these children are girls (UNESCO, 2003). Nearly 40% of out of school children live in Sub-Saharan Africa (ibid). Although many African countries have achieved parity in enrolment of girls and boys in the first grade of primary school, the dropout rate of girls is still higher than that of boys and many of those who dropout do so before acquiring functional literacy and numeracy (UNESCO, 1999).

Girls' access to education is concentrated at the lowest level; approximately 23 percent of primary school graduates enter secondary institutions while less than 3 percent of those who leave secondary school continue to tertiary levels of education, increasing the gender discrepancies from the lower to the upper levels and perpetuating a lack of role models for those girls who might otherwise choose to follow a scientific career (ibid). In terms of ratio when comparing the number of females with males enrolled in secondary education, there are

82 females per 200 males attending school with the exception of Latin America/ Caribbean where there is 1 female per 100 males (Scantlebury and Baker, 2007).

For tertiary education, there are 63 females per 100 males in Sub-Saharan Africa and 58 females per 100 males in South Central Asia. Overall there are 75 females per 100 males in universities in developing countries (ibid). Although this ratios do not depict the actual number of students enrolled, they still show that the higher one goes up the educational ladder, the fewer the women/ females.

There is considerable agreement among researchers, educators and policy makers that the last few decades have seen progress for women in science (Hanson, 1996). Despite of these gains however, the gender gap in science has not disappeared. Various studies provide alarming evidence of the persistence of the gender gap in the science pipeline running from early training in primary and secondary school through advanced training in the university, to the hiring of qualified scientists in the labor market. Hanson (1996) visualizes the science pipeline as a funnel, since all primary school students are in the pipeline but many dropout along the way. Research on women's participation in this pipeline shows a pattern of declining course taking and achievement along with increasingly negative attitudes about science. As suggested by many researchers, this decline begins in secondary school and worsens in the undergraduate and graduate years (AAUW, 1992; Oakes, 1990 cited in Hanson, 1996).

3.2.1 Middle East

In the Middle East, science is taught in Muslim countries as an integrated compulsory subject from the beginning school grades and is also part of the curriculum in the last two or three years in secondary school (Scantlebury and Baker, 2007). They note that fewer girls than boys enroll in these courses because girls are encouraged to enroll in Arts and Humanities classes. There is stereotyping of science and technology as suitable only for boys, and the curriculum does not relate science to the everyday life of women (Hassan, 2000).

Koenig (cited in Scantlebury and Baker, 2007) reported positive changes taking place in Iran, where among those women who graduate from secondary school and go on to tertiary education, 60% of incoming university students were females and, unlike in the past patterns they were choosing science (p.266). Despite increasing female enrollments in Iran,

Scantlebury and Baker observed the number of women in faculty positions in universities to be low for example in 1999 , women were 6% of full professors, 8% of associate professors and 12% of assistant professors in all academic fields.

Lie and Vogt (2003) studied enrollment figures for 1989, which showed that as in most other countries, Syrian female university students dominate in the humanities (60%), education (56%) and social and behavioral sciences (42%). According to them, women's (42%) representation in the natural sciences was surprising. It exceeds most western countries, but closely resembles that of the former Soviet Union and Eastern European countries. This may be explained by the influence the aforementioned countries have had on the higher educational system in Syria. A large percent of graduate students received advanced degrees from these countries. However, only 4% of full professors were women in 1994. In 1980 9% of faculty candidates were women, and this percentage rose to 23% in 1993 (p.9). Thus it is expected that currently, women's share of faculty positions has risen substantially.

Turkey although not in the Middle East, is an Islamic country but because of its secular government they are more women in science and there is less gender discrimination (Cohen, 2000 cited in Scantlebury and Baker, 2007). Consequently, far more female students are enrolled in university and more in science compared with other muslim countries. Further up the educational ladder, Turkey has been more successful in getting women into the upper ranks of the professoriate in science with 20% females (Ngezi, 2005).

3.2.2 Europe

The position of women in the EU reveals that women now constitute 50% of first degree students in many countries (ETAN Report, 2000:8). The proportion of women and men among undergraduate students is broadly similar for the member states. However they tend to disappear from academic life before obtaining career posts such as tenure where it exists. It has also been observed that in all European countries women tend to cluster in subjects belonging to the humanities and social sciences while science and technology remains a male bastion. Despite the increased participation of women in higher education, and despite the increase in women taking science subjects and moving into doctoral and post-doctoral studies, there remain remarkably few women in top jobs in science in any of the member states.

According to new findings from the European Commission, the percentage of women in top academic grades never exceeds 21% in Europe and men are three times more likely to obtain professorships than women (Kabeer and Magnus, 2004:3). The percentage of full professors who are women is very low ranging from 5% in the Netherlands to 18% in Finland. However, there is a reverse situation in Portugal which tops the league for women professors. Portugal seems to have been extraordinarily successful in incorporating women into science departments at universities and research institutes. In the science faculty at the University of Lisbon, 30.7% of the full professors, 58.9% of the associate professors and 57.2% of the assistant professors are women. This came about by an enormous increase in the number of young people both male and female attracted to science due to the possibility of getting fellowships and also through the establishment of a system to fund research grants (ETAN Report, 2000).

The lack of women in senior grades in science affects their prospects of achieving high office in senior management positions in universities such as Rector or Vice Chancellor. Ultimately the consequences of this is the absence of women in debates shaping policy, they are not there to provide a challenge to the status quo and *modus Vivendi* and their absence means there are few role models for women coming up the system. (ETAN Report, 2000:15). The higher the position in the hierarchy, the lower the percentage of women. Crucially, there are remarkably few women in important scientific committees and in key policy shaping arenas.

In Germany, various studies report that women are less likely to stay in science than men. Today women make only 2.6 percent of the highest rank of German professoriate, 7.3% at the middle and 24.2% at the entry level (Baker, 1998 cited in Ngezi, 2005). The threat of not being taken seriously coupled with many other issues like exclusionary experiences, dependence on hostile colleagues or seniors, conflict between gender roles and scientific roles, silence surrounding women's issues produce anxiety that interferes with scientific production and recognition. Baker notes that there is also a social disapproval for women who work outside the home.

Female scientists in Germany suffer discriminatory comments by peers and supervisors and in some instances it is reported that male PhD students were not willing to take orders from a female superior (Gupta et al., 2005). The same survey in Germany revealed the use of embarrassing languages by some men colleagues, that successful female scientists turned into 'dragons' and were in their opinion not women anymore. Like in India, women scientists in

Germany are seen as risky employees with stereotyped assumptions about their aptitudes and expected skills. Their contributions in discussion are continually ignored, with lesser recognition of their performance, and there is preference of male scientists when better or tenured positions are available.

In Norway, to get a true picture of female participation in science and technology programmes in universities and colleges, actual numbers rather than percentages are considered. The relative position of male and female graduands from first degree programmes in the academic years 1998/99, 2007/08 and 2008/09 is as follows: The number of males was 2185, 2017 and 2162 while that of females was 714, 704 and 809 respectively. Graduands from the second degree programmes in the same years above, males were 1524, 1498 and 1430 while females were 671, 830 and 786 respectively (Statistics Norway, 2010). The numbers reveal that less females in Norway complete tertiary education in the field of science as it has also been observed in some other European countries.

3.2.3 U.S.A and Canada

In the U.S, while the proportion of women with bachelor's degrees in science and engineering has almost doubled from 25% in 1966 to 47% in 1995, the percentage of women with a PhD in science and engineering was only 31% in 1995 (Gupta et al., 2005). Similarly National Science Foundation (NSF) in 2002 reported that the number of women moving into science majors and careers has increased steadily during the past few decades and they are reaching parity in several undergraduate and masters degree programmes. However, there is a dearth of women faculty in the sciences at colleges and universities, and women are underrepresented in the senior ranks (NSF, 2003 cited in Scantlebury and Baker, 2007).

A recent study of the top 50 departments of engineering and science, as ranked by the National Science Foundation, revealed that women faculty were more often associate or assistant professors than full professors and that women faculty were a minority of tenured faculty in the sciences (Rogers and Nelson, 2004). The reasons put forward for this anomaly in tenure track is a conflict between biological clock and tenure clock which tend to tick simultaneously (Gupta et al., 2005; Scantlebury and Baker, 2007). Juggling family life with tenure track faculty position was found to be extremely challenging such that some women trade off career advancement or higher earnings for a job that offers flexibility to manage work and family responsibilities. Women scientists regard partners career as more important

than their own and institutes see combining family and career as a private affair of women (Gupta et al., 2005). Studies have also argued that the variability in men and women's participation in the sciences may result from discrimination in the work place or subtler discrimination about what types of career job choices women can make.

A study on the Status of Women Faculty in Science at Massachusetts Institute of Technology (MIT) in 1999 found that there was a subtle and largely unconscious bias against women within the institute. As Kabeer and Magnus (2004) observe, the MIT study found evidence of clear institutional differences in salary, space, awards, resources and response to outside offers, with women faculty consistently receiving less than men despite equal professional accomplishments. In general salary differential between men and women could be explained by difference in age, length of experience, type of occupation, seniority and highest degree attained (Clewell and Campbell, 2002). The research on women science faculty issues at MIT found that, after tenure, many senior women faculty began to feel marginalized and sensed that they may not have been treated equally with their men colleagues.

Conclusively, although women's participation in the sciences in U.S has improved steadily over the last three decades, men still outnumber women in nearly every field in science. Women faculty have not yet caught up with men faculty in several areas including salary, tenure and research activities. Women faculty still more often taught as their primary responsibility, less often conducted research as their primary responsibility, less often held a professional degree or PhD, more often worked part-time, more often had less experience and more often were younger (Scantlebury and Baker, 2007).

In Canada, The Hypatia Project which has long term sustainable strategies to improve the representation of women in science and technology fields, argues that equal participation of women in the science and technology workforce will not occur if current enrollment levels at post-secondary institutions continue (Armour, 2003). Although girls in Canada represent about 50% of students enrolled in high school science courses, their numbers at university level is extremely low. The project reports that women represent only 21% of students enrolled in science programs at local universities. From the statistics it is very clear that most girls choose not to pursue careers in science and technology or to enroll in related programs at post-secondary institutions.

Like other studies conducted in the U.S and Europe, likewise in Canada researchers have found similar factors influencing the participation of girls and women in science education.

1) Attitudes and expectations of parents and teachers 2) Learning environment, teaching strategies and instructional materials 3) Images of science 4) institutional policies and practices 5) work place culture and environment were found to be factors that sustain barriers faced by girls and women.

As noted by Amour, gender role stereotyping has been observed to be a major barrier for women in science. Whether it manifests in the home, the science classroom, the research lab or in the science work place the effects are still the same. Amour in his own words contends that, “It is not just the images of science and technology that is at fault, but it is the actual social organization of the discipline and the work place”. Henwood (cited in Armour, 2003) argues that “equality cannot be achieved unless the underlying causes of inequality are tackled directly.

3.2.4 Asia

In India Science is considered as a male enterprise where educational decisions are family decisions (Gupta et al., 2005). Most families are less inclined to invest family resources in academic achievements of daughters than sons, even though science degrees bring in greater prestige and job opportunities. It is assumed that investment in a son’s education will benefit the family directly whereas a daughter’s education will after her marriage, primarily benefit her husband and his family (Mukhopadhyay, 1996; Gupta et al., 2005). Their studies observe that, attendance of girls in co-educational institutions implies immersion in an overwhelmingly male environment, unsupervised, close contact with unrelated males and residence in a campus hostel. Thus most families are reluctant to allow daughters to pursue science degrees given the high investment, dangerous social context and potential marriageability problems.

A recent report from the Indian National Science Academy (INSA) (2004) found that 42.5% of women are enrolled in graduate degrees in science and PhD enrolment in science is 37.2%. Despite the growing science enrolment, just like in U.S.A and elsewhere, women faculty are a miniscule 7% at institutions, with low proportion of women scientists at professor level (Gupta et al., 2005). They note that women are rarely present at higher administrative levels

and there have been no women Deans or Directors ever. The appointment and promotion committees bring up family issues and question women's commitment to the job.

Gupta et al. (2005) observe that mixed messages are being sent to women faculty scientists in everyday slights for example they explain about how women are being left out of study groups, being ignored in class, lab meetings, not being included in conferences and even sometimes being mistaken for a secretary. This makes women feel they are not welcome or expected to succeed. In such an environment where science is not only male dominated but also considered unfit for women, a woman scientist typically faces the contradiction in roles of a woman and a scientist.

3.2.5 Africa

Studies in Africa show that the problem of underrepresentation of girls and women in science has its roots in schools and universities. Research findings indicate that gender differentials in higher education are invariably rooted in inequalities at the primary and secondary levels where the real sorting out of university bound students takes place (Aguele and Uhumuavbi, 2003 cited in Aguele and Agwagah, 2007).

In a study on Building Women's Capacity in Science and Technology in the South, Kabeer (2004) discusses barriers facing women in science in the south and identifies Africa specific problems. He contends that the lack of access to good quality education for girls and women is a fundamental problem greatly reducing the numbers of women entering into the scientific professions and adding to the sense of isolation experienced by the few who do pursue a career in science. Hence he proposes that the issue of lack of access to education be solved before issues of retention and career progression could be tackled (p.22). He identified other factors being the male dominated culture of science such that women scientists are not welcomed by male colleagues, they are excluded from male networks and after hours-socializing, they are not taken seriously as scientists and male colleagues refuse to collaborate with them.

Kabeer also found out that woman scientists in the south tend to be more strongly constrained by cultural norms and family commitment than their colleagues in the North. Balancing family commitments and a career leads to time restraints, mobility restraints and a lack of flexibility. The difficulties facing scientists in terms of funding, resources, facilities,

opportunities and exposure to the international science community were also reported in this study. There was also a lack of facilities; there were very few well equipped laboratories and recent journals and textbooks were missing from libraries. Lack of exposure coupled with lack of funds for research and education was another problem as one cannot attend conferences or workshops abroad relating to one's research (Kabeer, 2004:19).

Direct discrimination, intimidation and sexual harassment in the workplace were also found to be a serious constraint. Women were sexually as well as financially exploited by their male peers and often suppressed by the male fraternity. He also found that there were self imposed constraints by women themselves. Internalization of various aspects of their socialization as women, coupled with apparent lack of ambition, self confidence, assertiveness and aggressiveness is a disadvantage to women as these character traits are highly valued in most competitive work environments like science. Kabeer argued that if science in the south is to flourish, it needs to both attract and retain talented women and men. This can be done through building capacity for world-class science among scientists in the south and also remove the various obstacles that prevent most women from competing for available scientific resources on a level playing field with their male colleagues.

In Nigerian universities significant differences exist between male and female enrolment in science education. University enrolment appears to favor the males more than females. A science study conducted on 12 states of Nigeria revealed that in the academic years 2000/01 and 2001/02 males were 9460 and 10450 while females were 3924 and 3650 respectively (Aguele and Agwagah, 2007). The number of males is almost three times that of females.

Falusi (2006) in her study of Science Education for Girls and Women in Nigeria, identified six reasons which might explain why women avoid the sciences; One, was the disparity between the cost of science courses and the cost of humanities courses, the time required for bench work in laboratories discouraged some, a lack of early financial returns in Science based jobs, scarcity of support and encouragement for practical science education and outdated, outmoded equipment are used to teach students in a purely theoretical fashion. Other reasons being the erroneous belief that highly educated women never find husbands as well as the perception that woman are not expected to be breadwinners, but rather homemakers, makes it extremely difficult for them to opt for a science based education.

Falusi further points out, the perception that the advanced core sciences interfere with homemaking in a way that the humanities do not is another hindrance to women joining science. The practice of early marriages and the idea that all funds spent on girls will be to the benefit of families they eventually marry into is a disincentive for girls to pursue science education. Lack of specific financial support for science based education coupled with lack of specific remuneration for science intense jobs to compensate for the extra effort required is also an obstacle to science education.

3.3 Girls' and womens' participation in science education in Tanzania

In Tanzania, girls' chances for schooling are also strongly influenced by the socio economic positions of their families. Low income earning parents would rather educate a boy for old age insurance (Malekela, 1995 cited in Ngezi, 2005). However, Omari (2001) and Malekela (2000) argue that parents have realized that girls are more helpful than boys even if they are married. TADREG (cited in Ngezi, 2005) contends that there is an increased rate of investment in private secondary schools for girls. This suggests that there is gradual withering a way of certain aspects of the old patrilineal system.

Mpama (1984) in his study of factors influencing performance of Mathematics in primary schools found out that there were significant differences between boys and girls in their performances. Girls' performance was identified to be poor than that of boys. He further suggested the cause of girls' high failure rates in mathematics in secondary schools to be girls' self concept. Mpama argues that girls have a poorer self –concept than boys and that parents are responsible for their children's self concept because they serve as the child's primary model. The physical home background was said to be essential in nurturing educational aspirations and expectations in children.

Sekwao (1986) studied the factors that contribute to poor performance in Advanced level secondary science subjects with special reference to Biology. He wanted to find out whether or not teachers competence, time available for studying, teachers' motivation and academic ability were the causes of continued poor performance in A-level Biology examinations. The study revealed that low academic ability of students was not the cause of poor performance in the National Form Six Examinations but rather, low teacher competence, insufficient time to cover syllabus, teachers' low interest and commitment to teaching were the causes of poor performance.

Sekwao (cited in Ngezi, 2005) in his study of why few girls choose to study science and technology in Tanzania despite the efforts of the government to ensure equal education opportunities, investigated three possible causal factors namely cognitive ability, attitudes towards science and classroom interactions. The findings revealed that boys had more positive attitudes towards science than girls, that girls in co-education schools were disadvantaged in classroom interaction, and teachers seemed unaware that girls were disadvantaged. No significant differences were found with the cognitive ability

The FEMSA project in Tanzania highlighted that, poor performance in females at lower levels results from many causes. The home and school culture, masculine image of science, girls frequent and prolonged interruptions in learning where science is most affected as it is highly hierarchical and generally poorly taught all contribute to such low performances.

FEMSA (Female Education in Mathematics and Science in Africa) was a project which was implemented in 4 countries in 1996 - 1998 and in 12 (8 additional) countries in sub-Saharan Africa in 1998 - 2001. This was a project of ADEA - Working Group on Female Education where FAWE (Forum for African Women Educationalists) and Rockefeller foundation hosted the project. In the first phase Cameroon, Ghana, Tanzania and Uganda conducted research on all possible issues that concerned girls' education in Mathematics and Science at basic education level (primary and lower secondary). This included education structures, infrastructure, learning and teaching, classroom dynamics, home environment, financing, etc. Data were collected from all players, parents, examination bodies, curriculum development bodies, ministries, civic and religious leaders, teachers, pupils/ students, classroom observations, education providers, analyses of curricula and examinations. In Phase two, 8 new countries were added in 1998 - 2001 (Malawi, Zambia, Kenya, Swaziland, Mozambique, Mali, Senegal and Burkina Faso).

It was observed that girls' frequent interruption in learning (by being absent from lessons for one reason or another) was among priority reasons that contributed to girl's poor performance and participation in Mathematics and Science subjects. Science subjects especially Mathematics and Physics are regarded highly hierarchical. It becomes difficult for one to catch up when she misses some concepts. Also if one misses an important experiment in Chemistry or Biology, that is it, the gap cannot be easily bridged and the experiment will not be repeated due to cost implications.

The causes of the interruptions in learning were identified to be: A helping hand at home (farming, taking care of the ill, helping during celebration or bereavement); when sent back from school due to needed fees or money contribution or torn uniform girls are most likely not to be given the money in reasonable time as compared to boys; helping hand at school (in teachers' houses – cooking, baby sitting; cook for school guests), frequently punished during study time because of coming late or not doing homework or not answering correctly, all these are due to overburden of chores at home. Also due to poor or lack of sanitary facilities at schools many girls missed out on school when in their menstruation period.

The intervention phase in FEMSA Tanzania analysed attendance in sampled classes and established that 87% (on average) of girls in those classes had a pattern of not attending school on a monthly basis. When samples of those girls were interviewed, they established that they missed school on those particular dates because of menstruation. In particular because of one or two or all of the following reasons: (i) they had stomach cramps and had nowhere to rest a bit when need be. The cramps were not there all day which means they could still attend but needed to rest a bit at some point (ii) toilets were not enough, or had no doors or there was no water or there was nowhere to dispose sanitary pads (iii) the period started unexpectedly and they had no pad so they had to go home. They were terrified to soil their uniforms so some girls stopped school when this happened (iv) or they had no money to buy sanitary pads so they simply could not come to school when in MP.

The factor of interruption in learning is such a big one that if not addressed girls will continue to drop out. Even if girls are kept in school physically, they can drop out academically if their performance in exams is below expectations to enable them continue to the next stage. Efforts by Education system to ensure the number of women/girls' toilets are in specified ratios, have doors/ are private enough, have water and disposal containers for pads, a school has a resting room and spare sanitary pads for those in emergency need; alone this can reduce absenteeism to a great extent and hence girls retention physically and academically.

3.4 Summary of Literature

The literature reviewed indicates that girls/women's participation in science education is not just a matter of enrolments or that girls cannot and do not have the ability to succeed in

science but rather there appears to be a complex constellation of factors hindering their full participation.

The review of literature revealed that in most developing countries the problem of female underrepresentation in science education is observed starting at the undergraduate level and onwards to faculty positions

In developing countries, overall female undergraduate enrollment is encouraging and they are almost reaching parity with males. In other cases like that of Iran, 60% of incoming university students were observed to be females. However, few females than males enroll in science courses at the undergraduate level and most women are found in the fields of Arts and Humanities. There are exceptions like Turkey which has succeeded in getting more female students in science.

The number of women in faculty positions in the developed countries is still low with most females concentrated in the lower ranks. Women are a minority of tenured faculty. Portugal succeeded in attracting more women in science both as students and staff due to the provision of scholarships and funding research grants.

