GENDER DYNAMICS IN SCIENCE AND TECHNOLOGY

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ABSTRACT
An understanding of gender dynamics in science and technology is based on the perspective of how social norms, values and attitudes dictate differentials in the participation of male and female in these fields. This in essence calls for a critical consideration of the forces, naturally and socially ascribed, that influence the choices that women and men make, both in education and professional alienation. While gender refers to socially ascribed differences between males and females as women, men, girls and boys, there are notable natural differences dictated by sex that cannot be ignored. The discussion thus zeroes into what males and females can do, and what they think they can do or are expected to do by the society. The ideal is therefore on the differences between nature and nurture and by extension, sex and gender. The argument is that more than the physiological make up of an individual, the concept of gender is responsible for the female's lack of venture into science and technology, viewing it as a no go zone, hence male dominated in theory and practice. While education as a whole is important in empowering individuals, skills and knowledge in mathematics, science and technology are known to guarantees a place in the related world of work. The existence of glaring gender disparities in the participation in science and technology on the basis of gender is a global concern; hence a need to engage in scaling up strategies to encourage female to intensify their interest and participation in these areas, while ensuring that boys and men stay on.

Key words: Gender, sex, participation, disparity, science and technology

1.0 INTRODUCTION

A consideration of gender dynamics in science and technology puts to question various aspects that dictate the relations between female and male in these fields as learners, scholars, professionals and consumers of the same. Importance in these aspects is on both the quantity and quality of the female and male participation in terms of numbers, specific disciplines of engagement, levels of participation as well as the existing 'laws', natural or man-made that at times govern the relationships among women, men, girls and boys. A noticeable trend in recent researches on gender is the revelation that girls and women live in a state of deprivation in terms of equal opportunities as compared to their counterparts, boys and men respectively. Whereas some researchers have attempted to offer explanations by analysing the state of affairs often from a historical perspective, others have remained purely descriptive with no reference to a general scientific theory by way of explanation (UNESCO, 2009; Kombo,2006).

This paper discusses the participation of women, men, girls and boys in science and technology, with reference to existing understanding of science and gender dimension in science and technology. From the historical perspective, the view held is that 'man' made laws, customs and traditions have created and enshrined a status that clearly differentiates between 'women and men' and 'girls and boys'. Nevertheless, whether or not these laws, customs and traditions exist according to natural differences is debatable. It is this concern that makes gender dynamics an important element in science and technology both as a field of study and a product (American Association of University Women, 2000).

2.0 THE CONCEPT OF GENDER AND SEX

Presently the concept of gender applies to the differentiation between women and men and girls and boys. The differentiation often refers to the attributes of roles, responsibilities, characteristics, attitudes and beliefs about themselves and each other. Further, these attributes are institutionalised through a socialisation process and are therefore learned and do change over time, with variations within and between cultures. Many discussions on gender are often superfluous, with the term gender being used interchangeably with sex. The differentiation, however, goes beyond mere natural differences as the emphasis is on socio-cultural distinctions, created and perpetuated by the society. In this respect, there is no reflection of the universal natural or physiological differences. This does not disregard the biological differences between sexes, a natural difference, whose laws and institutions must be respected. The sex differences are manifested within the sex characteristics and roles, and are limited to procreation. Further, science dimension appreciates sex roles such as insemination and pregnancy as natural as they are dictated by the physiology or the biological make up male and female. On the other hand, gender roles are nurtured and therefore not natural as they are learnt and perpetuated within social institutions and culture.

3.0 IMPACT OF THE CONCEPT OF GENDER AND SEX IN HUMAN RELATION

Sex differences alone do not necessitate the many varied and often institutionalised relations between women and men and girls and boys. It also does not justify the differences in the way women and men participate in science and technology whether in learning, profession or in the day to day living. The cultural norms influence the choices made by girls, boys, women and men, often making women to downplay their ego, expertise and leadership qualities. Women have therefore remained in a deprived situation that the society has created for them, usually not aware of this, and even when they are, they do not know of any escape route. The situation gets worse in marriage institution, where some husbands expect wives to be "as good as their mothers"- supporting, caring, sacrificing, working and promoting others. On the other hand, most married women have been socialised that good wives are the ones who are not ambitious, always at home, satisfied with less demanding careers and non-confrontational (Kimani and Chiuri, 2004).

The gender perspective brings in a new understanding of persistent and complex social structures and interests that perpetuate the subordinate status of girls and women, in relation to boys and men. While boys aspire to be the male figures they see in their fathers and other male adults, girls aspire to be the female figures they see in their mothers and other female adults they interact with. At the same time, the society and its institutions is making the best to intensify the interaction between young and adult males and females. Within this arrangement, family, educational institutions, religion, media and even politics play a key role as socialising agencies, based on the cultural realities and expectation. Since it is the mythological dimensions of culture that has had great influence on the lives and status of women and men, the gender dimensions remain critical in understanding why women and men live and behave the way they do and by extension why science and technology has fewer women than men.

Gender dynamics in science and technology are real and are perpetuated on the bases that every individual is socialised and filtered into 'his' or 'her' gender roles wrongly accepting the notion of differences as natural, permanent and therefore unquestionable. The complex nature of the situation in terms of what females and males chose to pursue and life priorities is the association of the perceived differences to nature, rather than nurture. Consequently, one school of thought argues that women have special characteristics, abilities, capacities and a distinctive feminine thought style which is more intuitive, more emotional, honest and creative and lateral rather than male thinking (Teichman and Evans, 1991). To counteract this argument, another school of thought advances that women and men are the same in nature, with acclaim that the special psychological characteristics of women and men are the result