In developing countries leakage of females in the science pipeline is observed even before girls start schooling as fewer girls than boys have access to schooling. In developing countries there are little such differences in attitudes towards girls and boys education at primary and secondary level as both girls and boys get the same possibilities to study. In primary and secondary schools in Africa, girls' performance in science is observed to be poor and hence they cannot move up the science educational ladder.

In Africa, women are underrepresented in all areas of higher education. Like in other Western countries, women are concentrated in Humanities and Social Sciences. The science field is greatly affected with low numbers of females both as students and faculty members at universities. The low participation rates and the paucity of women in science fields are attributable to factors affecting girls and women during the primary and secondary school years to university level.

This study sought to establish whether some of the reviewed factors above apply to universities under study as well.

4 RESEARCH METHODOLOGY

Introduction

This chapter presents methods and procedures used in the research in order to facilitate the attainment of the investigation of the study on women's participation in science education. It consists of the description of the research design, the area of the study, sampling procedures, research methods, data collection techniques, ethical considerations and data analysis procedures.

4.1 Research Design

Research design according to Kothari (2002) is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. It is the conceptual structure within which research is conducted.

In this particular study, case study research design was employed. Three universities were selected as cases. It was preferred by taking in consideration the views of Isaack and Michael (1981) that a case study tends to examine a small number of units across a larger number of variables and conditions. The argument is also supported by Patton, that a case study is particularly appropriate because it can be used to probe an area of interest in depth. Yin (1994) suggests that it as an empirical inquiry that investigates a contemporary phenomenon in its real life context using multiple sources of evidence.

This method enabled me to understand the complex real-life activities surrounding the science arena in which multiple sources of evidence were used. Bryman (2004) explains that a case study involves the detailed and intensive analysis of a single case or sometimes extended to include the study of just two or more cases for comparative purposes. In this case, a multiple-case study was employed in the research. The importance of doing multi-case study is to examine how the phenomenon performs in different environments but it is not a research design for comparing cases.

The primary advantage of the multiple-case design is that multiple-case evidence is considered more compelling and the design leads to greater confidence and robustness than that from single cases because it incorporates a 'replication logic' in which results of one case

study are compared or ‘matched’ with the results of subsequent ones (Yin, 1994). Also analytic conclusions arising from multiple cases will be more powerful than those coming from a single case (ibid).

In my case, the conclusions drawn from the findings from each university were studied in relation to the university as well as in comparison to the other universities (see chapter six section 6.1.4). The choice for multiple cases is appropriate given that Yin (cited in Mohd Noor, 2008) argues multiple-case studies should follow a replication, not sampling logic. This implies that two or more cases are included within the same study precisely because the researcher predicts that similar results (replication) will be found (ibid). One can have more confidence in the overall results if replications are found for the cases and the development of consistent findings over multiple cases can then be considered as very sturdy. In my case, examining three universities enhanced the accuracy, validity and reliability of the results by capturing the holistic essence of the subjects studied.

4.2 Research Site and Rationale for Selection

This study was conducted in two districts of Dar-es-salaam region, namely Kinondoni and Temeke where the three universities are located. University of Dar-es-salaam and Open University of Tanzania are located in Kinondoni municipal while Dar-es-salaam University College of Education is located in Temeke municipal. Dar-es-salaam region was chosen because the city is the commercial and administrative ‘heart’ of Tanzania. Also the region was chosen because the Ministry of Education and Vocational Training (MoEVT) under which higher education falls, is in Dar-es-salaam hence obtaining some information was expected to be easy. Furthermore, the city has large, diverse and popular higher education institutions worth examining.

The three universities were chosen for this research because they are well established compared to some other universities in the country. They all offer science programmes that can offer comparative analysis. Selection of the case study universities was also based on the anticipated willingness on the part of staff to participate in the research given existing linkages between the researcher and some of the staff in these universities.

The overall aim of the selection process was to choose sites which as a set, displayed characteristics that indicated a diverse range, from a normal university (UDSM) to a

university college (DUCE) and finally to an Open and Distance learning university (OUT). Rather than typicality or representativeness, the overriding requirement therefore was diversity of institutions (Lincoln and Guba, 1985). Consequently the selection process took account of the following criteria: All universities offered science courses, were located in the city and hence a diverse population and two of the universities offered PEP (Pre-Entry Programme) for female science students. Logistical consideration such as cost, time (less than two months were needed to complete data collection) and ease of accessibility also influenced the decision making process to choosing the research sites.

4.3 Methodological Approach

The study made use of both quantitative and qualitative research approaches because the researcher dealt with participants' opinions and views and quantified data. Patton (2002) points out that both quantitative and qualitative data can be collected in the same study as both methods involve differing strengths and weaknesses; they constitute alternative but not mutually exclusive strategies for research. Stake (2000) asserts that a case study might use quantitative as well as qualitative research methods. I chose both methods because I needed research methodologies which would give me more information about the studied cases and also answer my research questions which would otherwise not be possible to obtain through the use of only one method.

4.3.1 Quantitative Methods

To explore the nature and extent of the science gender gap in universities, quantitative research approach was used. The quantitative research approach was used where the researcher was interested with facts and figures. Data were collected and presented in tables which were further subjected to quantitative analysis. As a form of quantitative approach, tables are used as statistical models to classify features, count them and present their summation in attempt to explain what has been observed (Makame, 2008:39). The statistics that are presented focus on enrolment of students, fields of study, employment of faculty members, qualification and ranks among staff members in a gender comparative perspective. However, statistical data alone did not give enough insight into the cases as quantifiable data could not be easily analyzed in a narrative manner and that is why qualitative approach was further employed.

4.3.2 Qualitative Methods

Qualitative approach to research generates results either in non-quantitative form or in the form which are not subjected to quantitative analysis (Kothari, 2004). Qualitative research is holistic as it attempts to provide a contextual understanding of the complex interrelationships of cause and consequences that affect human behavior (Brock –Utne, 1996:609) yet it is also concerned with impressionistic assessment of attitudes, opinions and behavior (Kothari, 2004). To gain insight into the factors that contribute to the existence of the science gender gap among students and staff of the universities studied, views and experiences from female students and staff were taken in order to present a broader, more holistic and realistic view of the situation. This was made possible by utilising a variety of techniques from qualitative methods. Through this approach it was easier to gain deeper understanding of the participants' ideas, opinions, feelings and actions that reflected womens' participation in science education.

4.4 Data Collection Techniques

The choice of data gathering techniques or instruments depends on how they can serve the purpose of the study, the problem posed by a particular hypothesis or task. The choice of techniques which were used in this study was dictated by the research questions whose data and answers could be tapped by particular instruments. Therefore the researcher employed a combination of data collection techniques that included semi-structured interviews and documentary review. This was done in order to take into consideration the fact that there is no single instrument that is self-sufficient in data collection.

Furthermore, Cohen et al. (2000) point out that each technique checks and reinforces the other. Patton (1990) maintains that no single research instrument is adequate in itself in collecting valid and reliable data on a particular problem. The use of multiplicity of techniques served as a means of cross checking the authenticity of information from single sources, hence enhancing their reliability and validity.

Oppenheim (1992) is of the opinion that a combination of two to three methods makes data highly reliable. Thus, corroboration of multiple qualitative techniques for this case study research therefore enhanced the validity and reliability of findings.

4.4.1 Interviews

Interviews involve data collection through verbal interaction between the researcher and the respondents. This technique was preferred because of its ability to yield rich insights into peoples' experiences, aspirations, attitudes and feelings (May, 1998). I also made use of interviews because this technique has an advantage of being flexible in nature; hence it allows the researcher to collect much information from the respondents. Patton (1987) advocates that it enables participants to discuss their interpretations of the world in which they live and express how they regard their situation from their own point of view.

Bryman (2008:437) argues that in qualitative interviewing going off at tangents is encouraged, interviewers can depart significantly from any schedule or guide that is being used as a result interviewing tends to be flexible responding to the direction in which interviewees take. In this way researchers get more detailed answers compared to structured interviews. Further he asserts that qualitative interviewing is most preferred in feminist research since it brings much focus on interviewees (Bryman, 2004), allows many of the goals of feminist research to be realized (Bryman, 2008) and the in-depth face to face interview has become the paradigmatic feminist method (Kelly et al., 1994 cited in Bryman, 2008:463).

More specifically, semi-structured interviews were administered in this study comprising mostly of probing questions in order to get opportunity to discuss issues in more detail as they involve high level of flexibility and interactivity. I used in-depth semi-structured interviews because I wanted the women and men I interviewed to be able to express their ideas and their thoughts in their own way rather than my own words and ideas directing their thoughts. Descombe (1998) argues that semi-structured interviews involve a framework of questions or issues with considerable flexibility. Semi-structured interviews have a special place in feminist studies since they give much freedom for the interviewees to express their feelings (Makame, 2008:40).

To facilitate the process of interviewing, I prepared interview guides in two languages i.e in Kiswahili and English to allow flexibility among the interviewees. Majority of the respondents except two chose to be interviewed in English. Therefore parts of the responses presented in chapter six are my own translation. Two interview guides were prepared, one for each group of male and female students and another one for male and female teaching staff and administrators. Questions were carefully designed to provide adequate coverage for the

purpose of the research. In each personal and focus group interview, probes involved open-ended questions and occasionally close ended questions were used to elicit information from the informants. Patton (cited in Makame, 2008: 41) argues that Interview guides are essential in conducting focus group interviews for they keep the interactions ‘focused’ while allowing individual perspectives and experiences to emerge, they also help to carefully decide how best to use the limited time available.

The interviews were recorded using a voice recorder to secure an accurate account of the conversations and avoid losing data since not everything can be written down during interview. At the end of every interview, the conversation (voice) was automatically saved and labeled with a code number. This was useful in avoiding complications that may have arisen in mixing the voices since the same recorder was used for all three universities. The researcher further used note taking and assigned numbers to individual voices during focus group interviews. Note-taking was also used to capture some things like gestures, facial expressions, emotions which would otherwise be impossible using the voice recorder. At the end of each session, the researcher spent some time to review the notes in order to make sure important matters raised during the personal and focused group interview were noted.

4.4.1.1 Personal Interview

I conducted 12 personal interviews with male and female academic and administrative staff. All the administrative staff also had teaching positions within the respective universities. One female and two male administrators were interviewed from the three universities. The time spent on each interview varied a great deal. Interview sessions with teaching staff who are administrators took longer than interviews with teaching staff alone. The shortest interviews lasted 30 minutes while the longest lasted 60 minutes. Through the process of direct conversation and interaction with my respondents, the face to face interviews provided me with very rich information.

4.4.1.2 Focus Group Interview

Focus group interview was used in this study in order to gather information from female and male students concerning females’ participation in science in higher education. Patton (cited in Makame, 2008) argues that focus group interviews involve interaction where participants

get to hear each other's responses and make additional comments beyond their own original responses as they hear what other people have to say. Bryman (2008:487) supports Patton's argument by stating that focus group research is less artificial than any other methods because in emphasizing group interaction, it does not suffer from the problem of gleaming information in an unnatural situation and it successfully studies the individual within a social context. Bryman further argues that that focus groups method has considerable potential as a tool of feminist research as it may have a further role in allowing the voices of highly marginalized groups of women to surface.

I selected focus group interviews with male and female students because focus group interviews prompt interaction among participants making them comfortable and confident in responding to questions. It also stimulates the participants' to express their feelings, perceptions and experiences as a team that they would not otherwise express if interviewed individually (Patton, 1990). Sociologist and Feminist researcher Esther Madriz (cited in Patton, 2002:389) asserts that focus group allows access to research participants who may find one- to- one interaction scary or intimidating. It offers participants a safe environment where ideas, beliefs and attitudes can be shared in the company of people from the same gender, ethnic group e.t.c.

Six focus group interviews were conducted in the whole research, two in each university. The focus groups in each university consisted of five female members and five male members. The number of respondents in each focus group was selected based on the argument by Bryman (2004) that focus group interviews should involve at least four people.

4.4.2 Documentary Review

This technique was employed to gather relevant information from various documents. This was important to supplement as well as to compensate for the limitations of other methods. Yin (2003) emphasises that documentary evidence is an important source of data collection that can be used to fill out and confirm evidence from other sources. Similarly Merriam (1988:108) acknowledges the use of documents as data in qualitative research by stating the following:

The data found in documents can be used in the same manner as data from interviews or observations. The data can furnish descriptive information; verify emerging hypotheses, advance new categories and hypotheses, offer historical understanding, track change and developments.

Both primary and secondary sources of information were used. Primary sources comprised of policy documents and facts and figures booklets showing student and staff enrolment and employment records respectively. Secondary sources on the other hand consisted of derived information contained in text books, Journal articles, Newsletters, seminar and conference papers and reports that were related to the study. Documents were collected from libraries of various universities as well as from the internet source. The information that was extracted from these documents was used to provide background information which formed the chapter on review of related literature, insights on theoretical stances as well as in support of the empirical findings in the discussion chapter.

4.4.3 Purposive Sampling

Purposive sampling was used in this research as a sampling strategy. It focused on three levels; these were the universities, the students and the academic and administrative staff. The target universities were those which offered science programmes. Purposive sampling was used in order to study in depth a small number of selected male and female students and staff. A total of 15 female students and 15 male students (six focus groups) and 12 male and female faculty and administrators were purposefully selected so as to provide the in-depth information required.

The names of students to participate in the focus group interviews were determined with the help of the management. Students were drawn from a variety of science degree programmes. The names of staff were also determined by the help of management of each university through record based on their job responsibilities, position and involvement in the subject studied e.g in University A, I was directed to a female administrator who has written extensively on females and science education. Through interview, I obtained relevant information on the topic under study.

4.5 Validity and Reliability

In assessing and judging the quality of an empirical research, validity and reliability are used. In qualitative research, the term trustworthiness has been used by various authors to incorporate reliability and validity (Lincoln and Guba, 1985). In this study trustworthiness was maintained in the following ways.

In this study methodological triangulation as well as data triangulation was employed. Triangulation is the use of more than one method or source of data in the study of a social phenomenon so that findings may be cross checked (Bryman, 2008). The use of different methods (semi-structured personal and focus group interview, documentary review, field notes) to collect data provided me with access to various types of data.

Triangulating data sources provided me with the opportunity to cross check data and interpretation especially when different informants gave conflicting or contradicting information. The information derived from what interview respondents reported was cross checked against documents and other written evidence on womens' participation in science education. Triangulation is not meant to provide a single answer; rather it is meant to bring richness and diversity to a topic so that it is not reduced to a simplistic solution. In this case the use of quantitative and qualitative approaches in the same study helped to bring richness and diversity in the topic. Also the use of multiple case studies enhanced the accuracy of the results because more consistency results were found in the three universities (replication observed).

In establishing the chain of evidence (Yin, 2003), I made sure my thesis has made sufficient and relevant citations by collecting referential adequacy materials. Also the findings chapter shows the chain of evidence presented which is grounded in the empirical data. The chapter exhibits asserted testimonies.

In handling the data I also employed 'comprehensive date treatment (Silverman, 2000) in avoiding becoming a victim of what he calls anecdotalism. I incorporated views that contradict with the findings and generalization of the study to avoid damaging the validity of the study. This also helped me to avoid personal bias. To ensure credibility of my study, I used two months in gathering information prior to fieldwork and had data collection periods of at least two and a half weeks in each site. Using a good number of informants (N=42)

enabled me to get holistic views of the context. The use of fieldwork notes and audio recorded interviews ensured that complete records of all phases of the research process were kept in an accessible manner.

4.6 Data Analysis

Data analysis involves organizing what has been observed, heard and read to make sense of the acquired knowledge (Glesne and Peshkin, 1992 cited in Mhehe, 2002). According to them, in working with data we must create sensible explanations, pose hypotheses, develop theories and link our story to other stories. Patton (2002) simply defines qualitative analysis as a way of transforming data into findings. He explains that it involves reducing the volume of raw information, sifting trivia from significance, identifying significant patterns and constructing a framework for communicating the essence of what the data reveal.

Qualitative data were subjected to content analysis in order to extract relevant information. Descombe (1998) defines content analysis as a method which helps a researcher to analyze text in form of writing, sound or pictures, as a way of quantifying the contents of the text. Similarly Bryman (2008:275) defines content analysis as an approach to the analysis of documents and texts that seek to quantify content in terms of predetermined categories and in a systematic and replicable manner. I employed content analysis because this approach has the advantage of providing the means for quantifying the contents of a text through a method that is clear and repeatable by others.

I initially, transcribed in full all the audio recorded interviews from the three universities. The process of transcription was very time consuming as I had to replay some sequences recorded over and over again due to difficulties in hearing and understanding some of the English words which were said by students.

Following transcription, data coding was undertaken. In coding, I looked for topics in the data and then phrases (codes) were assigned to topics with the same pattern covered by the data collected. Coding categories provided the means of sorting descriptive data so that the materials bearing a particular topic could be separated. It was easy to arrange and rearrange the data in various groups or to locate a certain category or piece of information with this simple coding system. With themes outlined and emerging meaningful patterns delineated, it provided a frame for structuring the main study findings presented in chapter six.

As outlined above, both quantitative and qualitative approaches were employed in the study. The data generated from documentary review was quantified and organised in tables, counts, sums, and percentages for easy interpretation. In this case my data were well organised in such way that conclusion could be more easily drawn.

4.7 Ethical Considerations

The basic ethical principle governing data collection is that no harm should come to participants as a result of their participation in the study (Cohen et al., 2000; Keya et al., 1989). In order to assure the participants that they were not subjected to any harm, I considered the following ethical issues:

I deployed an informed consent by informing my participants beforehand about myself and the research I will be conducting. I provided explanations on the intention and significance of the study. This assisted participants to have clear understandings on the aims of the study and decide whether to take part in the study or not.

In order to ensure privacy among participants, data were registered by numbers rather than names. As a major ethical concern I assured interviewees that their responses will be kept confidential. More over I was extra careful probing into sensitive issues like sexual related matters as this was among the questions in the interview guide. Those issues that informants thought to be in their private realms and therefore they did not want to make public I did not push.

To gain access to the three chosen research institutions, a letter of introduction from the University of Oslo was presented in each university and permission sought was granted through either Directorates of Research (UDSM and OUT) or from individual constituent college (DUCE).

4.8 Limitations of the study

This study on women's participation in science education faced a methodological limitation in the sense that observation as a method of data collection in lecture classes in order to establish a pattern of what happens there was not possible. This was due to the fact that examinations were going on at DUCE and UDSM during the period of field work. Since OUT is a distance

and open learning institution, observation at the regional center was even much more difficult. Therefore only focus group interviews were conducted in the three universities.

This study focused on one country Tanzania and therefore broad generalizations from this study may not necessarily be made to other contexts.

I encountered difficulties while reviewing the position of girls and women in science globally because of the lack of systematically collected and published gender disaggregated statistics.

4.9 Chapter Summary

This chapter contains a description of the methodology part of the study. It covers selection of the research site, research design, sampling procedure, data collection techniques, validation of the instruments, data analysis and ethical considerations. Limitations to the study were also explored.

The study area was Dar-es-salaam region where all three universities under study are located. A case study design with the use of both quantitative and qualitative approaches was used because the researcher dealt with quantifiable data that cannot be easily analyzed in a narrative manner. The study used qualitative approach so as to collect in-depth information. To enhance the process of gathering qualitative information semi structured personal and focus group interviews were used. Documents were also collected from all three universities. To maintain validity and reliability of the study methodological triangulation as well as data triangulation was used. Sampling procedure employed was purposive sampling which involved 42 informants including 30 female and male students and 12 male and female faculty and administrators.

5 CONTEXTUAL ANALYSIS

Introduction

This chapter will provide the background information about Tanzania and its education system. Tanzania's higher education and a brief situation of the gender gap in higher education will also be given. An overview of the responses by the Tanzania government, NGOs and higher education institutions in addressing the problem of gender inequality will be presented.

5.1 Brief presentation of Tanzania

Tanzania is the largest of the East African countries which is bordered by Kenya and Uganda in the North, Rwanda, Burundi and DRC in the West, Malawi, Zambia and Mozambique in the South and Indian Ocean in the East. The United Republic of Tanzania was formed in 1964 after a merger between two states, the mainland Tanganyika and the island of Zanzibar. The island of Zanzibar is separated from the mainland by a 22-mile channel (Directorate International Trade, 2006).

Tanzania has a population of approximately 43.7 million (PRB, 2009), 51% women and 49% men respectively and an average of 945,087 square kilometers (364,900 sq miles) including islands of Mafia, Pemba and Zanzibar. Dodoma, located in the center of Tanzania is the official capital city although the government is operating from Dar-es-salaam which is the commercial capital. The country has 26 administrative regions of which 21 are in the mainland, 3 in Zanzibar and 2 in Pemba. Over 80% of the population live in the rural areas and are engaged in agricultural activities.

There are different languages used for communication in Tanzania. There are approximately 130 ethnic groups. Each ethnic group has its own language, but the national language is Swahili, a Bantu-based tongue with strong Arabic borrowings. Swahili and English are both official languages and Arabic is widely spoken in Zanzibar. Christianity and Islam are the main religions practiced by more than 90 percent of the population, but each has many different sects

Tanzania is a unitary republic based on multiparty parliamentary democracy where the president, members of parliament and local governments are elected through popular vote every five years. The President is the Head of State for a maximum of two terms in office. Zanzibar retains considerable autonomy over her internal affairs and has her own legislature (House of Representatives), judiciary (Chief Justice and Attorney General) and an executive (The President) that is streamlined into various ministries (Makame, 2008:7). This study was conducted in Tanzania mainland, in the city of Dar-es-salaam where all three universities are located.

5.2 The Tanzania (Mainland) Education System

The Ministry of Education and Vocational Training (MoEVT) is a government body responsible for providing education in Tanzania. To plan, coordinate and implement all educational plans, the ministry is guided by the Education Act No. 25 of 1978, the Education and Training Policy of 1995, Tanzania Development Vision 2025 and the National Strategy for Growth and Reduction of Poverty (NSGRP) (URT, 2005a). The Ministry consists of eight departments mainly: Office of the Chief Education Officer, Basic Education, Secondary Education, Teacher Education, Inspectors of Schools, Policy and Planning, Administration and Personnel, Vocational Training and Higher Education.

Tanzania has not changed its education structure over recent years. The education system in Tanzania comprises three levels namely, Basic or first level education which includes pre-primary, primary and non- formal adult education. The length of the pre-primary education is usually two years. The provision and management of pre-primary education rests with the government, individuals or private institutions. Pre-school teachers are required to undergo formal training before they can teach in pre-schools.

There are far more pre-primary institutions in urban areas than there are in rural areas. Enrolment in these schools is expected to increase steadily as more pre-school classes open on government primary school premises. Primary education lasts seven years which is concluded by the Primary School Leaving Examination (PSLE). There is no academic certificate for this examination; however the results of the PSLE are used for selecting primary school leavers for admission into secondary education.

Secondary or second level education includes Ordinary (O) and Advanced (A) level secondary schooling. The length of the lower secondary education is four years while that of upper secondary education is two years. The lower secondary includes Forms 1 – 4 and the upper one comprises form 5 and 6. The Lower and Upper secondary levels culminate into the national Certificate of Secondary Examination Certificate (CSEE) and Advanced Certificate of Secondary Education (ACSEE) respectively.

Finalists of the Lower secondary education who pass the CSEE qualify for admission into the Upper secondary education while finalists of the Upper secondary education who pass the ACSEE and obtain principal passes or subsidiary level passes will find admission into tertiary or higher learning institutions. Some of the finalists in the Lower and Upper secondary levels may join Teachers Training Colleges for Certificate or Diploma courses respectively. The colleges provide teacher education at diploma and Grade A levels. Diploma trainees are prepared to teach in secondary schools while Grade A trainees are earmarked to teach primary and pre-primary schools.

Tertiary or third level education includes programmes and courses offered in non-higher and higher education institutions. The length of programmes in higher education institutions can either be three, four or five years depending on the courses taken. The Departments of Higher Education and Technical Education which were under the Ministry of Science Technology and Higher Education (MSTHE) were moved to the Ministry of Education and Vocational Training (MoEVT) in February 2008. Kiswahili is the medium of instruction in primary schools while English is used as the medium of instruction in secondary schools and in post-secondary education.

5.3 Higher Education in Tanzania

The government of Tanzania defines tertiary education as all post secondary education (Benjamin and Dunrong, 2010). Higher education refers to an advanced diploma or a degree. The Government of Tanzania through its policies and strategies acknowledges the contribution of higher education and training for national development. Higher education in Tanzania is provided by universities, university colleges and several training colleges and institutes. Higher education is organized at two levels - non-university and university level. Non-university tertiary level institutions include those which offer up to three year courses

leading to an Advanced Diploma as the highest award possible while university level institutions include those which offer courses leading to the bachelor's degree and above.

A higher education institution is so identified by its mission, objectives and curricula orientation. The distinction between a higher and non-higher education institution is in the students' academic entry requirements, level and duration of courses offered, awards conferred and minimum academic and professional requirements of academic staff. These and related requirements, are normally validated by academic boards or committees for colleges of higher education or senates of universities against internationally accepted standards (URT, 2005b).

The public universities are semi autonomous and manage their own affairs under the Vice Chancellor, who is appointed in accordance to the charter establishing a particular university or university college. The Chancellor for public universities is appointed by the President of Tanzania. The running costs of the public universities are subsidized by the government. Private universities are also established under charters and are privately funded. The Charter and the Rules of the public and private universities in Tanzania have been put in place to make Tanzanian universities to perform more efficiently in their prime tasks of teaching, research and consultancy services (Mbwette, 2009:2). Universities and all higher learning institutions in Tanzania are eligible for material or financial assistance from the Tanzania Education Authority (TEA) Act No. 8 of 2001. Other higher learning institutions are supervised by the National Council for Technical Education (NACTE) Act No. 9 of 1997 while all universities are supervised by the Tanzania Commission for Universities Act No. 7 of 2005 (IAU, 2009:2).

It is worth noting that in the spirit of expanding opportunities for higher education, the number of higher education institutions in the country has grown from one institution at the time of independence in 1961 to 30 institutions by December, 2006 (Msolla, 2007:2). The number of Public Universities and University Colleges during that year was 11 while that of Private Universities and University Colleges was 19. By 2008 there were 21 private universities and university colleges making a total of 32 universities and university colleges. Private higher education came into being during the 1990s with the liberation of the economy. Many higher education institutions, mainly private, were established after 1996, that is in response to the government decision to liberalize the establishment, ownership and management of higher education institutions. The door was opened to this shift by the

National Education and Training Policy of 1995 which liberalized education delivery services at all levels including the higher education sub-sector. Existing public institutions have expanded their facilities and continue to introduce new programmes and courses (URT, 2005b).

Increasingly many countries across the world have devoted to establishing students loan schemes as viable projects not only for supporting students but also as one way of diversification of sources for financing higher education sub-sector (Rugambuka, 2008:4). In Tanzanian context, the government has been making efforts to assist the higher education students through grants and loans. The establishment of the Ministry of Higher Education, Science and Technology in 1992 that had a section dealing with students' loans and later the establishment of an independent body (HESLB) that exclusively administers and manages students' loans are among the efforts (ibid).

Thus the Higher Education Student's Loan Board (HESLB) is the main funding organ for Tanzanian students pursuing Advanced Diploma and Degree studies. The students' Loans Act No. 9 of 2004 that established the HESLB inaugurated on the 30th March 2005 and became operational in July 2005; identifies the major responsibilities of the Board as to disseminate loans to students pursuing advanced diploma and degree studies at accredited higher learning institutions in and outside the country; to find and mobilize all financial resources for the board, and recovery of the disbursed money.

5.4 Administrative structure of Tanzanian universities

Administration of each of the two universities and one university college will briefly be discussed in this section. All the three higher learning institutions under study are public universities and hence they are semi-autonomous. As mentioned above, Tanzania Commission for Universities (TCU) is the main supervisory authority of all universities in Tanzania. The HESLB is entrusted with the task of assisting, on a loan basis, needy students who secure admission in accredited higher learning institutions, but who have no economic power to pay for the costs of their education.

5.4.1 Open University of Tanzania

The Open University of Tanzania was the first distance and open learning teaching institution of post-secondary education in Tanzania offering degree courses through distance learning systems (Mhehe, 2002). The justification for the establishment of an open university in Tanzania was based on the importance of filling the gap left by the conventional universities in the country (Ministry of Education, 1990 cited in Mhehe, 2002:16). The Open University of Tanzania was the third government owned university to be established in Tanzania through the Act No. 17 of 1992 and the institution became operational a year later (Mbwette, 2009).

Since January 2007 OUT has been operating under the Open University of Tanzania Charter and Rules designed in line with foregoing universities Act. The Universities Act No.7 essentially gives more powers to manage the universities to the respective University Councils, leaving the Ministry of Education and Vocational Training with the responsibility for preparation and overseeing implementation of the policy and reviewing/updating the legal regimes accordingly (ibid). It is a fully fledged semi-autonomous and accredited public university which offers Certificates, Diplomas, First degree and Postgraduate qualifications.

In 1994 the university started with two faculties; Education and Arts and Social Sciences. Since then the university has expanded programs on an annual basis and as in May 2009, following curriculum review by some faculties and introduction of some new academic programmes, OUT offers 20 undergraduate degrees, 3 certificates, 3 Diplomas, 2 Postgraduate Diplomas, 20 Masters and 5 PhDs (Mbwette, 2009). To date, OUT is the only Tanzanian university that allows submission of its Ph.D theses in Kiswahili language thus depicting its relative openness and realism of its education. OUT has established twenty five Regional Centres that are supplemented by the three Coordinating Centres of Zanzibar, Pemba and Egerton University in Kenya.

The Open University of Tanzania is governed by the council which has 22 council members. University Council is a governing body which consists of members from the university, education officers, student representatives and others. The principal officers of the university are Chancellor, Vice chancellor and Deputy Vice Chancellors in descending order. The head of the OUT management team is the Vice Chancellor who is assisted by three Deputy Vice Chancellors.

OUT operates through the new organizational structure designed in line with the universities Act No. 7 of 2005, which is considered appropriate for facing the new challenges and ensuring effective exploitation of opportunities. The new corporate structure of positions has the Vice chancellor assisted by Deputy Vice Chancellor Academic, Deputy Vice Chancellor Resource Management and Deputy Vice Chancellor Regional Services. It is worth noting that there is no female in any of OUT's top administrative position mentioned above.

At the Faculty of Science, Technology and Environmental Studies where the research was conducted, the Dean of faculty is a male. However, you have few female members in the university council. Muhwezi (n.d:3) in his study of Top University Women Administrators/Managers reported that in OUT 0% women occupied top Management positions, academic staff had 18% women, 12.5% women were occupying position of Deans and Director of Institutes while the university had 33.3% women on its University Council and 29% women on the University Senate. This is evidence that universities continue to be male dominated enclaves having small percentages of women in top administrative positions. Lewis (cited in Morley et al., 2006) argues that even when women are physically present as staff and as students in higher education, they are often excluded from decision making, discussion and debate.

5.4.2 University of Dar-es-salaam

Prior to independence, Tanzania did not have a University. Students who sought university education during that time were forced to travel to other countries, notably Uganda and Kenya, but England and the United States were also possibilities. It was in 1961 that the first higher education institution in the country was established as a College of the University of London. In 1963, it became a constituent college of the University of East Africa, together with Makerere and Nairobi University Colleges. It was then known as University College of Dar-es-salaam. At that time, the guiding policies for higher education operations were less national and more regional in view of the three East African countries owning one university each (Mollel, 2005). The Ministry that was responsible for education is the one which coordinated higher education matters.

In 1970, it was decided to dissolve the University of East Africa, thus on 1 July 1970, through parliament Act No. 12 of 1970, the University College of Dar-es-salaam became an

independent national university today so called the University of Dar-es-salaam (Mkude et al.,2003). It was established to act as a centre where scientific research could advance the frontiers of knowledge as well as meeting the high level human resource needs of the country (ibid).

University of Dar-es-salaam offers academic programmes leading to the award of certificates, diplomas and degrees. A total of 4 certificates, 5 diplomas and 63 undergraduate programmes are offered at various academic units of the University (UDSM, 2010). There has been a steady increase in the number of students at the UDSM from 14 in 1961 to 18,266 (11,472 males and 6,794 females) undergraduate and non-degree in the 2007/08 academic year. Female students constitute 37.2% of all undergraduate students at UDSM. At the postgraduate level, Postgraduate diplomas, Masters degrees and PhD's are offered. Starting with only the Faculty of Law in 1961, the University has expanded considerably in terms of both disciplines and administrative units. The university fulfills its mission of teaching, research, consultancy and public service through 5 Schools, 2 Constituent Colleges and 3 Campus Colleges, 4 Institutes, 6 Centres, 4 Directorates and 5 Bureaus.

The university council is the principal policy making body of the university vested with powers to govern and control the university (UDSM, 2010). The university council consists of members from the university, permanent secretary of MoEVT, student representatives and others. Like in the Open University of Tanzania, no woman has ever been appointed as chairperson of the council. Out of the 21 members of the university council, only 5 members are females (UDSM, 2010). It is interesting to note that the current secretary to the council is a female.

The principal officers are Chancellor, Vice Chancellor and Deputy Vice Chancellors. The head of the university management team is the Vice Chancellor who is assisted by two Deputy Vice Chancellors namely for Academic and Administration. The Chancellor of the UDSM appoints the Vice Chancellor, Deputy Vice Chancellors, Principals, Deputy Principals of Campus Colleges, Deans of Schools and Directors of Institutes.

Female staffs are not observed in any of the three universities top most important administration positions. The few females observed are concentrated in low management positions while all senior positions are dominated by males. This female invisibility among university top decision makers indicates the presence of a gender segregation of very high

degree. UDSM (2006a: 9) observes that there is an unequal opportunity for women and men in the UDSM leadership positions both academic and administrative including the key policy making organs such as Senate and the Council and even in the student leadership ladder. The university top and middle management structures are generally dominated by men.

Observable data in 2006 showed that the university had one Vice Chancellor (M) , one Chief Academic Officer (M), one Chief Administrative Officer (M), 5 College Principals (M), 7 Directors of Administrative Directorates (1F, 6M), 16 Directors of Central Bureaus (3F, 13M), 84 Heads of Department (17F, 67M), 110 University Senators (14F, 96M), University Council (appointed members 4F, 25M) (UDSM, 2006:9). There is only one woman up to now who has served at a high position in the administrative structure of the UDSM. She served as a Chief Academic Officer for eight years starting in 1991 (Luhanga, 2009:2).

In the College of Natural and Applied Sciences (CONAS) where the research was conducted, the top management staff namely Principal, Associate Principal (Academic) and Associate Principal (Administration) all are males. Even the Heads of the eight departments (Botany, Chemistry, Geology, Mathematics, Molecular Biology and Biotechnology, Physics, Zoology and Wildlife Conservation, Aquatic Sciences and Fisheries) found within the college all are males except one. The female head of department is observed in the Botany department, a field which is regarded as a soft science.

5.4.3 Dar-es-salaam University College of Education

Dar-es-salaam University College of Education (DUCE) is a constituent college of the UDSM. It was established through the government Notice No. 202 published on 22nd July 2005, under section 55 (1) of the university of Dar-es-salaam Act No. 12 of 1970. The college was established to address the acute shortage of graduate teachers and experts in education sector in Tanzania especially in the science based disciplines as a result of the expansion of primary education enrolments through Primary Education Development Programme (PEDP) and the creation of the new secondary schools in turn through Secondary Education Development Programme (SEDP).

DUCE has a student enrolment of more than 3000 distributed across the Faculties of Science, Education and Humanities and Social Sciences. Programmes taught are Bachelors Degrees in a number of disciplines in these faculties (DUCE, 2010). The management committee consists

of Principal, Acting Deputy Principal (Academics), Deputy Principal (Planning, Finance and Administration) and Deans faculty of Science, Education and Humanities and Social Sciences. Women are again invisible in all the management positions aforementioned. However in the Faculty of Science, at the departmental level the head of the Mathematics and Informatics and Virtual Education are observed to be females while for the departments of Physics, Chemistry and Biological Sciences the heads are males. This is encouraging to see female figures in leadership positions even though they are concentrated at the lower levels of management as opposed to UDSM where 7 out of the 8 heads of departments are males.

5.5 Equity Concerns in Tanzania

Gender equity is an important agenda in higher education in Tanzania. UNESCO (2007) observes that even though women's participation in higher education in Tanzania is only 32%, it is rising rapidly. Prior to 1990, less than 10% of students in higher education were women (URT, 2004 cited in Benjamin and Dunroog, 2010). By 2001 women's participation rose to 23.7% and by 2004 had reached 29% (UNESCO, 2006a). Girls' participation in science and equity issues in education cannot be separated. Only if a girl had an opportunity for education could have access to science education. Ever since independence the question of equity has been central in Tanzanian policies. Tanzania has made several attempts at ensuring gender equity in society.

5.5.1 National policies addressing widening participation in higher education in Tanzania

In order to impact gender equity at various levels of education in Tanzania, strategic initiatives have been introduced. In addition to signing international and regional agreements related to women's rights, it has also developed a number of national policies.

The Constitution of the United Republic of Tanzania is built on the principles of equality before the law, based on the principles of human rights and it bans discrimination on whatever grounds (Onsongo, 2007; Meena, 1996).

Article XI (2) States that: "Every person has the right to self education, and every citizen shall be free to pursue education in a field of his choice up to the highest level according to his merits and ability" (URT, 1998:19).

The Arusha Declaration launched in 1967 placed equity issues at central position. The Arusha Declaration aimed at building a nation guided by fundamental principles of equity, respect for human dignity, democracy, work by all and exploitation by none (Nyerere, 1968 cited in Ngezi, 2005). It encouraged people's commitment to development with the words of freedom, development and self-reliance and education was realized as one of the solid paths to achieving development.

The Universal Primary Education (UPE) policy was enacted in 1974 and its implementation began in 1977. UPE resulted in compulsory enrolment of school age boys and girls which further resulted in primary school enrolment becoming slightly over 50% girls as per population demography (Masanja, 2003 cited in Lihamba et al., 2006). UPE did not affect enrolment in higher education directly until the Musoma Resolution of 1974 was introduced (ibid).

Musoma Resolution was the first affirmative action that resulted in the increase of female enrolment in higher education. The government made a deliberate exception for girls to ensure that those who qualified for entry to the university proceeded directly without the delay of a 2 year compulsory work period that their male colleagues had to adhere to. The reason of this initiative was to minimize possible drop out through marriages during the two years of work experience. As a result of the exemption, for the first time more females were able to enter the university directly from secondary schools.

In an attempt to address development challenges, Tanzania came up with its "Development Vision 2025" which among other things aims at achieving a high quality livelihood for its people as well as a well-educated and learning society. To attain this, universal primary education, the eradication of illiteracy and the attainment of a level of tertiary education and training, gender equality and the empowerment of women in all socio-economic and political relations and cultures are considered. In this light, the education system is restructured and transformed qualitatively, with a focus on promoting a science and technological culture from its lowest levels, giving a high standard education to all children between age of 6 - 15.

Basic sciences and mathematics are accorded great importance in keeping with the demands of the modern technological age without losing sight of the humanities. The vision emphasizes the need to ensure that science and technology education and their application for promoting and enhancing productivity permeate the whole society through continuous

learning and publicity campaigns. This vision identifies in a broad sense education as a national priority, however it does not stipulate specific strategies on how to pursue the targets.

The National Strategy for Growth and Reduction of Poverty (NSGRP) (2005) known as the 'MKUKUTA' the Kiswahili acronym, is a development from an earlier Poverty Reduction Strategy Paper (PRSP) released in 2000. It outlines the government's strategies to ensure equitable access to quality primary and secondary education for boys and girls and universal literacy among women and men. The strategy also stresses the expansion of higher, technical and vocational education.

5.5.2 National higher education policies

Higher education and training in Tanzania is influenced by several policy frameworks and plans. Apart from the Tanzania Development Vision 2025 and related Poverty Reduction Strategy Paper, the other major relevant policy documents include the Education and Training Policy (1995), National Science and Technology Policy (URT, 1996) and the National Higher Education Policy (URT, 1999).

The Education and Training Policy (1995) is gender sensitive in that it has put promotion of girls' education as one of its major goals. The main policy thrust of the ETP is to support girls' boarding and hostel facilities, review curriculum in order to strengthen and encourage participation and achievement of girls in mathematics and science subjects and eliminate gender stereotyping through the curricula, textbooks and classroom practices.

The first National Science and Technology policy was enacted in 1985 and revised in 1996. One of the thrust of this policy has been to promote active participation of women in Science and Technology. The realization of the objective above depends on more female access to education at higher levels. Accessibility to higher education is dependent upon female students' enrolment at lower levels. Among the strategies put in place include the encouraging of girls to study science subjects in Secondary Schools so that there can be a pool of drawing females to join higher education science courses.

The Tanzania National Higher Education Policy published in 1999, observes that higher education in Tanzania is constrained by a number of factors including imbalances in student enrolment with more students enrolling in humanities and social sciences programmes as

opposed to science and technology-based programmes, high running costs, limited space, deteriorating infrastructure and facilities and curricula that do not adequately focus on the demands and priorities of the society (URT, 2005b). Among other things, it is aimed at correcting the gender imbalance in enrolments and improving female participation rates in Science, Mathematics and Technology (URT, 1999:5). To address this problem a number of strategies have been proposed as listed below:

- Encouraging through the Ministry responsible for Secondary Education, increased annual pupil intake into science subjects at secondary school levels, by providing attractive training and employment packages.
- Admitting into universities and the allied non-university institutions of higher education increasingly bigger students numbers into science and technology based programmes.
- Expanding physical and pedagogical facilities (e.g laboratories, scientific equipment, chemicals) within the science based faculties, departments and schools.

Implementation of the strategies above has been realized in higher education even though not to a greater extent. Affirmative action programmes in higher education have been implemented allowing an expansion of female participation in science education. These affirmative measures will be discussed in the next section.

Cost sharing is also enshrined in the National Higher Education Policy (1999) which aims at shifting the shouldering of higher education costs from the government to beneficiaries. Johnstone (cited in Rugambuka, 2008:14) explains that cost sharing has been used in higher education to refer to the shift of the burden of costs for higher education from exclusively being borne by the governments or taxpayers, to being shared with parents and students and/or donors. As a development of the cost sharing policy, Higher Education Students' Loans Board was instituted by the government to provide loans to all eligible students.

It is worth noting that from the year 2005/06 the government set an additional criterion for securing loans, to include those female students with a science specialization and had achieved a Division 2 grade in the final form six (Advanced Level) examinations (HESLB, 2006). This is in recognition of the science gender gap that exists in higher learning institutions. Women are favored by the Higher Education Student's Loan Board (HESLB).

Admitted female students with divisions I and II are directly entitled to the loan while males must have division I (Makame, 2008:16). Generally, in support of the views of Lihamba et al., (2006) I also argue that these policies have to some extent reduced the gap between the thinking and the practice of gender in Tanzania, even though much still needs to be done in realizing satisfactory equity level. I argue that gender sensitive policies (e.g. on equity in enrolment) may have no impact unless concerted efforts to increase female entry in High School science subjects are made.

5.5.3 Strategies adopted by universities selected to reduce gender imbalance in higher education

Most institutions in Tanzania have been taking steps to improve female participation in universities. Statistics by the Ministry of Science, Technology and Higher Learning Institutions indicates that out of 23,348 total students enrolled in both public and private universities in the year 2002/2003, only 7704 of them were females. Females' enrolment is smaller than males, whereby males exceeds females by almost 50 percent (Lwinda, 2009).

This is clear evidence that reveals an imbalance between males and females in higher learning institutions. The University of Dar-es-salaam has put in place several affirmative actions to increase the number of female students. The following discussion focuses on the interventions which were established since 1996/97 academic year. Since DUCE is a constituent college of the university of Dar-es-salaam, the same discussion below also focuses on the college.

5.5.3.1 Gender Dimension Programme Committee (GDPC)

Gender mainstreaming at UDSM is implemented as an integral policy strategy for promoting equal opportunities. Efforts towards institutionalizing gender issues at UDSM led to the formation of the Gender Dimension Programme Committee (GDPC) in 1997. This programme operating since 1998 was established at UDSM to help reduce excessive gender imbalance and address other relevant gender aspects related to students.

It has the main objective of maintaining the lower cut-off point policy for female students, manage scholarship programmes and support Pre-entry programmes, also deal with matters of sexual harassment, mainstreaming gender issues in the curricular of all faculties at UDSM as well as providing counselling services to handle gender based psychological pressures within

the first year. Counselling centers have been established by GDPC on all campuses of the university. Mbilinyi (2000:29) explains that GDPC has carried out sensitisation programmes with top management of the entire university, with full support of the Vice Chancellor. GDPC also provides gender sensitisation module during the first year student orientation. All the first year students receive gender training by means of weekend workshops. The leadership of the student organisation has received gender sensitization in past years and will continue to do so.

Some of the key achievements of mainstreaming gender issues at UDSM have been the establishment of the UDSM Gender Centre in 2006 by the university council and putting in place the UDSM Gender Policy (2006a) and UDSM Anti Sexual Harassment Policy (2006b). The University of Dar-es-salaam Gender Policy represents an attempt to redress the historical gender imbalances that have placed women in a disadvantaged position in accessing, benefiting and getting fair treatment. The policy recognises that enrolment of women is lowest in the natural science based disciplines and Policy Statement (2.2.2) states that:

UDSM shall continue to rectify the historical imbalance through the adoption of affirmative action (p. 7).

Strategies which have been put in place include continuing with the affirmative action efforts such as pre-entry, lowering of cut off points for female students and also introducing empowerment programmes targeting female students to enhance their self esteem and confidence. It is interesting to note that among the strategies put in place, gender sensitisation programmes for male students to empower them to handle empowered female students is also included. This shows that the policy is equally gender sensitive for both males and females. Policy statement 2.5.2 states that:

UDSM shall institute gender responsive structures and processes by putting in place mechanism for increased women participation (at least 30% as per institutional policy) in governance and management processes but with a long term goal of attaining the 50/50 percent for both women and men (staff and students) (p.10).

One of the set strategies in this statement has been the target of reaching at least 50% females of top leadership positions, heads of department and student leadership by the year 2010.

The Anti Sexual Harassment policy was initiated by the university of Dar-es-salaam through Gender Dimension Programme Committee after realising the need for institutionalising

efforts to address acts of sexual harassment that were taking place at UDSM. The objectives of the sexual harassment policy among others include eliminating incidents of harassment, preventing sexual harassment, remedying sexual harassment situations and providing methods for dealing with individuals who harass (URT, 2006b:4).

A study carried out by GDPC indicated that there were explicitly and implicitly glaring forms of harassment among students, academic and administrative staff. In July 2003 GDPC rated sexual harassment as the number one gender issue that faced the university population (UDSM, 2006b). This coincides with a study of Kenya and South Africa by Omale (2002), where she identified sexual harassment as a key factor in blocking women's participation in higher education. She links this to the hierarchical power relations in the universities where women lack institutional power to challenge male abuse and harassment. She further argues that students believe such acts occur but yet remain unreported because of fear of embarrassment, fear of retaliation and lack of assertiveness.

5.5.3.2 Preferential Admission Criteria (PAC)

PAC was an intervention for female students which had the broader objective of facilitating the admission of qualified female applicants but with the grades and matriculation points lower than those of male applicants. This was effected in all faculties at UDSM. This means that the female candidates are admitted at up to 1.0 or 1.5 points lower than the university entry points. The decision on a cut-off point is made by individual departments. The use of PAC depends on the number of applicants in each year as well as the level of performances in relation to UDSM's minimum entry qualifications. FAWE (2001) explains that after even lowering the cut-off points, very few or no females qualified for entry specifically in the Faculty of Science. That is why the PEP discussed below was introduced to allow more female participation in university education.

Lihamba et al. (2006) mention that, the impact resulting from lowering the cut-off points below the set cut-off point resulted in the percentage increase of females, for example in 2000/01 admissions, there was an increase from 13% to 51% in Arts, 28% to 48% in Law, 12% to 25% in Education (Arts) and from 8% to 25% in Medicine. These admission-related strategies have indeed to some extent succeeded in effecting concrete steps to address the low enrolment of female students at UDSM.

5.5.3 Pre- Entry Programme for Female Science Students (PEP)

The PEP which was launched in 1997 at UDSM and in 2006 at DUCE when enrolments commenced, has been ongoing until 2008 when it was decided there is no need for it anymore because the entrance qualification has been lowered to two principal passes for women, which gives room for anybody who qualifies to join the university. The objective of PEP has been to increase the number of female students in Science disciplines and thus increase the number of A-level Science subject teachers in the country (Lihamba et al., 2006).

This programme was later expanded to include those who wanted to enter Engineering, Economics and Statistics programme. This programme worked in preparing female students who qualify for university admission, but lack specific admission points necessary for pursuing courses in their respective faculties. To gain these points and secure admission, a six weeks remedial course was run each year and those who pass the post remedial examinations gained university entry. The first cohort of the pre-entry programme graduated at the end of the academic year 2000/01.

A survey of the performance of the students admitted under this programme showed that they performed very well in their academic work. In the 1999/2000 third year B.Sc (Ed) programme, in the Chemistry and Biology subject combination among the top 20 student 13 were females students admitted through this programme (FAWE, 2001:20). The best Physics student in that same batch was a PEP female student. This shows that the programme has borne visible fruits. These results negate the widely held and deep rooted belief that female students are inherently incapable of attaining high levels of Science, Mathematics and Technology. In general at some instances their performance is better than that of their peer (boys and girls) who entered with much higher passes. Based on enrolments, PEP increased the proportion of female students from 15% to about 30% in the year 2003 (Faculty of Science, 2001 cited in Nawe, 2002).

There is a need to note that there has been an improvement in the natural sciences especially in Engineering where the proportion of female students rose from a low 7% (2003/04) to 21.2% in 2005/06. From 1997 to 2004 these PEP programmes have been able to facilitate the enrolment of 486 female students (Lihamba et al., 2006). The funding of PEP has been from various agencies, example the first cohort was by the Dutch government under the Teacher Education Assistance in Mathematics and Science (TEAMS). The Forum for African Women

Educationalists (FAWE) and Gender Dimension Programme Committee (GDPC) funded the second, third and fourth cohorts. As mentioned earlier, in 2009/ 2010 this initiative that aimed at increasing the number of female enrolment in Science has entrenched a new transformation to the university. This is clearly seen with the university's management decision to adopt the admission criteria which have been used to females applying for pre-entry programme to be official criteria for all those female students applying for science degree programmes.

5.5.3.4 Special Scholarships

The Female Undergraduate Scholarships Programme (FUSP) was introduced when it was realised that the 1.0 or 1.5 scheme on its own was inadequate in terms of enhancing women's access to university education. The programme conceived and managed by the University Gender Programme targeted female students particularly those from disadvantaged families and those in specialities that are highly marked with the imbalance more especially the hard science. This programme gave an opportunity to 356 female students to be enrolled in different faculties and colleges since 2001, who would otherwise not get an opportunity for university level education. These scholarships were awarded through the financial assistance of the Carnegie Corporation of New York.

OUT currently does not have its own written gender policy and sexual harassment policy even though the institution formulated strategies ensuring policy and measures for promoting female enrolment to be in place by June, 2008 (OUT, 2007:3). Other strategies formulated by OUT include increasing the proportion of female staff in the OUT top management to 30% by June, 2008, increasing proportion of female students enrolment to 40% by June, 2010, and also increasing proportion of female staff to 35% by June, 2011 (ibid). Remarks of the Vice Chancellor of OUT (2007) at the official opening of the Gender Awareness Seminar for academic staff recognized the lack of a comprehensive institutional gender dimension policy and sexual harassment policy.

5.6 Chapter Summary

This section reviewed efforts which have been taken by the government, institutions and various groups to ensure gender equity in education provision in Tanzania. Observations on strategies adopted by the government, NGOs and universities to reduce gender imbalance in education including science education showed positive achievements. For example, UDSM adopted the strategy of encouraging women participation in science through various affirmative action programmes and activities. Also the university is committed to institutionalizing gender equity making its gender policy and sexual harassment policy one of the very first in Tanzanian universities. The gender programme of the university through the financial assistance of NGOs has also awarded scholarship to female students especially in the sciences. Despite all these efforts women's participation in science lags behind that of men. On the side of staff few female lecturers and administrators are still observed. Some of the strategies that should be adopted to help encourage more women in science is by giving appointment to more female lecturers and this will in turn encourage more female participation as they will also serve as role models for female students.

The successes achieved through affirmative actions are easier to be established using quantitative indicators for example by looking at the number of students who have benefited from such action programmes or by looking at the number of staff who are currently in management positions. But the assessment of the qualitative aspect such as changes in the institutional cultures and behaviors in order to appreciate gender equity are more difficult to be established as there are no qualitative indicators for such measurement. Hence a study to explore what could be done further is necessary.

6 STATISTICAL SITUATION OF WOMEN TAKING SCIENCE FIELDS IN TANZANIA (MAINLAND) UNIVERSITIES

Introduction

This chapter brings into discussion statistical data illustrating the quantitative differences between males and females. I will present quantitative evidence documenting how women's entry into science at the undergraduate level and university departments differs from men's. In order to determine the level of participation of women in science in the three universities selected, the enrolment figures were collected from individual universities.

6.1 Participation of female students in Tanzanian universities

In this section I examine female students' participation in science education for each of the three universities under study. I will examine the enrolment trend between the years 1997/1998 and 2004/2005 and also discuss the distribution of males and females in various fields of study. Enrolments by subject specialization will also be presented. I have chosen B.Sc. with Education as a reference point to examine the distribution of females and males within subjects of choice because B.Sc. Education includes many subject combinations.

6.1.1 Undergraduate students' participation in science fields at the University of Dar-es-salaam

Table 1: Undergraduate Students Total Enrolment by Gender and Academic Year

Year	Male	Female	Total	% Male	%Female
1997/1998	215	81	296	72.6	27.4
1998/1999	205	77	282	72.7	27.3
1999/2000	250	78	328	76.2	23.8
2000/2001	282	93	375	75.2	24.8
2001/2002	256	135	391	65.5	34.5
2002/2003	300	109	409	73.3	26.7
2003/2004	281	105	386	72.8	27.2
2004/2005	338	63	401	84.3	15.7

Source: Field data, 2009

The statistical data reveals that gender gap exists and females lag behind male students in enrolments. The science gender gap in the faculty of science is in such a way that male student make 65% and above of the total enrolments within the eight years period while females do not exceed 35%. This enrolment is a reflection of what takes place in other universities in the country. The table indicates a decreasing enrolment trend for females from the year 1997/1998 to 1999/2000. Thereafter it reflects a marked improvement in female enrolment in the year 2001/2002 then followed by fluctuating enrolments in the remaining three years from 2002/2003 to 2004/2005. In all the eight academic years, 2001/2002 had the highest enrolment for females (34.5%) while 2004/2005 had the lowest enrolment (15.7%).

Table 2: Female Enrolment as Percentage of Total Enrolment by Degree Programme and Academic Year

Degree	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05
B.Sc. General	27.3	42.6	34.1	41.2	58.2	43.7	34.8	17.6
B.Sc. In Computer	0	4.5	14.3	10.5	11.9	22.4	20.8	20.3
B.Sc. with Computer	4	25	10	24.2	22.2	22.9	37.8	10.8
B.Sc. Electronics	4.8	10.5	4.8	3.9	13.8	18.5	5.7	9.1
B.Sc. Education	44.9	31.9	28.2	24.4	36.5	27.9	27.3	36.7
B.Sc. In Geology	0	7.1	10	16.7	9.1	7.7	6.3	7.1
B.Sc. with Geology	-	-	-	-	41.4	16.3	16.7	10
B.Sc. Molecular Biology	-	-	-	-	-	-	42.9	23.8
B.Sc. Wildlife Science	-	-	-	-	-	-	54.3	18.6
B.Sc. Engineering Geology	-	-	-	-	-	-	0	0
B.Sc. Aquatic Science	-	-	-	-	-	-	-	38.1
B.Sc. Fisheries	-	-	-	-	-	-	-	10

Source: Field data, 2009

UDSM being the biggest and oldest university in Tanzania offers many fields of specialization in the Faculty of Science (currently College of Natural and Applied Sciences, CONAS). Some of the degree programs presented from 1997/1998 to 2004/2005 are currently no longer offered by CONAS (inaugurated in 2009) as they have been moved to other colleges within the campus. B.Sc. in Computer, B.Sc. with Computer and B.Sc. in Electronics which appear above are now offered by the School of Informatics and Communication Technologies (SICT). Two fields of specialization that are offered by UDSM are also offered by OUT and DUCE. These are B.Sc. with Education and B.Sc. General

Enrolments in the science field at the University of Dar-es-salaam, show a lot of variation between 1997/1998 and 2004/2005. The data reveals that gender gap in the science fields exist with females lagging behind males in almost all degree programmes. The gap exists in the sense that in the period of eight years, male students make up 50% and above of total enrolments while females do not exceed even 45%. However it is worth noting that in 2001/2002 and 2003/2004 males were lagging behind females in B.Sc. General and B.Sc. in Wildlife Science respectively. According to the figures above, in those two specific years female enrolment in B.Sc. General and B.Sc. in Wildlife Science was 58.2% and 54.3% respectively while males remain with 41.8% and 45.7%.

The science gender gap shows some fluctuations between years. For example female enrolment in B.Sc. Education in 1997/1998 the proportion was 44.9%, but the following three years there was a fall to 31.9%, 28.2% and 24.4%. Then it increased again in 2001/2002 to 36.5% but the following two years there was a fall to 27.9% and 27.3% while in the eighth year the enrolment rose again to 36.7%.

B.Sc. with Education is the second female favourite study after B.Sc. General whereby in 1997/1998 females accounted 44.9%, the highest enrolment in the entire B.Sc. Education programme within the eight years. This high enrolment for that particular year can be explained by the introduction of Pre-Entry Programme for female science students (PEP) which was discussed under chapter 5.

The PEP programme commenced in 1997 whereby all female students were admitted into B.Sc. with Education degree programme. PEP was later extended to include students in other fields of studies other than education. It appears that among all the Degree programmes, Geology is the most affected with no female enrolment in 1997/1998, 2003/2004 and 2004/2005. In 1997/1998 there were also no females enrolled in B.Sc. with Computer.

Reasons behind this discrepancy might be due to the component of mathematics which is involved in both Computer science and Geology. Geology is an interdisciplinary science which consists of subjects like Chemistry, Physics and all of these are math related. In chapter seven, some of the interviewees explained that mathematics is the worst taught subject in Tanzania and it becomes difficult for students to approach it in higher levels if they didn't have a good background in lower levels. So females automatically do not enroll in those fields which involve intense mathematics as they perceive them difficult.

Table 3: Female and Male Enrolment as Percentage of Total Enrolment by Subject Specialization and Gender 2006-2009

Subject Specialization	%Male	%Female
Biology and Chemistry	64.0	36.0
Physics and Mathematics	83.1	16.9
Biology and Geography	44.8	55.2
Chemistry and Mathematics	74.0	26.0
Physics and Chemistry	77.1	22.9

Source: Field data, 2009

As shown from Table 3, males outnumber females in all subject specializations except Biology/ Geography combination. It was mentioned by some interviewees in chapter 7 that females prefer science subjects which do not involve a lot of Mathematical computation. One respondent explained that females prefer subject combinations involving Biology because many of the things studied are found within their vicinity.

Secondly according to my respondents as discussed in chapter 7, women prefer biological sciences because of the simplicity of the subjects and hence easy to pass examinations. From the above observation it clearly proves what was mentioned as you have more females in Biology and Geography (55.2) and Biology and Chemistry (36.0%) subject combinations than in other fields which involve either Mathematics or Physics. Physics and Mathematics combination is the least favoured by females at UDSM as the percentage point is only 16.9. Respondents in chapter seven explained that Physics, Chemistry and Mathematics are traditionally viewed as male dominated specializations hence women think it is difficult to perform well. Keller (cited in Makame, 2008:12) notes that people believe hard is masculine and soft is feminine. Since these subjects are hard they are considered to be for men.

6.1.2 Undergraduate students' participation in science fields at Dar-es-salaam University College of Education

DUCE is a constituent college of the UDSM offering education degree programmes only. B.Sc. with Education is the only programme offered at the Faculty of Science,

Table 4: Undergraduate Students Total Enrolment by Gender and Academic Year

Year	Male	Female	Total	% Male	%Female
2006/2007	92	79	171	53.8	46.2
2007/2008	51	46	97	52.6	47.4
2008/2009	44	33	77	57.1	42.9

Source: Field Data, 2009

The Faculty of Science at DUCE offers one degree program, so the enrolment data is for B.Sc. with Education Degree program only. In year 1997/1998 to 2004/2005 data are not presented because student admission commenced in 2006 even though the University College officially started in 2005.

From the above data it is evident that there exists a science gender gap between males and females in all the three years. There had been a considerably increase in enrolment from 2006/2007 to 2007/2008 (46.2% to 47.4%), however the year 2008/2009 the female enrolment fell for about 4.5 percentage points. The percentage difference in enrolment between males and females in the three years is 7.6% for 2006/2007, 5.2% for 2007/2008 and 14.2% in 2008/2009.

From this observation it is clear that the proportion of females has been fluctuating from the year 2006 when student admission commenced at the university college, to the year 2009. However it is worth noting that even though the gender gap exists, the percentage difference between the two genders is neither below 5% nor above 15%. This range is considered slightly low as compared to the other two universities where the data show a huge gender disparity in enrolment of science students.

Table 5: Female and Male Enrolment as Percentage of Total Enrolment by Subject Specialization and Gender 2006-2009

Subject Specialization	%Male	%Female
Biology and Chemistry	50.5	49.5
Physics and Mathematics	45.2	54.7
Biology and Geography	81.7	18.3
Chemistry and Mathematics	23.3	76.7
Physics and Chemistry	50.0	50.0

Source: Field data, 2009.

The figures in Table 5 demonstrate the opposite of what was observed at UDSM whereby you have the least number of females (18.3 %) in Biology/ Geography subject combination. Chemistry/ Mathematics combination has the highest female enrolment (76.7%) followed by Physics/ Mathematics (54.7%). While Physics/ Mathematics is considered the least favourite at UDSM, the opposite is observed at DUCE where gender parity was reached with 50% males and 50% females.

6.1.3 Undergraduate students' participation in science fields at Open University of Tanzania

Table 6: Undergraduate Students Total Enrolment by Gender and Academic Year

Year	Male	Female	Total	% Male	%Female
1997	101	15	116	87.1	12.9
1998	126	24	150	84.0	16.0
1999	94	17	111	84.7	15.3
2000	137	39	176	77.8	22.2
2001	204	33	237	86.1	13.9
2002	176	38	214	82.2	17.8
2003	165	40	205	80.5	19.5
2004	213	70	283	75.3	24.7

Source: Derived from the Open University of Tanzania Facts and Figures 1994-2009.

It should be noted that the enrolment figures above are from twenty two regional centers and four coordinating centers spread throughout the United Republic of Tanzania and beyond her borders. It was not easy to get data from one specific regional centre.

The figures in table 6 demonstrate that there is serious gender imbalance in female student enrolment into the Faculty of science. The gender differences in science education at OUT are so persistent that they might not self-correct in the foreseeable future as the female student enrolments keep fluctuating. In 1997 female enrolment increased by 3.1 percentage points which dropped again in 1999 to 0.7 percentage points. The year 2000 was a year of success as enrolment rose by 6.9 percentage points. The following year the enrollment dropped by 8.3 percentage points and continued to increase by 3.9, 1.7 and 5.2 percentage points for the rest of the three years from 2002 to 2004 respectively.

Female enrolment in this particular university shows less sign of improvement because it proves a widest gender gap between male and female students when compared with the other two universities. Why then is this the case in this particular university? The answer to this question refers to the respondents views given in chapter 7. On top of the respondents' views, issues concerning distance and open learning play a role.

Mhehe (2002) conducted a study on Women's Enrolment and Participation Issues at the Open University of Tanzania. She found out that women experienced institutional barriers and socio-cultural barriers in enrolling with OUT. With institutional barriers, She found out two major reasons as to why so few women enroll with OUT. First, she explains the organization itself how it is underfunded and unable to adequately publicize its programs such that women, especially those in the more rural areas do not know that OUT is available for them. Second, she explains about how the present publicity at OUT focuses on inviting people to apply and then advising successful applicants of the orientation session but with little information explaining what distance education is or how it works and what it requires from students. According to her, women enroll and go up to the first session but many drop out soon after because they are unable to understand the system.

She further found out that financial constraints coupled with fear of the distance education discouraged some females from enrolling with OUT. She elaborates what the respondents said in the interviewees by arguing that, both women and men are used to the traditional system of education where there is a teacher physically teaching the class. She explains that

many potential students of OUT especially the women do not trust themselves that they can study on their own and pass examinations. There must be someone physically teaching in order for the learners to trust their own abilities to study effectively. She also asserts that the major problem for students is lack of confidence especially for women students because most Tanzanian women are not brought up with much academic work where they have to study on their own (p.70).

Table 7: Female Enrolment as Percentage of Total Enrolment by Degree Programme and Academic Year

Degree	1997	1998	1999	2000	2001	2002	2003	2004
B.Sc. General	10.0	11.5	14.5	22.7	14.2	18.0	21.8	29.6
B.Sc. Education	17.4	22.2	16.1	21.2	13.6	17.5	16.3	17.5

Source: The Open University of Tanzania Facts and Figures 1994-2009

OUT is a distance and open learning institution. In the year 1997 to 2004 it had only two science fields being offered (B.Sc. General and B.Sc. with Education) but later admissions were extended to include B.Sc. Information and Communication Technology and B.Sc. Environmental Studies. From Table 7 it is observed that in the year 1997 to 2000 there was an increase in enrolment by 12.7 percentage points for B.Sc.General degree programme. However, in 2001 the proportion of females fell by 8.5 percentage points. From 2002 to 2004 enrolment rose again by 11.6 percentage points. Lowest (10%) enrolment rate was observed in 1997 while highest (29.6 %) was observed in 2004. Similar fluctuating trends have also been observed in B.Sc.with Education field with highest enrolment in 1998 and lowest in 1999. It is evident from Table 7 that there is no much difference in enrolment between B.Sc. General and B.Sc. with Education among females. A difference of 0.5 percentage points is observed between the two fields. It appears that at OUT both fields are preferred by females even though males continue to lead enrolment wise.

6.1.4 Enrolment comparison between the three universities

The student enrolment level under consideration is level 5A. According to International Standard Classification of Education (ISCED 1997), level 5A programmes are tertiary programmes that are largely theoretically based and are designed to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skill requirements (UNESCO, 2006b).

The total number of students shown in Table 8 from 1997/1998 to 2004/2005 comprise of only two universities since Dar-es-salaam University College of Education started enrolling female students in 2005/ 2006 year of study (see Table 4).

Table 8: University of Dar-es-salaam and Open University of Tanzania total undergraduate enrolments, 1997 to 2004.

Year	Male	Female	Total	% Male	% Female
1997/1998	316	96	412	76.7	23.3
1998/1999	331	101	432	76.6	23.4
1999/2000	344	95	439	78.4	21.6
2000/2001	419	132	551	76.0	24.0
2001/2002	460	168	628	73.2	26.8
2002/2003	476	147	623	76.4	23.6
2003/2004	446	145	591	75.5	24.5
2004/2005	551	133	684	80.6	19.4

Source: Derived from tables 1 and 6 above

The figures in Table 8 portray a fluctuating enrolment trend from the year 1997/1998 to 2004/2005. Enrolment of female students decreased from 23.3% in 1997/1998 to 23.4% in 1998/1999. This means enrolment decreased by 0.1 percentage points. In 1998/1999 to 1999/2000 there was another decrease but this time it was of 1.8 percentage points. The following two years there was a slight increase of 2.4 and 2.8 percentage points. However, for the remaining three years from 2002/2003 to 2004/2005 a considerable decrease was observed of 3.2, 0.9 and 5.1 percentage points respectively.

In 2001/2002 the proportion of females noticeably increased by 2.8% which is the outstanding increase of all the years presented. Also the table illustrates that for the period of eight years female undergraduate enrolment in science has been somewhere between 19 and 27 percent while for males it has been between 73 and 81 percent. All in all, it is evident that there exists a science gender gap in the two universities where female students are outnumbered by male students in each consecutive year. The enrolments of females have never exceeded 27% of total enrolments for all the years in a row while male enrolments have gone as far as in the range of 80%.

From Table 1, 4 and 6 it is observed that in all three universities males outnumber females in enrolment. The science gender gap is more prominent at OUT with undergraduate enrolment somewhere between 12 and 23 percent in the eight years. UDSM is in the middle with female undergraduate enrolment somewhere between 15 and 35 percent in the eight years while DUCE has the least science gender gap with female undergraduate enrolment ranging between 43 and 48 percent in the three years.

Reasons behind the success of DUCE might be the provision of education courses since teaching is believed to be among females' favourite profession. Adler et al., (cited in Makame, 2008) comments that teaching profession is regarded as an acceptable job for women and one that fits with women's other roles. Davies (cited in Makame, 2008:55) argues that, women prefer teaching profession to the extent that some sociologists classify teaching as 'semi-profession' because it has large number of females, hence apparently lowering its status. Kwesiga (cited in Makame, 2008:61) contends that women's preference to education courses hence teaching profession is a result of stereotypes within societies which create male or female subjects so that even when options are offered students are likely to choose subjects which are identified with their own sex. He explains that women as children bearers and main actors in the field of domestic labour they feel that they should study and work in feminine fields, thus women prefer subjects that will prepare them to take caring jobs. They are believed to relate education in what they do in homes with their children.

Antonucci (cited in Makame, 2008: 62) highlights that education, domestic housecleaning, nursing and the like was one of the earliest fields to become readily accessible to women. This might also be another reason why women prefer education since women are believed to learn what a society wishes them to learn or that women accept whatever a society offers them. Antonucci suggests that in order for women to have more academic choices and

become as career-oriented as males they need female role models and some degree of re-socialisation.

Also the minimal success might be explained by the introduction of Pre- Entry Programme for female science students (PEP) whereby almost three quarter of females enrolled in the faculty of science at DUCE qualified through this programme. The remaining quarter of female students joined the university under normal qualifications competing equally with males.

If education is regarded as one among females' favourite profession, then why few females are still enrolled at this university as compared to males? The answer to this question referring to the respondents in chapter 7 might be: 1) The lack of encouragement and support from families, the society and the government about females' education in science fields, Also 2) Lack of motivation and role models during lower levels of education who can inspire and motivate the girls to participate in science education.

It is also worth noting that although UDSM has many science degree programmes offered, it still ranks second in enrolment while DUCE with only one degree programme ranks first in enrolments. OUT had only two degree programmes offered in the eight years but still ranked third in enrolment. From this observation it is clear that having more or less degree programmes in the Faculty is not a determinant of high female enrolment rates in science. There are many factors that militate against few females taking science education in Tanzania universities as discussed in chapter seven. They are varied and range from socio-economic factors, socio-cultural factors, religious factors, institutional factors to individual factors.

6.2 Participation of female faculty in Tanzania universities

In this part I will discuss the gender gap among male and female academic staff in the three universities. I will investigate the relative position of faculty members in relation to their choice of field of study. The relative distribution of females at the different levels of seniority within the employment hierarchy will also be examined and discussed. I will look at the seniority of female faculty in relation to two aspects mainly their qualifications and Ranks or Titles. Qualifications range from Bachelors Degree to Ph.D. while the titles range from Tutorial Assistant to Full Professor. For Open University of Tanzania the discussion will include female staff in all faculties as specific information about staff in the Faculty of science

was not available. This information will somehow give a picture of the relative position of female and male staff in OUT even though not in the sciences. The year selected for investigation is 2009. This is the time when the research was conducted. The percentage of female academic staff presented below comprises of full-time/permanent academic staff only.

6.2.1 Female faculty participation in science fields at University of Dar-es-salaam

Table 9: Female and Male Academic Staff by Qualification, Rank and Department.

2009 DEPARTMENT	B.Sc.			Masters			Ph. D. holders												TM	TF	Total
	Tutorial Assistant			Assistant Lecturer			Lecturers			Senior Lecturers			Associate Professors			Professors					
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T			
BOTANY	2	0	2	6	1	7	2	2	4	3	1	4	0	0	0	0	0	0	13	4	17
CHEMISTRY	2	1	3	4	2	6	4	0	4	6	2	8	3	1	4	1	0	1	20	6	26
GEOLOGY	4	2	6	3	0	3	2	0	2	5	0	5	3	1	4	3	0	3	20	3	23
MATHEMATICS	5	1	6	9	2	11	3	0	3	2	0	2	0	2	2	0	0	0	19	5	24
MOLECULAR BIOLOGY	2	0	2	2	3	5	2	1	3	5	0	5	1	0	1	0	1	1	12	5	17
PHYSICS	1	0	1	1	1	2	1	1	2	4	0	4	1	0	1	1	0	1	9	2	11
WILDLIFE CONSERVATION	2	1	3	4	2	6	3	0	3	7	3	10	3	0	3	2	0	2	21	6	27
Total	18	5	23	29	11	40	17	4	21	32	6	38	11	4	15	7	1	8	114	31	145

Source: Field data, 2009.

The figures in Table 9 reveal that Physics and Geology have the least numbers of female academic staff than other departments in the Faculty of Science (Currently College of Natural and Applied Sciences). It is worth noting that in 2009 the department of Geology had no female Professors, Senior Lecturers, Lecturers or Assistant Lecturers. Female academic staffs were concentrated in the lowest rank of Tutorial Assistant where again the numbers are too small as compared to their male counterparts.

In the Physics department females are under-represented as Professors, Associate Professors, Senior Lecturers and Tutorial Assistants. The under-representation is in such a way that you have no females available in these ranks. However, it is worth noting that gender parity was reached in the ranks of Assistant Lecturer and Lecturer (50% males; 50% females).

From the figures above, it is observed that there is only one female professor in the entire college found in the department of Molecular Biology and Biotechnology. Maybe this is because the Biology related field is said to be favored by females. It is interesting to note that

in the entire department there is no male professor but only a female professor is present. In the Assistant Lecturer rank, females (3) outnumber males (2). However, males still continue to dominate other ranks as there are no female Associate Professors, Senior Lecturers or Tutorial Assistants in the department.

In the Mathematics department, there is neither a female nor a male professor. Two associate professors are present at the department, who are both females.

Chemistry department is the only department which has female staff distributed in at least 4 out of the 6 ranks presented. The department lacks female lecturers and female professors. All in all, it is evident from the above table that females are under-represented in all departments in the Faculty of Science. Rank wise, females dominate in only two departments as discussed above but only as Tutorial Assistants and Assistant Lecturers. It is also interesting to note that in the entire college you have more females as Assistant lecturers (11) than any other rank. In comparison with males, this number is still too small to be appreciated.

It is obvious that the Professorial level has the least number of females (1) as compared to other ranks. The reasons for having few women lecturers in Tanzanian universities as mentioned by some respondents in chapter seven, is due to having few female undergraduate students such that the pool from which to recruit female lecturers is very limited and also due to the clash between tenure clock and biological. One respondent is quoted as saying, "Being a university lecturer requires one to do further training to Masters and PhD levels and this is also the time when women are engaged in reproduction activities (child bearing and rearing). One can argue therefore that female scientists tend to be more strongly constrained by cultural norms and family commitments than any other observed barriers.

6.2.2 Female faculty participation in science fields at Dar-es-salaam University College of Education

Table 10: Female and Male Academic Staff by Qualification, Rank and Department.

2009 DEPARTMENT	B.Sc.			Masters			Ph. D. holders														
	Tutorial Assistant			Assistant Lecturer			Lecturers			Senior Lecturers			Associate Professors			Professors			TM	TF	Total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T			
CHEMISTRY	0	0	0	4	2	6	1	0	1	0	1	1	1	0	1	0	0	0	6	3	9
MATHEMATICS	2	1	3	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	3	2	5
INFORMATICS AND VIRTUAL	2	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	5
PHYSICS	2	1	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	1	4
BIOLOGICAL SCIENCES	2	3	5	4	3	7	0	1	1	1	0	1	0	0	0	0	0	0	7	7	14
Total	8	8	16	10	6	16	1	1	2	1	1	2	1	0	1	0	0	0	21	16	37

Source: Field Data, 2009

The Figures in Table 10 reveal that female academic staffs are highly under-represented in the Physics department with only 4 individuals. This proves what the respondents mentioned in chapter seven that there are fewer females participating in Physics specializations in higher education. All the females employed in the department are Bachelor degree holders, the least qualified personnel in Tanzanian universities. This also applies in the department of Informatics and Virtual whereby all the staff employed are Bachelor degree holders. At this lowest level only one female was employed with no staff in the Masters and Ph.D. levels.

Female staffs dominate in Biological Sciences accounting for 7 out of the 16 female staff employed in the Faculty of Science. It is also observed that Chemistry and Informatics and Virtual departments rank second in having more females, accounting for a total of 4 out of 16 female staff employed in the Faculty. Mathematics department has only two female staff employed in the Faculty.

It is interesting to note that in the whole Faculty there are no female professors or Associate professors. The highest rank that females hold is Senior Lecturer. However, even males are under-represented at the Professorial level with no full Professors. Only one male Associate Professor is employed in the whole Faculty of Science. Unlike at UDSM where you have more female staff concentrated in the Assistant Lecturer level, at DUCE most females are concentrated in the Tutorial Assistant Level accounting 8 individuals of the total female staff.

6.2.3 Female faculty participation at Open University of Tanzania

Table 11: Female and Male Academic Staff by Qualification and Rank.

2008	First Degree			Masters			Ph. D. holders														
	Tutorial Assistant			Assistant Lecturer			Lecturers			Senior Lecturers			Associate Professors			Professors			TM	TF	Total
ALL FACULTIES	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T			
	37	20	57	51	23	74	36	14	50	7	2	9	9	0	9	8	0	8	148	59	207

Source: The Open University of Tanzania Facts and Figures 1994-2009.

Table 11 proves that female academic staff are the minority as Faculty members. As mentioned earlier in the introduction of the section, even though the figures do not show the distribution of females in the various science departments they portray a similar situation in the Faculty of Science. It is worth noting that like in the other two universities, females are highly under-represented in the Professorial Level. There were no female Associate Professors or Full Professors in the entire University in the year 2008. A similar situation of having more females in the Tutorial Assistant (20) and Assistant Lecturer (23) Level is also observed in OUT.

6.2.4 Summary of Female Faculty Participation in all three Universities

Table 9, 10 and 11 provides a proof of how wide the gender gap is among faculty members as to their academic qualifications. Apart from being fewer in number, female academic staffs are more concentrated at lower levels of education. Many women are employed as Tutorial Assistants and Assistant Lecturers the two least qualified personnel in Tanzania universities. Ph.D. level which is the highest or senior level of education at university level has extremely few females in all the three universities.

These institutional inequalities caused by a variety of systematic and socio-cultural factors pose serious challenges to the integration of gender equality commitments within institutions of higher learning and also prevent women in higher education generally from moving beyond positions as lecturers. They reflect the prevailing climate of higher education, male leadership posing particular barriers to women faculty members and subsequently women students who find few female role models in the tertiary system in Tanzania.

Makame (2008: 69) argues that employment hierarchy is crucially important because it is at senior levels that decisions are made and leadership is exercised in defining and carrying forward the research agenda. He asserts that University remains to be the male preserve and senior education levels are the men's stronghold. He explains that this pattern of presence (or absence) creates the impression of a male-norm for seniority, and the fact of male-dominated decision making and leadership, either or both of which may affect women's progress through the hierarchy.

Probert et al., (cited in Allen and Castleman, 2001: 153) found in their survey of university employees that there is a significant association between women's lower average level of qualifications and their lower status in the academic hierarchy. This seems to be a fact in Tanzania universities as Table 9, 10 and 11 shows. Having few female faculty members means having few female role models. Female role models motivate female students and help to develop their own autonomy and career aspirations (Makame, 2008: 70).

Antonucci (cited in Makame, 2008: 71) suggests that having few female faculty members at the senior levels will not inspire female students. She believes however that presence of one or two women is a great success and improvement, and it signifies a beginning and recognition that more women should be represented in the higher education system.

I argue by supporting other researchers like Randell and Fish (2008:4) that, institutional inequalities pose serious challenges to the integration of gender equality commitments within institutions of higher learning as they reflect the prevailing climate of higher education; male leadership posing particular barriers to women faculty members and subsequently women students who find few role models in the tertiary system in Tanzania. It is obvious that equal participation of women in science and technology will not occur if current enrollment trends of women in science and technology programs at higher learning institutions continue.

7 PRESENTATION OF THE INTERVIEW RESULTS

Introduction

Apart from the analysis of the quantitative information on male and female enrolment in science in the selected universities, results of the interviews conducted are presented below. Female and male students, teaching and administrative staff were asked to give their opinions on womens' participation in science education in Tanzanian universities. It was reported from the majority of respondents from OUT, UDSM and DUCE that womens' participation in science in universities is still very low.

This part is divided into two sections. Each section explores the opinions of female and male students and staff concerning women's participation in science education at the level of higher education in Tanzania. Finally the summary of this chapter will be given at the end of the section. Majority of the respondents selected English as a language of interview and very few responded in Kiswahili. Therefore all Kiswahili responses are my translation.

7.1 Socio-cultural and attitudinal barriers

The socio-cultural context of women's lives in Tanzania places many constraints on women's involvement with science in higher education. Within their descriptions, interviewees mentioned the strong cultural expectations for women around early marriage and child rearing, the lack of support for girls' education and societal role and stereotyping to be among factors affecting their participation in science education.

7.1.1 Significant value given to marriage

The majority of respondents mentioned that value placed on marriage is a major factor that mitigates equal representation of women in science education in Tanzanian universities. Early marriages coupled with early pregnancies were cited to be among the causes of girls drop-out in Tanzanian schools. From the focus group interview, a male student from institution B said this:

We have very smart ladies who are dropping out of school just in very early stages as a result of early marriages. Those who are bright enough to whom we could have thought they would be good science takers are no longer in the education system.

It was also learned that traditional rituals and ceremonies which are still practiced in some Tanzanian tribes today contribute to girls early marriages. Adolescence socialization “Unyago” is done by elder female relatives, who are entrusted by the traditional cultures to orient girls in their communities to the way men want their women to be. A female student from institution B explained that:

There are tribes like X and Y still practicing puberty rituals and these encourage early marriages. Most of the teachings from the mentors are centered on issues of marriage.....taking proper care of the husband and how to behave as a wife. So after puberty, girls consider that they have only two roles in the society; getting married and bearing children.

The centrality of marriage and child bearing is internalized very early in life by girls in Tanzania. Girls/ women are oriented differently in that they have been made to believe marriage, child bearing and child rearing are the most respectable roles for them in the society. Her personal observations indicated that this is due to the inheritance from past generations.

A woman administrator from institution, A who had similar opinion about girls’ early marriages, explained that parents preference of early marriages was as a result of their belief that marriage is a solution to problems that girls might encounter in adolescence such as getting pregnant before marriage. Parents believed that marriage protects girls from men’s temptations.

7.1.2 Lack of motivation and role models

Another reason identified from the participants’ responses was the lack of role models who can inspire and motivate the girls/women especially during primary and secondary level of education. Females were said to lack role models at home to encourage them and there was no one to imitate among those surrounding them. Culturally the status of women in their families and communities is low, the mothers fail to be good role models for their daughters to emulate (as many sons may emulate their fathers) in order to aim high in their education development. One female student from university C commented that:

Girls face discouragement from parents; they choose the subject/career paths for their children even if the children like science and they have the ability to do science subjects well up to the university level.

It is evident from these comments on the socio-cultural context that women are controlled from birth. As the girl child, the father is not only responsible for making the final decision for her access to schooling but also on matters of subject choice.

In the same situation, she also explained the role played by mothers in influencing their daughters' education. She laments that:

I think it is a kind of behavior, or attitude that is in our society which makes a woman feel and accept that situation [that she is not supposed to pursue the so called hard science subjects]. An educated mother may tell her daughter that she didn't take science subjects because they were hard and the daughter listens to her mother and internalizes the words such that this becomes a vicious cycle as the same message will be passed on to future generations in the family.

From the above statements, it appears that from an early age parents are involved in killing the science passion of their children. The attitude of the parents and the society towards girls/women denies them the freedom to decide on their own to participate in science education.

On the other hand she argued that teachers are not involved with female's motivation in a way that is supposed to be. She claimed that students spend a lot of time with teachers rather than parents and students always feel that teachers know a lot of things, so they tend to listen and trust them. She asserted that, if motivation was part of the teachers' daily habit when he/she enters the class, especially encouraging the form ones that they can do science subjects while citing examples of those women who have taken science and they have succeeded; then more female students would have opted to continue with science subjects.

7.1.3 Societal roles and stereotyping

The socio-cultural context of women's lives in Tanzania places many constraints on women's involvement with higher education. Majority of interviewees mentioned that the strong cultural expectations for girls and women in the society are a barrier to their full participation in higher education including science education. Due to societal and reproductive roles many girls and women consider education as of secondary importance to them.

A final year student from university B explained that she perceived that many other women do not enroll in science education because they are overburdened with too many family

responsibilities. She explained that women are involved with reproductive activities, caring of children and other domestic tasks.

She explained the way traditional husband-wife relationship in the African society has made many men believe that naturally women are born to handle all home related duties in the society including taking care of children and the husband. Education, employment and business roles are believed to be only a man's responsibility.

She argued that science subjects are more demanding and they need a lot of concentration so many women think that being married and studying would overburden them as they already have many tasks to do in their lives. They believe that it will be contradicting expectations of their married roles in society and will be creating conflicts in marriage with their spouses.

From the above perception it is clear that some women think balancing science education and family is difficult so they opt to take other less demanding courses like Arts.

The Dean faculty of science (male) from institution B explained that the clash between tenure clock and the biological clock makes some women not to participate fully in science education. He pointed out that:

The time by which female staffs are employed is also the time they are newlyweds striving to start their families as well as striving for their masters and PhDs. This takes some effort out of them in balancing all the burdens. I will give you an example, this year alone we have had three postponements, one by an academic staff who had a caesarian delivery and was supposed to finish her masters in June 2009 so she won't be finishing this year. Six months postponement of one's prime years in life is a lot. When you go to the undergraduate students we have two who have postponed their exams because of the same reasons. So it's one of those things there is nothing we can do about because we want them to be mothers, we want them to be wives and we also want them to be scientists.

A Mathematics female professor from university A stated that at the masters and the doctoral level, as well as institutional leadership level, women are greatly underrepresented. The few women who succeed to join the academia at university level face a number of gender related problems. She explained that being a university lecturer requires one to do further training to Masters and PhD levels. This time is also the time when women are engaged in reproduction (child bearing and rearing).

She lamented that the woman academician has to balance the reproductive age and further studies. If the choice is to bear children first and do Masters and PhD later, she becomes age

barred for scholarships. When she chooses studies and child bearing, she leaves her young children and husband behind to go abroad because the science disciplines have extra requirements such as need to go abroad due to laboratory and supervision that is not available in Africa.

It appears that the balance between being a wife, mother and a student is stressing to some women so they drop out of science because they cannot manage the triple burdens.

A female student from institution C explained that girls are overloaded with house chores such that they hardly have time for self study. She further pointed out that science requires extensive preparation so if one misses school catching up with school subjects becomes difficult. This leads to poor performance in exams and at the end they cannot qualify for university entry. She suggested that the government should build more boarding schools rather than day schools where girls can stay and be protected from lots of other societal destruction like housework. She claimed that cultural practices coupled with day schools prevent majority of girls from participating in science education effectively.

7.1.4 Lack of encouragement and support

The majority of respondents commented that girls/women are not supported or encouraged in achieving their university education. They said that girls face discouragement beginning right from childhood; from their families, their peers, the society, the government, in their marriages and even in the teaching institutions themselves.

A female lecturer from institution B lamented that, many girls/ women do not aim high academically because they lack conscientization, sensitization, motivation and encouragement right from their early life upbringing. She explained that most parents in the rural areas and even some in urban areas have hardly gone to school so they don't see the importance of girls' education. She elaborated that fathers usually decide not to enrol the girls for schooling and encourage them as they do for boys because they feel that if they invest their money in education, it will be transferred to other people's families. This is because when girls get married they move to their husband's families who by tradition are empowered to control the lives of wives.

A female student from institution C explained that parents believe boys to be future fathers while girls are future wives, hence boys must work to be fathers and heads of the households while girls become wives. She lamented that girls in Tanzania are married right after completing grade seven or form four hence the majority do not really consider university education to be of much importance to their lives compared to their male counterparts. Boys normally get more encouragement to aspire for better education than girls.

She also noted how women are thought to be inferior in many of the tribal cultures whereby they don't have the power to tell the parents and the society to educate them equally to the boy children. She complained on how the tribal cultures in each of the tribes in Tanzania have oppressed their women so much that women do not get the courage to attempt to enroll with higher learning institutions and take science subjects.

Another male student from university A explained that some women find it difficult to do their post-secondary education because the society does not support girls' aspirations for higher education. The society does not have any contributions to strengthen or empower women to take science education. He commented on the perception of the society towards those girls who study science by saying the following:

There are negative comments in the society that those girls who study science at the university are only very ugly girls....they are left out by men to study science for no men want to marry them. They are not beautiful and smart as those who take Law and Sociology.

He points out that these negative comments make women insecure and they decide not to opt for science education because they fear that they won't get married due to society generalizations. With the disappointment others opt to drop out of science specializations. He further argued how the rural society perceives science subjects. The society does not see the immediate application of science at the family level and they question for example those taking Physics in O-level, how they can apply the knowledge to solve the immediate problems in the society. Physics is seen as a subject which involves a lot of mechanical or industrial things so it is treated as a subject not suitable for females.

A female student from the same institution mentioned that discouragement from male peers was a limiting factor in females' full participation in science education. She explained her own experience as a science student in university A whereby during group discussions, fellow male students intimidated her and other female students verbally by telling them they had low

cognitive ability. In Kiswahili they were called ‘Viwango duni’ meaning of low academic ability or merit. She explained that these intimidations came about as the majority of female students taking science in university B (almost three quarter) including her, did not qualify for direct entry as males because they did not meet the cut-off point but they gained entry through the Pre-entry Programme for Female Science Students (PEP). She complained that girls are bombarded with disappointment at every juncture of their educational ladder starting from childhood to adulthood.

It was also pointed out by many respondents that teacher’s attitude towards girls pursuing science exert an important influence on the learners (girls). Students trust teachers so if one sends a negative message to girls, it will definitely affect their performance and hence their participation. A male student narrates an experience he had in secondary school mathematics class by saying:

During my O-level studies, when the mathematics teacher entered the class almost all the girls used to get out and the teacher was just leaving them and saying, “Let them go out after all if I leave them to stay in my class they will get a lot of F’s and it will therefore be a shame to me”. The result was that girls performed poorly in that subject and the teacher kept telling the girls that mathematics is a subject for men so if they get low marks they should not wonder about it.

Some female student respondents reported that there was lack of support and encouragement from their husbands in pursuing higher education. They indicted that most women have too many roles in the family and society which limit them from enrolling with higher institutions.

One among the female students from institution B lamented why many women remain silent when their husbands refuse to allow them to enroll with higher education. She said, “Wives consider that if they fight for their right to get more educated, their husbands will abandon them and marry other women willing to remain home and do the family work”. She further explained who get a chance to be enrolled, the husbands put more obstacles on their educational path such that balancing family and studies becomes difficult and they are forced to drop out of university.

A male respondent from institution B explains a female colleagues’ experience whereby the husband intentionally impregnated the wife after learning that she was joining the university. It was an unplanned pregnancy and the wife was not ready to conceive at that time because of the studies. He explains that the wife had other two children who were not above six years.

I probed him further, why the husband did that? He answered me with great astonishment expecting that i already knew the answer.

O.K, you know the problem with us men is that we are very jealousy. That man who impregnated my colleague had first of all finished only grade seven, so he was insecure about his wife joining the university. He thought that the woman will meet a lot of men who are rich and educated more than him and have affairs with them. Now that lady is suffering and performing poorly because the science subjects are very difficult and they need concentration. I am so sorry for that lady because she is getting a lot of problems especially during Chemistry practicals, the smell of chemicals and reagents affect her. Sometimes she is forced to skip practicals and if she remains in class she is always going in and out to spit. This is a lot of interruption for her concentration. Throughout the third year program we have about five pregnant students who have 3 to 4 supplementaries. So if they don't work hard they might be discontinued.

In many of the African societies, the wives have not often been more educated then their husbands, so this is a typical example of how men find every means culturally to try to oppress and dominate the woman.

7.1.5 Confidence and female inferiority complex

Lack of confidence was also stated by some interviewees as another reason restricting women from pursuing science education. A male student explained that girls/ women do not have confidence in themselves that they are able to perform well as their male counterparts. He said, “Some women depending on the environment they have been brought up in, do not really have self confidence to perform those tasks which are considered masculine, for most women are made to believe that women are inferior to men in everything”.

He explained that in schools teachers treat boys and girls just like at home, where teachers expect girls to be more conforming than boys. He commented that, “boys’ aggressiveness is tolerated than girls’ aggressiveness so you find that some teachers tend to concentrate more with boys than girls because they believe that boys are more suitable for science than girls, as a result girls develop negative attitudes towards sciences and develop inferiority complex”. He also noted that women don’t have the willingness to study science on their own until they are encouraged.

7.1.6 Girls and women's career expectations and aspirations

Few respondents mentioned that career expectations for girls and women are a limiting factor for their effective participation in science education.

A male lecturer from institution C explained that most girls think science is for boys because careers associated with science are regarded by the society as male careers. He explained about children's upbringing in many societies in Tanzania whereby boys are exposed to environments that foster science interest since childhood while girls are exposed to an environment that prepares them for mothering and domestic work.

He also explained that science careers take long to pursue while girls have to think about getting married before they are too old. He also noted that many females avoid the sciences because they need extra effort and commitment and some girls think that the time and effort that one puts in science is not worth it. He commented that it is true that people with arts specialization spend less time and energy and they get well paying jobs and hence better lives.

Another female lecturer from institution A said that some female graduates end up working in other fields such as the Bank industry where the salaries are much better compared to what is paid at the universities so they tend to drop the science profession.

Because of the same reasons of job dissatisfaction, a male lecturer from institution A explained that some of the female students who take science subjects at secondary levels opt for other subject combination at university level.

7.2 Institutional (educational) and economic barriers

Much of the information provided by participants indicated that the non-participation of women in science arises from a number of factors, principally, lack of science teachers and teaching facilities, sexual harassment, poor performance at lower levels, financial constraints,, the masculine nature of the administrative role and limitations to academic opportunities.

7.2.1 Lack of Science teachers and teaching facilities

Respondents mentioned inadequate facilities, equipments, teachers and books for science as

discouraging factors for girls to drop science specializations. A senior woman administrator from institution A argued that:

Many more girls than boys are in schools that are poorly resourced, some from catchment area are day scholars studying in good boys boarding schools but have no access to the good science facilities, they go back home or leave in foster houses where they face numerous problems and are not able to concentrate on science subjects.

A number of lecturers from university C mentioned that female students applicants do not have a good academic background in the sciences. Much of this was blamed on poor secondary schooling although other interviewees discussed the lack of appropriate socialization which hampers girls in competing academically with boys.

A female assistant lecturer from the Organic chemistry department from institution A explained that women more often than men experience difficulties in achieving well in the sciences. She said that while the society has a mythical belief that women are naturally not good in science studies, the reality are that girls find science studies difficult mainly because of their school background.

She claimed that many girls' secondary schools have fewer qualified teachers and inappropriate teaching facilities than are in boys' secondary schools. She maintained that some of the good science teachers who are usually males are not commonly posted to many of the girls' secondary schools. She complained that some girls' secondary schools have no degree qualified science teachers and thus those students would have a very bad science background. She claimed that since most girls are selected from these schools to come to university, they don't get on very well with the science studies.

It was also reported by many respondents that methods used in teaching science subjects in secondary schools are not appropriate as they involve more theory than practice due to lack of laboratories, laboratory technicians, practical equipments and chemicals. It was asserted that schools with laboratories had outdated, outmoded equipments which are used to teach students in a purely theoretical fashion. This leads to unclear mastering of the science concepts as the apparatuses used are old or broken sometimes leading to inaccurate results.

A senior student taking science with education specialization from institution B explained about the situation in secondary schools in Tanzania where many are without laboratories as a

result the examinations administered are alternative to practicals. He lamented that there is a difference in academic performance between a girl taking science subjects practically and the one who only does alternative to practicals.

It is evident from these comments that science teaching in most of the secondary schools in Tanzania involve more theory and this leads to poor performance and hence failure of females to qualify for university entry.

One female student from institution C who had similar opinion commented that, "Science without practicals is not real science". She further explained that the methods used in teaching science subjects in Tanzanian secondary schools are inappropriate as they only teach a student to receive from the teacher (teacher centered) and are not participatory (learner centered). She argued that the teaching methods used emphasize a lot of rote learning involving cramming rather than students' understanding and applying the knowledge.

Many respondents also noted that there was lack of enough science teachers in secondary schools and the few who were available some of them were not well trained and hence they are less competent. A male student from institution C explained the issue of teachers by saying:

Tanzania has a big problem with science teachers especially in government schools. A lot of teachers are trained in other fields which are not science. You may find one Physics teacher teaching all the classes in a school from form one up to four so it becomes difficult for most of the girls to get individual assistance from the teacher and they find the subjects to be even harder.

I probed him further why there are few science teachers and this is what he said:

There are few science teachers because those trained to teach science subjects can diversify and get some other type of employment. They divert careers because the salary scale for government secondary school teachers is very low. The issue of salary has consequences on the students as teachers are not motivated to use their efforts and abilities in teaching and this leads to poor performance. Some do not even care whether they enter class or not and the authorities/ administration concerned does not take any disciplinary measures against them. Teachers are forced to engage themselves in other income generating activities to aid in the daily up keeping as what they are getting is not enough.

From the above comments, it is clear that teachers are a source of this problem of few females participating in science education. Their job dissatisfaction as a result of low salaries hinders the proper teaching and learning of science for females.

Another male student from the same institution argued that there are no well trained science teachers in secondary schools because the governments selection process is in such a way that those who perform poorly in secondary school exit examinations are the ones who are selected to join teacher training institutions. She explains:

Instead of the government taking those high achievers to be trained as teachers, it takes those with poor performance and that's why the competence of some is questionable. Some do not have the academic ability to teach science subjects even if they are trained in that field.

The problem of text books was also cited as a hindering factor in female's participation in science education. A male student from university B was quoted as saying:

The nature of books being used at this time is of low academic quality. Some of the local Tanzanian writers are trying to simplify the materials in these books and in the process you may find that most of the important detailed concepts have been omitted. They include very few shallow concepts. For instance you find a question in a book saying, what are the factors that affect the rate of respiration? The answer given is just temperature. The how and the why is not there. The writers just list the factors without detailed explanation or discussion. As most of the students like simple things, they use the same concepts in the examination. Since most of the writers of these books are the ones who are also involved with marking the final examination, you find that even the marking scheme relies on the same points. When it comes to the level of university, one is required to have the ability to discuss and explain issues and not listing alone. So at the end this contributes to poor performance and finally discontinuation of some female science students.

He suggested that the government should establish a system to assess all printed books before being released into the market. If this is not done the quality of education in Tanzania will continue to go down.

A senior male Lecturer from institution C explaining why there are poorly resourced schools said, "Due to political agendas of some government leaders in Tanzania, they initiated the building of many ward secondary schools (nick named in Kiswahili 'YeboYebo' schools) which now do not have science teachers and laboratories". He continued by citing an example of a certain government secondary school in Tanzania which had only six teachers altogether who were teaching from form one to four and in one level there were about five streams with 30-40 students. He adds, "My nephew reported to me that since the beginning of the term, no teacher had set foot in their class."

The performance of both boys and girls in science will continue to be poor unless a solution is found for this problem. It is better to improve few schools and provide them with laboratories and equipments rather than building many schools without these facilities.

7.2.2 Masculine image of Science and Mathematics

Most of the respondents mentioned that the very old traditional thinking that science is for men, the time consuming nature of science and mathematics, coupled with its complexity and intensity, cause many girls not to enroll in science subjects but rather opt for Art subjects. The dominant fallacies among people that were mentioned by various respondents included “science subjects are only special for boys and not for girls because they are hard”.

A female student from institution B explained that, “there is a notion among many of us that we cannot do science subjects because we are women...we think that science is difficult and difficult things are for men while simple things are for women”.

Another male student from the same institution asserted that:

Most girls and women have the idea that science subjects are difficult, especially mathematics and physics, which is not the case when you devote your time in studying.

He contends that this perception is not only seen in girls but it is also there in some boys. In probing further about the issue of mathematics and physics, he said that at the university level most of the girls do not participate fully in the subjects which involve mathematical computation or calculation. He explained that there are very few girls in the subject combination of physics/mathematics and physics/chemistry as compared to chemistry/biology or biology/geography even though females compete equally well as males in academic performance. He further explains the root of this problem by stating the following:

The problem of mathematics starts from secondary school, in Ordinary level (O'level) and Advanced level (A'level) whereby you find that most of the teachers that are teaching these subjects are mainly men. Women teachers are only teaching subjects like Kiswahili and Civics so a student who is coming in form one, by just looking at the teachers she is getting the concept that of course these subjects are only for men. So that idea is now growing up in girls and as they move forward to other levels their marks become poor and poorer and you find that they come to conclude that, of course I knew that these subjects are not for us but for these men. Finally this notion is carried up to the higher learning institutions.

Another male administrative staff from institution A in different situations pointed out that the issue of mathematics in Tanzania has nothing to do with gender but it has something to do with teaching methods. He lamented that mathematics is the worst taught subject in secondary schools in Tanzania as a result you have less than 7% of secondary school students who take science, with less boys and even lesser girls.

The male administrator said that the subject is perceived difficult by both boys and girls. Students spend extra time and even money (tuition) on these subjects. Even those girls who want to struggle with the science subjects, few of them get money and time to put in the extra efforts. Also many parents don't allow their daughters to go for extra tuition lest they get pregnant. He observed that as one goes higher up the level, those who take physics and mathematics are a fraction of those who take other subjects say language, geography or history.

He commented on why there are more women in biology related subjects rather than physics related subjects at the university level by saying that:

Females are more interested with biology as many things taught are found within their vicinity e.g plants, animals and also females prefer social careers like being doctors, nurses of which chemistry and biology are more important, rather than careers dealing with objects/materials like physics and mathematics. They find no direct or immediate application of physics in their lives as it is with the case of biology. They also prefer this subject because of its simplicity nature.

Another male academic staff from institution B asserted that:

Males are found more in physics/mathematics and physics/chemistry subject combinations because of their high cognitive ability.

A male student from institution B explained that the problem of physics/ mathematics lies with the women themselves because they see that the science subjects are very difficult. He said, "Myself I am taking physics/chemistry and physics is very difficult and women have got a lot of problems in physics".

I probed him, why women have a lot of problems in physics? He took a deep sigh and answered me while shaking his head. I got the message he was feeling pity for the girls, he said:

Physics is very difficult and requires a lot of mathematics. It involves a lot of calculations and most Tanzanian students do not have a good background with

mathematics in secondary school. It is very difficult to approach things in physics if you don't have a good background of maths from lower levels. The problem that women get here is in the topics of integration and differentiation. So the syllabus should be changed in such a way that it incorporates these topics all the way from Ordinary level to Advanced level because when one comes to higher education it is more advanced.

Other respondents also explained how curriculum materials portray gender bias. They observed how many science and mathematics textbooks have illustrations showing men performing various scientific activities like doctors at work and engineers at work. They elaborated that gender bias in textbooks gives an implication that science and mathematics are for men and not for women.

In general, apart from the masculine nature of science, it was observed that within the sciences there are divisions in terms of participation, with fewer females in specializations which involve mathematical computation.

7.2.3 Poor performance at lower levels

Several respondents mentioned females' poor performance in science at lower levels as a limitation preventing them from enrolling with higher education institutions. Female students were said to perform poorly in science subjects in A-level. One female student from institution C was quoted as saying, "Poor preparation of girls in O-levels leads to poor performance in A-level final examinations and thus they cannot qualify for university entry".

When I probed the lecturers about the performance of males and females at the university level, most of them explained that there was no significant difference in science performance between males and females. A male assistant lecturer from institution B noted that in Biology courses male and female students performed equally well irrespective of their sex. He commented that difference in performance was not due to the sex differences but rather because of a complex interplay in socio-cultural factors.

Another female Lecturer from university A, who teaches Marine Botany, Wetlands Ecology and Coral Reef Ecology, said that, "At the departments of Aquatic Sciences and Fisheries, female students generally perform better than their male counterparts".

So it is evident that issues of performance at the university level play a minimal role as a limitation in preventing women's continued participation in science education

A male student from institution C had positive comments about some girls' secondary schools in Tanzania. He said that there are some girls' schools which compete equally or above boys' secondary schools. He gives an example of school X which has been holding the overall first position in the country with high performances in science. He observed that this high performing school was private and had higher financial resources and quality physical facilities.

So most girls/women if they are not really doing well, they should not be judged immediately as low in performing or that they do not work hard. Instead, we really need to study what environment keeps them where they are because it may have nothing to do with the issue at hand, such as many women not participating in science education programs because of low performance.

7.2.4 Sexual harassment

The common sexual-related practices reported at higher learning institutions were between male academic staff and female students and also between female academic staff and male academic staff. There were also some few cases reported between male students and female students. For girls in secondary schools the common sexual-related practices reported were between female students and male teachers or males they interact with on their way to school.

A female student from institution A complained about the existing situation of young school girls in Tanzania by saying that most secondary school girls are harassed by senior men. She observed that the female day scholars attending co-educational schools in Dar-es-salaam, have to go through all types of harassments daily on their way to and from school. She said because many big cities are highly populated, the public transport system becomes not easily accessible as sometimes city buses do not offer chances for students because they pay only half the normal price. She complained that men with fancy cars take the advantage and offer lifts to these girls and then they end up seducing and dragging young girls' attention away from their studies. She explained the way they do it, by putting up so many temptations (offering expensive mobile phones, money) until the girls are willing to abscond their studies to get married.

She concluded by saying that this act makes many intelligent girls to be removed from school before they can get to their university education, while the men who do that are not held responsible by any law.

In a different situation a senior male administrator from institution B was quoted as saying:

Lack of enough boarding facilities for girls taking science contributes a lot to high dropout rates, as day schools do not really lead to good students. Girls in day schools face transportation problems and they end up falling trap to sexual harassment acts which lead to teen pregnancy. The government does not concentrate any more on building boarding schools because they think it is more expensive and provides less access for student populations in school.

He argues that the governments' cost saving measure of providing and expanding access alone without retention measures for these girls is not cost effective. It will cost the government and the society more when these girls drop out of school as those expected to provide future expertise will no longer be in the system. He suggested that girls must be taken away from the vulnerable unprotected circumstances and environments in order that they are given the chance to compete equally well with their boy counterparts.

A male student from university B admitted that sexual harassment practices between female students and male lecturers were still going on. He was quoted as saying:

We cannot deny that there are no sexual harassment acts in this university. We have some of our friends here who are taking Biology and Geography specializations and the teachers are disturbing them. They ask for sexual relationships in exchange for favors like giving them examination papers or better grades. Others are threatened by some lecturers that they won't pass their exams unless they are engaged in sexual relations with them. This creates fear and less concentration among women science majors. I don't agree with the idea that ladies are dull in classroom so they seek ways in getting examination papers. At one time there was rioting here because some of the lecturers were giving papers to some ladies but i must say that this is strictly set on ones' behaviour.

Female students who were said to be the victims of sexual harassment and abuse were in most cases those who seek academic help from male teachers and those who were beautiful.

Male faculty members were said to have negative attitudes towards women who fail to respond to their demands for sexual favors. They find ways to humiliate female students during lectures.

A senior female administrator from university A explains her experience in that institution as a student, teacher and an administrator. She lamented:

As a student I was almost raped by my lecturers when I went to collect marked assignment or to ask for clarification of a concept and even during the final year project I did not dare to join study groups because all in my combination were boys, so I worked alone. Throughout my student life at all levels, there was a lot of discouragement of girls/ women to take mathematics or physics subjects. As a lecturer, when I applied for a research grant with a male colleague, one of the administrators at university A spread rumors that the two of us are lovers and that is why we applied together. The grants applications were to be done in a team not by individuals and there were no women to collaborate with (even if I was to be forced to work with a woman). The person I applied with is married to a former student of mine who had so much respect for me. She heard these utterances and was very much hurt and actually believed the rumours. Fortunately, my husband did not believe the rumours otherwise there would have been fire in two households. In any case this type of sexual harassment was very painful to me. I lost trust of a young woman whom I taught in class for something that did not exist. I reported the case to the officials concerned but the matter was not treated with any seriousness.

She also reported that as an administrator she witnessed many cases of students and teacher harassing women/ female students sexually and these were treated in a very flimsy manner. She further argued that girls/ women must be taken away from harassment generally done to them as subservient members of society by culture, and even more seriously they must be protected from the general male harassments.

Another female lecturer from the same institution explained that she had received respect from her fellow colleagues most of them being male and majority of whom she had known since she was a student. She lamented:

I must commend our University administration for the efforts it takes in organizing such courses as “Work ethics and Professionalism” for newly recruited members of staff in which we are trained in many aspects including matters of bad practices.

Based on these two different experiences in the same institution, it is evident that issues of sexual harassment cannot be generalized as they happen under different circumstances.

7.2.5 Financial Constraints

Financial constraints were mentioned by many respondents as a limitation preventing women from participating in science education. It was mentioned that many Tanzanian students come from families with low socio-economic status so parents fail to support their children

financially. One female student laments that science specialization in higher education institutions are expensive compared to arts specializations. For example tuition fees for studying science at University of Dar-es-salaam for the academic year 2009/2010 in the College of Natural and Applied Sciences is 1,300,000 per year while studying some other Arts subjects at the College of Arts and Socials Sciences is 1,000,000.

She explained further that since the introduction of cost sharing policy in higher education only students with better grades are funded by Higher Education Students Loan Board (HESLB) but for the case of those with lower grades they are supposed to be supported by their parents. She elaborated further that even though the government policy on higher education loan allocation gives priority to female science students, very few of them qualify for university entry.

7.2.6 The masculine nature of the administrative role and Limitations to academic opportunities

Male and female faculty and administrators involved in the study observed that there were few female science faculty and administrators in universities. A female professor from institution A explained that, the main reason for having few females as faculty and administrators is because of male dominance and gender insensitive university environments.

She noted that there was a widely held belief that women were not able to do management and administration as men. This widely held view according to her results in negative biases to women applicants. She also complained that women themselves believe they cannot do the managerial tasks and hence do not apply for such positions. Further she complained about how longer it takes for women in academia to be promoted. She argued that this is because some promotions are arrived at through informal networks e.g. in pubs over a beer where women do not go. She further elaborated that women are as capable and as productive as men in the academic arena. She suggested that efforts should be made to increase the number of female staff in higher education.

Another male tutorial assistant from institution C explained that there a few women in administrative positions because the structure of most universities requires that the top most administrative positions be held by full professors and number of women as full professors is

small. He further commented that administrative positions are so challenging and women cannot withstand the stiff challenges from students like boycotts and demonstrations.

A female lecturer from institution C mentioned that low qualifications and shortage of qualified female science graduates was the reason for under-representation of females in senior positions in the administration of Tanzanian universities. She complained that small number of female academic staff has resulted in having no representatives in higher positions in their faculty.

7.3 Chapter Summary

This chapter explored the results of the interviews conducted in three universities with male and female students and staff in order to find out the possible reasons for the gender gap in science in higher education in Tanzania. The interviews carried out revealed that there are a number of factors contributing to the existence of the gender gap in science education. Factors can be summarized into socio-cultural related factors and institutional related factors.

8 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Introduction

This chapter discusses the findings and presents conclusion and recommendations of the study. The major concern has been to investigate the nature and extent of the gender gap in science in Tanzanian (Mainland) universities and explore the factors contributing to the gender gap. Also the study has been set to examine the strategies aimed at addressing gender inequality in science education. The discussion is based on the following research questions:

- What is the nature and extent of the gender gap in sciences in higher education in Tanzania?
- What factors contribute to the existence of the gender gap in the field of science in Tanzania universities?
- What strategies are put in place by the government and universities to reduce gender imbalance in science in higher education?

8.1 Summary of Major Findings

The major research findings based on the research questions above are as follows:

It was found that, there is a wide gender gap in sciences in Tanzanian higher education institutions. Students and staff are less represented in enrolment and employment respectively. In a period of eight years consecutively male students have outnumbered female students. Female academic and administrative staff are seriously underrepresented compared with female students. Female students and faculty are concentrated in the Biological Science fields, a field which is said to be females' favourite. It has been observed that female students tend to avoid the 'hard sciences' which involve subjects like Physics, Chemistry and Mathematics. However, at DUCE females were observed to dominate these fields. It has also been observed that the science gender gap is more prominent at OUT followed by UDSM. DUCE has the least science gender gap.

It has also been found in the study that the majority of female faculty possess lower academic qualifications and are mostly concentrated in the ranks of Tutorial Assistants and Assistant Lecturers. Female Faculty in science departments are seriously underrepresented at the PhD

level with completely no female Professors or Associate Professors in two institutions (OUT and DUCE). Women are also severely underrepresented in senior administrative positions in Tanzania mainland universities to the extent that out of eight heads of departments at the College of Natural and Applied Sciences (UDSM) only one is a female. Women are invisible as college principals or Faculty deans. As one climbs the education and management ladder the number of women decreases drastically.

The study has also revealed that there are many factors that militate against equal participation of females in science education. These include: Early marriages, masculine image of science, lack of science teachers and teaching facilities, lack of motivation and role models, poor performance at lower levels, lack of encouragement and support, sexual harassment, societal roles and stereotyping, temptations, confidence and female inferiority complex, financial constraints as well as the masculine nature of the administrative role.

The findings of the study have also shown that the strategies adopted by the government and institutions to address the problem of gender disparity in science have not been effective enough. However, there are measures adopted by some universities which have helped to some extent in increasing the number of females in science programmes. Other universities have not yet taken any affirmative action measures for students. Affirmative action favouring female teaching staff and administrators has not been observed.

8.2 Discussion of Major findings

The findings from the interviews confirm and reflect the work of a number of researchers and writers on education in Africa (Meena, 1996; Bendera, 1999; Kwesiga, 2002; Mhehe, 2002; Bunyi, 2008). Many of these researchers and writers have noted that the major impediments to schooling for girls and womens' education mainly to be socio-culturally related which generally refers women to marginal positions in their society. These socio-cultural factors cannot be analyzed in isolation of the educational factors as attitudes and cultural values influence the curriculum design, the nature of content, methods of imparting knowledge and even institutional policies and organizational procedures. These factors that militate against women's participation in science education are discussed below in relation to the literature in order to provide grounds for the recommendations made at the end of the chapter.

8.3 Socio-cultural and attitudinal barriers

The most important reason, in an African setting where sex differences in performance and participation in science education are persistent, is more of a pedagogical and cultural problem. The socio-cultural and attitudinal factors identified in the findings are discussed below.

8.3.1 Significant value given to marriage

Generally, the study demonstrated that female dropout due to early marriages during primary and secondary school level contributes to a great extent in reducing the numbers from which potential girls taking science can be drawn for university education participation. The preference for early marriages which is supported by traditional and religious cultures in Tanzania discourages some females from participating in science education at the level of higher education as leaving home at a very young age to get married precludes or abruptly terminates their schooling.

The findings in the study revealed that girls who choose to continue with school and take science subjects are identified as poor marriage partners and not beautiful to attract male attention for marriage. This is particularly prevalent in higher learning institutions. My personal experience as an undergraduate student at one of the universities, I have witnessed females being labeled by males as ‘wagumu’ meaning hard cores like males, in that science female students are not attractive and smart as those taking Law or other Arts subjects. Due to the nature of the science subjects being too demanding, female science students do not have the extra time the non-science students have in trying to maintain their appearances. The time which others spend in saloons or beauty shops for makeup is used either for discussion or personal study.

The portrayal that science female students are ugly and not smart poses some threats to some female students as they think men will not approach them and hence they will not get married. In such situations those girls who could have entered the university and opted for science specializations choose other fields instead, in fear of not getting married.

So such accounts capture how labeling and treating female science students as ugly hardcores makes women feel uncomfortable and perhaps this is part of the reason why women might choose to opt out of science. Such incidences highlight the moment of realizing that women in

the social world of science are stigmatized by gender. This suggests that how some men can play an active role in discouraging women from participating in male dominated fields. The implication of this is that, in order to succeed, women have work to do in addition to their science, in trying to ignore all verbal intimidations and blunders of their male colleagues which on the other hand men do not have to do this.

8.3.2 Lack of motivation and role models

Role models both in and out of school are crucial in encouraging greater involvement of girls and women in science as stated by respondents in chapter seven. The influence of role models is often underestimated by many, yet testimonies abound of women in high positions in scientific fields who their success and choice of career has inspired some females to participate in science education. Lack of female role models in science specializations from the lower levels discourages Tanzanian female students from specializing in science-related fields in higher education levels.

Bandura's observational learning theory indicates that people identify more readily with and learn faster from people who are similar to them. Assumptions are that, the more sex-typed behavior the child observes, the more sex-typed the child's own behavior and attitudes are likely to become because children tend to imitate people who they see as being like themselves. In this case the low numbers of women in science fields in Tanzania pose threats to females' participation in science as female students as well as junior staff may have no senior women colleagues to act as role models and serve as mentors in providing them with access to networks of necessary professional information. Also since there are few women at the executive level or university boards in all three universities, women students have few role models and their views are seldom heard enough to make an impact.

Parents' education especially mothers is an important influence for the daughters education. Because of poverty in Tanzania, you find that those children who are out of primary school have mothers who themselves received no education. The implication of this is that the education of a daughter can often seem pointless to households where the mother has traditionally spent her life doing domestic work. When mothers are educated, they serve as role models to their children and they want them to have higher education. This emphasizes the importance of getting more Tanzanian girls into school, especially as they will be the mothers of the future and thus be essential in ending the vicious cycle.

I would therefore argue that without role models that are proportional to the number of women in society, the education system will continue to uphold male power and authority roles and we will continue to see few women engaging in science education. Exposing girls to more female role models who engage in science the same way as their male colleagues can reflect an equality feminist perspective.

8.3.3 Lack of encouragement and support

The findings from the study revealed that many girls and women in Tanzania do not aim high academically in pursuing science education, because they lack sensitization, motivation and encouragement right from their early life upbringing. Girls and women in Tanzania have not been supported or encouraged to pursue science education by their families, peers, the society, the government and by the teachers themselves.

Parents play a central role in the creation of sex-differentiated values and self perceptions. Socializing effects of parents' behaviors and beliefs where girls are asked to help mother doing the house work while boys are asked to assist the father in doing craftwork, have an impact on girls engagement in science education.

The implication of this is that since girls have less opportunity to practice in technical and scientific activities than boys, their science knowledge acquired has a much smaller basis of experience so when teachers rely on equal processing for boys and girls, boys have the better chance. I argue that girls should be given the same opportunities as boys to gain experiences that are relevant for the learning of science. The same methods of learning science should be used to teach boys and girls in a relevant manner since there is no difference in how males and females engage in science.

Apart from parents, husbands were also mentioned as a discouraging factor in females' participation in science education. Some husbands who did not attain post-secondary education do not encourage their wives to continue with university education. Recalling the case of a student from institution B, the husband purposely impregnated the wife after learning that she was joining the university. It was not in their plan to have children at that time but because of the selfish behaviour of the husband, he did it and as a result the student was performing poorly in studies and had a lot of supplementaries. For such a case the female student was at the verge of discontinuation. My personal feeling about this situation is that

those husbands who are too much engrained in traditional cultural practices, what they would like to see from their wives is to give birth, raise children and take care of the husband. I condemn such a cultural practice because it contributes to the under developing of both the household and the society at large.

It was also learnt from the findings that discouragement by male peers at the level of higher education influences academic performance and motivation of females in science education. The verbal intimidations mentioned in chapter seven that is 'viwango duni' meaning low merits, erodes the confidence of some females. Science enrichment programs can be helpful in counteracting these effects by giving the females a science supportive peer network.

In addition, teachers' attitudes were mentioned as an influencing factor in females' participation in science education. The case of a male mathematics teachers' behavior towards female students portray how well teachers contribute in the discouragement of females in pursuing science education (see section 7.1.4). It is obvious that the teacher did not make any comments that would encourage students to stay in class, but rather made some comments that might infact discourage girls from ever attending the maths class. If general attitude in society is that science is better suited for boys than girls, then it is not surprising that the teachers have the same attitudes as the rest of the society. My opinion about this is that teachers unconsciously discriminate against girls in classes because of their many years of exposure to the pedagogy of difference, which stresses differences between males and females rather than similarities.

These common practices of gender discrimination in the classroom are not only observed in Tanzania but also elsewhere in Africa. A study conducted in Rwanda revealed that there was silencing and subjugation of girls through deliberate discriminative behaviour in mathematics classroom (Wamahiu, 1996:55). The researcher found that the male teacher called the weaker girls to the blackboard more often than boys and brighter girls. If the girls called to the blackboard could not complete the work, comments were made by the teacher and male students alike concerning the ability to complete the task. Often the teacher would then call upon one of the more capable boys to complete the problem (ibid).

It is clear that the messages being sent in educational setting really matter and that through one's message female students can be helped to perform up to their potential. With all the above arguments indeed I support Wamahiu (1996:56) when he argues that, "The pedagogy

of difference ensures that more African girls than boys remain out of the formal education system of their countries”.

The equality feminist view is that sexes are equal enough in their intellectual abilities; hence men and women should therefore have equal opportunities in education. Women like men flourish in science when they are given the opportunity and a supportive environment. The success of those who went through Pre-Entry Programmes sometimes outperforming direct entrants has been attributed by the support and encouragement which they get from some teachers and parents which builds their confidence and determination to perform. Science teachers, parents, husbands, the government and professional associations have important roles to play in promoting women and girls’ participation in science and technology education in Tanzania.

8.3.4 Confidence and female inferiority complex

Lack of confidence in some Tanzanian women was identified as a factor affecting women’s equal representation in higher ranks in universities and in science education as a whole. This is evident in Tanzania during undergraduate science classes whereby female students do not participate as much as male students in asking questions during lectures. If something is not understood in class females would rather keep quiet until the lecture is over and that’s when you will observe them seeking for clarification from either male or other female students. This holds true even in secondary schools where females are observed to be passive in class unless the teacher devises a method to make them talk.

Schenkel (cited in Makame, 2008) asserts that women lack confidence because they have doubts and fears among them. They normally question their intelligence, talent, and skill. They wonder about the value of their ideas and actions. Women have trouble taking themselves seriously, finding it hard to believe their talents warrant full expression and recognition. Women have tendency to minimize their accomplishments. The major reason for women to lack confidence is that they, as women learn to view their abilities in the same way that society views them (ibid). In the context of Tanzania, many women lack confidence to do science subjects because the society itself does not have confidence on women that they are able to do and accomplish those tasks done by men.

8.3.5 Societal roles and stereotyping

In most African societies, women's places are markedly distinct from that of men in almost all aspects of life (Mhehe, 2002:164). The perceptions of women's abilities, roles and needs are strongly held, defining the boundaries of both what women are expected to do by their communities and societies and what women expect of themselves; this has profound implications for the education prospects for girls and women right up the education chain (ibid).

In the Tanzanian context, the society considers women's major roles to be child bearing and rearing. Due to societal and reproductive roles many girls and women consider education as of secondary importance to them. There are concerns about balancing academic life with family such that many women resist the pursuit of science education because they perceive it as incompatible with raising a family. Women faculty members often choose not to continue the studies needed to gain advancement within higher education institutions because of the caretaking roles they assume, and the need to undertake doctoral training outside of Tanzania.

This double burden of social responsibility reproduces the gendered nature of higher education institutions, which remain predominantly male, in both the formal classrooms and the broader institutional climate. A male administrator from university B explained how women's science career attainment and productivity tend to be comprised during child bearing and early child rearing years. He explained that this period for most women occurs during the crucial early stages of their career. The most discouraging part of the interview was when he said, (I quote him):

So it's one of those things there is nothing we can do about because we want them to be mothers, we want them to be wives and we also want them to be scientists.

These comments are discouraging because it shows that the situation at hand does not have any solution. It appears that this is a helpless situation to women scientists and at one juncture or the other they are supposed to sacrifice either their family issues or their academic careers.

I argue that if post secondary institutions in Tanzania had women convenient structures such as child care facilities for nursing mothers and those with young children then balancing the triple burdens of being mothers, wives and scientists could have been solved. Even public affordable day cares which are currently unavailable in Tanzania could have helped in reducing the child care burden to women. It is obvious that personal needs of young female

faculty (child bearing and care) that are by nature poorly aligned with female –unfriendly government and institutional policies could account for some of the gender gaps in science.

8.4 Institutional (educational) barriers

The educational related barriers are discussed below with literature.

8.4.1 Lack of Science teachers and teaching facilities

The study also identified that inadequate facilities, equipments, teachers and books for science as discouraging factors for girls to drop science specializations.

Lack of a school laboratory, facilities or chemicals is observed to be a major hindrance in the effective learning of science. Unavailability of some apparatus and chemicals like Nitrates, Bicarbonates and Ammonium salts deprive students the ability to do practical work. It is obvious that laboratory activities offer important learning experiences in the learning of science. Inability to do practical work in the laboratories makes teachers rely more on the ‘chalk-talk’. For over a century, laboratory experiences have been purported to promote science education goals including understanding of scientific concepts; the development of scientific practical skills and problem solving abilities; and interest and motivation (Lunetta, 1998 cited in Ngezi, 2005).

From the study, it was learnt that most of the recently built government ‘ward’ secondary schools had no laboratories. It was also learnt from the findings that those schools without laboratories opted for ‘Alternative to Practical’ mode of teaching and administering exams. The School Inspectorate department under the Ministry of Educational and Vocational Training conducted a research on the effectiveness of alternative to practical mode of teaching science subjects in the provision of practical education and it was found out that 85.24% of the respondents in the survey recommended that schools should conduct laboratory practicals instead of alternative to practicals as these develop skills in students that are necessary for societal and individual needs (URT, 2008:49). It is known that for teaching and learning to be effective classroom facilities are inevitable. So for such cases where there are no laboratories, it is clear that if students do not take the effort to seek extra coaching elsewhere, their performance in science will continue to be poor.

In the study it was found that teaching methods used in secondary schools is one of the strong factors that contribute to the low participation and performance of girls in science in Tanzania. Methods used in secondary schools in Tanzania are predominantly teacher-centred with very little effort to relate the concepts being taught to real life in the context of the girls' environment. In Tanzanian secondary schools, a lot of rote learning and memorizing is encouraged and students learn science for the sake of passing exams and not mastering the concepts. It is high time now that teachers be encouraged to use methods that stimulate curiosity, questioning of existing procedures, hypothesizing, experimentation and looking for reasons as opposed to cramming facts and memorizing definitions. It is true that effective teachers use a variety of instructional techniques to encourage meaningful learning as suggested by Elliot et al. (cited in Ngezi, 2005). The use of a variety of teaching strategies should be advocated as each student is a unique being and has different learning needs.

Findings from the data show that qualified science teachers were lacking in Tanzanian secondary schools and this results to poor performance in females taking science hence they cannot qualify for university entry. To counteract the effect of lack of enough and qualified teachers the government made a deliberate effort in 2005 to upgrade two teachers' colleges to university colleges now called Dar-es-salaam University College of Education (DUCE) and Mkwawa University College of Education (MUCE). This will help to a great extent in reducing the shortage of science teachers in Tanzania.

The findings also revealed that secondary school science teachers were engaging themselves in other income generating activities such that they tend to concentrate so much on their business and tend to be less effective in teaching. The erosion of salaries in Tanzania has meant that secondary school teachers often receive less than half the amount of the household absolute poverty line. This implies that teachers often need to supplement income by offering private lessons, running their own business or the like to the detriment of their regular attendance and performance in schools.

It is a very common practice in Tanzania that teachers give supplementary lessons called 'tuitions' sometimes during the ordinary school hours in order to make more money. At one time the government intervened and abolished the so called tuitions but again this practice resumed and is still going on today. Tuitions themselves are not bad if they are conducted in a proper manner such that they are done after the ordinary school hours. Since not all parents can afford paying tuitions for their children, if these children miss what is supposed to be

taught in class by teachers, there is no way for compensation through after class coaching. Also given the circumstances that these tuition classes are sometimes conducted late in the evening, parents do not allow girls to attend such classes in fear that they may be victims of harassment.

I can argue that tuitions have brought some kind of division whereby students from low socio economic backgrounds are discriminated as they cannot afford to pay for the tuitions.

I attribute the shortage of science teachers and teaching facilities in Tanzania to the lack of policymakers' will to invest much in the science education sector. Not because Tanzania has no money to do so but because most of the financial resources are directed towards political activities rather than science development. My argument is that, conducive teaching and learning environment; provision of social services to teachers and good salary raises teachers' job satisfaction hence brings about students' high academic performance in science.

8.4.2 Sexual harassment

Sexual Harassment as defined at the University of Natal is any unwelcome and unwanted sexual conduct such as verbal comments, abuse, gestures or physical contact of a sexual nature by an individual or a group which is judged by the recipient(s) to have resulted in discomfort of some kind being mental, physical or social in nature (FAWE, 2001).

It was revealed from the findings that, on campuses females suffer sexual harassment from their colleagues and from their teachers. In the studied universities some male lecturers were said to prey on their female students, threatening to fail them, on the other hand rewarding female students who 'cooperate' with high marks. Such intimidation and harassment at some instances has created an atmosphere where girls are scared to join universities.

The case of the female administrator who has experienced harassment throughout her academic career is painful. She experienced sexual harassment and discrimination as a student, lecturer and even as an administrator just because of her gender. The accumulative effect of these putdowns which occur in the course of everyday interchanges creates a chilly learning environment to both female students and academic staff. Such experiences can place women student at an educational disadvantage through discouraging their classroom participation, preventing them from seeking help from male teachers outside the class, causing them to drop or avoid certain classes and even to leave an institution.

So apart from the pressure of studying science subjects which are demanding, girls are being inflicted with other non-academic experiences which males on the other hand do not have to go through. The blames being casted on women for their low performance is not for any other reason like biological differences or cognitive differences but it is because of such actions. All of these can have the effect of undermining confidence and dampening career aspirations.

Such actions are indicators of the hostile learning environment that girls and young women face especially in some African universities where no official policy for protection of women exists. Even those universities which have specific policies, example UDSM has the Anti Sexual Harassment Policy, such acts are still going on as was reported by some respondents in chapter seven (see section 7.1.7)

The data show that sexual harassment is not only evident at the level of higher education. Young girls attending day secondary schools are said to encounter a lot of sexual assaults on their way to and from school. No wonder many girls are withdrawn from school partly due to parental fear of girls' safety. There isn't a specific government policy like that of UDSM dealing with sexual harassment issues against female students in secondary schools in Tanzania.

If this problem is not tackled first at the secondary school level, we will continue to see less and lesser females enrolling with higher education institutions, particularly science education as many would have been affected and dropped out of school before even completing high school. I argue that subtle forms of harassments such as the ones described in chapter seven can often inflict the most damage to females participation in higher education hence science education, because they occur in a silent and flimsy manner and are not treated with any seriousness. Equal participation of women in science education will not occur if such actions at secondary and post-secondary institutions continue. The government should take more serious measures in combating these acts by bringing before the law those men who are suspected to be conducting such actions and taking girls away from such environments by building more boarding facilities especially those studying in big towns.

8.4.3 The masculine nature of the administrative role and limitations to academic opportunities

From the statistical findings it was observed that women in science are greatly underrepresented as lecturers, associate professors and professors in all three universities. It is acknowledged that there is gender imbalance in the staff recruitment and development for both academic and administrative staff. Consequently there are unequal opportunities for women and men in higher academic and administrative positions.

Socio-cultural attitudes strongly influence the level of women's participation in the university and research institution. Tanzania is characterized by a patriarchal system that determines gender relations across social, economic and political spheres of life and hence makes women lag behind men in all aspects including in science education. Equality feminists recognize that women have largely been barred from practicing science because of political and social forces external to science. Persistent attitudes in Tanzania such as women's reproductive responsibilities are not compatible with a career can prevent women from being hired or even if hired can prevent women from promotion as people have the tendency to think that a woman cannot hold positions which are held by men as she has other family responsibilities to take care of.

Equality feminists argue that the ability of creating valid scientific knowledge is not determined by gender or sex but by one's scientific training, thus women and men are equally capable of contributing to scientific development provided that all obstacles hindering their participation are removed. Sex/gender of the individual should not impact on the production of scientific knowledge

The comments mentioned by one respondent that administrative positions are challenging and women cannot withstand such things as boycotts from students are not true. My undergraduate experience while studying in one of the universities under study, I have witnessed women who can perform their administrative roles equally as men. For example one of the very first women to hold a very high position in the University administrative structure was very successful during her term of service. Being a Chief Academic Officer she was able to handle her duties well. I recall during demonstrations when science male students used to assault her and use all forms of abusive language that they cannot be led by a woman.

The male students from faculty X were known to be the most arrogant and aggressive among all other faculties. One of the fore front male student in a demonstration was quoted as saying:

Atatuambia nini sisi? Kwanza degree yake ni ovyo ukilinganisha na sisi wanaume tunasomea vitu vya nguvu.

Translation

What can she tell us? First of all her degree is nothing compared to us men we are studying things which are worthwhile.

So it is evident that women in administrative positions can often encounter condescension on the part of the male students and colleagues. Underestimation and misjudgment of females working capacity discourages some females in taking part in senior management positions. It is true that some tenured women faculty in the universities studied, feel marginalized and excluded from significant role in their departments despite having professional accomplishment equal to those of their male colleagues.

8.4.4 Masculine image of Science and Mathematics

It is clear that particular attitudes about science may define it as a male field and therefore encourage male participation and discourage female participation. The wide spread myth that science is for boys makes girls wonder why they should labor so hard in such subjects. The cognitive development theory assumes that if the image of science to male and female members of the society is different from childhood, this image does not seem to improve as the child of either sex grows up and is capable of making sense of the world by his/her own accord. Cultural beliefs about the masculine nature of scientists and science abound and may distance women from the field.

The study revealed that scientific textbooks in Tanzania have reinforced the notion that science is a masculine endeavor by mentioning and picturing men almost exclusively and by showing the few women who do appear in gender-stereotypical roles. Barbercheck (2001:118) argues that it is difficult to imagine that the constant pairing of ‘scientist’ and ‘man’ has no effect on women.

Wamahu (1996) argues that the differential treatment of the genders not only appears at home but is also observed in African textbooks where girls and women are particularly absent from Mathematics, Science and Technologically oriented books. He contends that the

pedagogy of difference is not only transmitted through textbooks but also by teachers themselves who act as the mediators between curriculum developers and textbook writers. It is true that textbooks are sometimes the sole property of the teacher especially in developing countries like Tanzania where books are scarce. The teacher is the one who transmits and interprets the content to the learner as a result the content of the textbook is indirectly transmitted to the learners influencing them in some way. Wamahiu notes that the authoritarian climate of the African classroom provides a perfect breeding ground for the pedagogy of difference.

Studies in Tanzania and Zambia have documented the continuing presence of stereotypes in textbooks (Stromquist, 1998 cited in Geiger, 2002: 12). It is interesting to note that even after 12 years from Stromquist's observation, gender stereotyping in science and mathematics textbooks still exists in Tanzania. It is therefore necessary that gender biased illustrations in text books should be removed and males and females should be portrayed in untraditional gender roles.

The Pedagogy of difference propagates the view that males and females are not only radically different, but that females are physically, and more significantly, intellectually inferior to males (Wamahiu, 1996). From this statement it is a fact that gender stereotypes are used as standard for evaluating categories of people which result in certain fields being reserved for certain groups. This is a typical case with science education where because of the several aforementioned arguments; females automatically feel they don't fit in the male science arena especially Physics which is taken to be the most masculine of the science subjects as expressed by the interviewees. This results in low achievement and low participation by women.

As revealed by statistical data in chapter seven, the image of science in higher learning institutions in Tanzania is strongly gendered and aligned with hegemonic masculinity. The perception of science as a male area by some females filters them from an unconditioned choice.

From all the above I can then say that the textbooks that are used in schools must present both male and female gender fairly because the image that both boys and girls receive in school shape their self-perceptions and views of themselves and also shapes what they grow out to be in society. Because of many types of equity intervention programmes in Tanzania, some

teachers are now more aware of how damaging stereotypic comments can be and they are trying to avoid making them. However the problem has not been totally eliminated.

8.5 Evaluation of the strategies set by the government and universities to reduce gender imbalance in science in higher education

The UDSM which is the oldest university in Tanzania launched its Gender Policy in 2006, and one of the set strategies has been the target of reaching at least 50% females of top leadership positions, heads of departments and student leadership by the year 2010. This target is still very far from being achieved as it is evidenced at the College of Natural and Applied Sciences where seven out of the eight heads of departments are males. Also at DUCE in the faculty of science, so far the highest academic rank held by a female is a senior lecturer position and only one female possesses that rank. Females' participation has not increased in the levels anticipated as it is evidenced by persistence gender gaps in the entire UDSM management. From a feminist point of view, I argue that gender equity in science education can only be established by changing discriminatory practices that obstructs females opportunities to engage in science education on equal terms as males.

The objectives of the UDSM Sexual Harassment Policy among others include eliminating incidents of harassment, preventing sexual harassment, remedying sexual harassment situations and providing methods for dealing with individuals who harass. Many of these set objectives are not met or if met it is to a very small extent. Sexual harassment practices are still going as it is evidenced by responses from the interviews. There is a need to popularize the policy further so that all victims of sexual harassment become aware of their rights because many cases still remain unreported

The Pre- Entry Programme for female science students at the UDSM has succeeded in increasing enrolments in science specializations. For example in 2003 the proportion of female students increased from 15% to 30% (Faculty of science, 2001 cited in Nawe, 2002). This is indeed a great achievement and a very gratifying development in the fight for equal rights in the science fields as girls in Tanzania have rarely been encouraged to consider pursuing scientific subjects. Such a development is seen as an opportunity for the recruiting of more women onto second degree programmes as well as in teaching positions in secondary schools where the female to male science teacher ratios are discouraging.

Due to the success of the Pre-Entry Programme that aimed at increasing the number of female enrolment in science fields, a new transformation was entrenched at the UDSM whereby university's management decided to adopt the admission criteria under PEP to be official criteria for all those female students applying for science degree programmes.

My personal opinion about these strategies is that, a strong policy environment exists at the UDSM but the implementation strategies set are very slow. I support Armour (2003) when he argues that many post- secondary institutions and workplaces have policies which support gender equity but practice and behaviour within the institutions are inconsistent with these policies and the implementation of guidelines and monitoring of compliance to equity policies are often absent.

The government through its Education and Training Policy (1995) has put the support of girls' boarding and hostel facilities as one of its major policy thrust. The government currently no longer concentrates in supporting and encouraging the construction of hostel/ boarding facilities for girls in day secondary schools especially in big cities like Dar-es-salaam and as a result girls continue to suffer from sexual harassments acts on their way to and from school.

In order to raise the participation rates of women, the Education and Training Policy (1995) advocated the implementation of policy number 3.2.11 which states that: Education and school systems shall eliminate gender stereotyping through the curricula, textbooks and classroom practices (pg.20). Up to now no major changes in textbooks have been realized in Tanzania. I would therefore like to argue that the school practices and the curriculum offered in schools in Tanzania and elsewhere in Sub –Saharan Africa have failed to address the gender concerns and help eliminate gender biases as early as in Primary education such that the consequences are observed at a later stage in higher education where girls are invisible in science education.

The Tanzania National Higher Education Policy published in 1999 acknowledges deteriorating infrastructure and facilities in secondary schools and higher education in Tanzania. It has set the strategy of expanding physical and pedagogical facilities (e.g laboratories, scientific equipment, chemicals) within the science based faculties, departments and schools. Tanzania still has a long way to go with the implementation of this strategy of expanding physical and pedagogical facilities. Observations based on the findings have

revealed that many ward secondary schools which have been built recently lack the necessary facilities for science training. Many secondary schools completely do not have laboratories and this hinders effective teaching and learning of science subjects. With inadequate facilities, the chance for a good teaching approach in science is in my opinion very limited.

8.6 Conclusion

The education of girls and women in science is a very important topic as it relates to future equality of the next generation of women. Therefore it is understandable why feminist critics of science are so interested in correcting the flaws of the system.

Parity between men and women in higher education in Tanzania is still far from being achieved in the three universities. The number of women participating in science education is still very low despite the considerable efforts that have been made to narrow the gap. I argue that the pedagogy of difference is a dominant factor responsible for the underrepresentation of women in science education as it stresses more on the differences among African males and females rather than the similarities. Indeed, it is unless the *pedagogy of difference* is replaced by the *pedagogy of empowerment* otherwise the gender gap in African education will continue to widen. To increase the participation of women in science, it is necessary that all obstacles that have been identified in the study be removed.

The barriers to girls' and womens' participation in science mentioned so far are all relatively easy to overcome in principle atleast. It is to a great extent a question of money; in building facilities and providing adequate materials, increasing salaries to motivate science teachers but those barriers bolstered by social and cultural norms and practices are difficult to change and that's why more sensitization and conscientization programmes are required to educate the mass about the importance of girls' and womens' education.

8.6.1 Recommendations for Action

On the basis of findings and conclusion above the following recommendations are made.

- The government needs to adopt a comprehensive National Higher Education policy to promote science education for females and in favor of females already engaged in science education.

- Scholarships should be awarded to deserving women who are kept from achieving high performances in science due to many other issues. These scholarships should be awarded both at the undergraduate and graduate level so that those who can succeed in their studies can come back to boost the teaching staff strength at the university. Poland has succeeded in attracting more women in science through such scholarships and funding research work.
- The Affirmative Actions such as Pre-Entry Programme for female science students are short lived. They have succeeded in increasing the number of female students in science programs, so the government should make them long-term action programs by seeking more internal donors to fund them.
- Awareness should be created in the society such that those perceptions like women are the one's responsible for family activities should be eradicated.
- In secondary schools, long term strategies should be improvement of school conditions, increasing the number of science teachers and facilities and improving the competence of teachers through salary increment.
- Sexual harassment acts should be eradicated to ensure that female students and staff study and work in environments which allow them to use their abilities and potentials in realizing higher achievements and success in science.
- Gender disaggregated data should be kept in place in order to enable better implementation of initiatives.

8.6.2 Recommendation for further studies

This study limited its focus to the factors that keep women away from participating in science education. Further research focusing on women who have succeeded in science is needed.

This will help to shed light on why these women have succeeded while many fail.

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Appendix

Appendix 1: Letter of Authority from Directorate of Research, UDSM.

UNIVERSITY OF DAR ES SALAAM
DIRECTORATE OF RESEARCH
P.O. BOX 35091 ♦ DAR ES SALAAM ♦ TANZANIA

Tel: 2410500-8 Ext. 2087,2077,
2410743, 2410727
Mobile: 0754 270789
0784 767247



Fax: 255 022 2410743
255 022 2410 023
e-mail: research@udsm.ac.tz

Ref. No: AB3/12(B)

The Principal,
College of Natural and Applied Sciences,
University of Dar es Salaam.

8th July, 2009
RECEIVED
Date 10/7/09
College of Natural and
Applied Sciences
University of Dar es Salaam

**Re: PERMISSION TO CONDUCT FIELDWORK AT THE UDSM –
MS S.D. BIPA**

I am writing to introduce to you Ms Susan Darius Bipa who is pursuing a Master of Philosophy Degree in Comparative and International Education at the University of Oslo, Norway.

Ms Bipa is currently in Tanzania for her fieldwork. She is thus requesting permission to collect data from your College, particularly from the Departments of Chemistry, Physics, Botany and Zoology. Her research is entitled "**Participation of Women in Science Education: Trends and Issues in Higher Education in Tanzania**".

It will be appreciated if Ms Bipa will be granted any help that may facilitate her to achieve research/fieldwork objectives.

Prof. J.V. Tesha
DIRECTOR OF RESEARCH

Appendix 2: Letter of Authority from College of Natural and Applied Sciences, UDSM.

**UNIVERSITY OF DAR ES SALAAM
Principal's Office
COLLEGE OF NATURAL AND APPLIED SCIENCES**

Telephone: 2410500/-8 ext.2686
Direct: 2410129
E-mail: principal@science.udsm.ac.tz

Our ref: T.8/Vol.VII/SC/2009
Your ref



Address: P.O. Box 35065
Dar es Salaam
TANZANIA

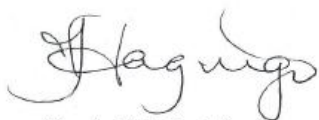
Date: 16 July 2009

To: Head, Botany Department
Head, Chemistry Department
Head, Physics Department
Head, Zoology and Wildlife Conservation Department

**Re: PERMISSION FOR MS. S.D. BIPA TO CONDUCT FIELD WORK
AT UDSM**

Attached please find copy of letter from the UDSM Director of Research and the University of Oslo Senior Executive Officer.

You are directed to facilitate Ms. Bipa to achieve her research/field work objectives.



Prof. F.S.S. Magingo

Principal, College of Natural and Applied Sciences

Permission Bipa

Appendix 3: Letter of Authority from Dar-es-salaam University College of Education



DAR ES SALAAM UNIVERSITY COLLEGE OF EDUCATION



A Constituent College of the University of Dar Es Salaam

Tel 022-2850975
Fax 022-2850952
E-mail: principal@duce.ac.tz

**OFFICE OF THE DEPUTY PRINCIPAL
ACADEMIC**

PO Box 2329,
Dar es Salaam,
Tanzania.

DUCE/OF/R2/5/4

13th July, 2009

Ms. Suzan Darius Bipa
P.O.Box 35475
Dar es Salaam.

RE: PERMISSION TO CONDUCT RESEARCH AT DUCE

Reference is made to your letter of 8th of July, 2009, on the subject matter.

You are hereby informed that permission has been granted to you to conduct your research at DUCE on "*PARTICIPATION OF WOMEN IN SCIENCE EDUCATION*"

Also note that the permission period for your research should not exceed one month, i.e. from 15th July 14th August, 2009. While you will be at DUCE, you may consult the office of Deputy Principal, Academics for assistance.

Shaaban M. Mtengeti
For: Deputy Principal Academic

cc: Principal
cc: Deputy Principal (Academic)
cc: Deputy Principal (PFA)
cc: Deans of Faculties
cc: Head, Library

Appendix 4: Letter of Authority from Directorate of Research, Open University of Tanzania

THE OPEN UNIVERSITY OF TANZANIA
DIRECTORATE OF RESEARCH, PUBLICATIONS,
POSTGRADUATE STUDIES AND CONSULTANCY

P.O. Box 23409
Dar es Salaam, Tanzania
<http://www.openuniversity.ac.tz>



Tel: 255-22-2666752/2668445
ext.2101
Fax: 255-22-2668759
E-mail: dpgs@out.ac.tz

15.07.2009

Ms. Susan Darius Bipa,
P.O. Box 35475
Dar es Salaam
Tanzania.

Dear Ms. Susan Bipa,

RE: REQUEST FOR FIELD WORK AT THE OPEN UNIVERSITY OF TANZANIA

Kindly refer the above heading and your letter dated 8th July 2009 for conducting field work at the Open University of Tanzania.

I am pleased to inform you that your request has been accepted to conduct field work as outlined in your letter.

Yours sincerely,
THE OPEN UNIVERSITY OF TANZANIA

Prof. S. Mbogo
**DIRECTOR, RESEARCH, PUBLICATIONS, POSTGRADUATE STUDIES
AND CONSULTANCY**

Appendix 5: Letter of Authority from Open University of Tanzania

THE OPEN UNIVERSITY OF TANZANIA *Office of the Deputy Vice Chancellor (Academic)*

Tel: +255 22 2668820
Fax: +255 22 2668230
Fax: +255 22 2668759
Email: dvc-ac@out.ac.tz
Website: <http://www.out.ac.tz>



Kawawa Road, Kinondoni
P.O. Box 23409
Dar es Salaam,
TANZANIA

Ms. Susan Darius Bipa,
P.O.Box 35475,
Dar es Salaam.
Tanzania.

23rd July 2009


Dear Ms. Susan,

RE: PERMISSION TO ACCESS DATA SOURCE AT THE OPEN UNIVERSITY OF TANZANIA.

Kindly refer the heading above; Susan Bipa is the student from University of Oslo, Norway pursuing masters of Philosophy in Comparative and International Education.

In order to fulfill writing her thesis she needs to collect data in different areas particularly in the enrolments of students, performance, employment and distribution in the fields of Physics, Chemistry and Biology.

Please assist her accordingly.


Prof. M.A.M Victor,
Ag. Deputy Vice Chancellor (Academic)

C.C DFSTES
C.C Admission Officer
C.C DES
C.C. Statistician

Appendix 6: Interview guide for female and male students

1. It appears that women's participation in science at the level of higher education is very low in many developing countries. What do you think is/ are the reason(s) for the under-representation of female science students in Tanzanian universities?
2. Being a female/male student in this university, have you ever experienced bad practices such as sexual violence, sexual harassment, abuse, sexual assault and the like as you interact with male/female academic staff, male/female students and fellow male/female students? Please express your views on this.
3. Do you think female under-representation in science related fields has any impact on Tanzanian society? If it has, Please briefly explain how?
4. What is your general opinion about the methods used in teaching science subjects in secondary schools in Tanzania? Please explain briefly.
5. Are you aware of any interventions/ Affirmative Actions at the university that are geared towards increasing participation of women in Science related fields? If so, what can you say about them?
6. Explain briefly what you think could be done to reduce the science gender gap in higher education in Tanzania.

Appendix 7: Interview guide for female and male teaching staff and administrators

1. It appears that employment of women in science fields in many universities in developing countries is very low compared with men. What do you think is/are the reason(s) for the under-representation of women lecturers and administrators in Tanzanian universities?

2. Could you please give reason(s) why there is a small number of female students in Tanzanian universities?

3. Being a female/male lecturer or administrator in this University, have you ever experienced bad practices such as sexual violence, sexual harassment, abuse, sexual assault and the like during the course of teaching or working? Please express your views on this.

4. What is your general opinion about the methods used in teaching science subjects in secondary schools in Tanzania? Please explain briefly.

5. Are you aware of any interventions/ Affirmative Actions at the university that are geared towards increasing participation of women in Science related fields? If so, what can you say about them?

6. Do you think female under-representation in higher education and in science related fields has any impact on the Tanzanian society? If it has, please explain how?

7. In your opinion, what do you think could be done to reduce the science gender gap in higher education institutions in Tanzania?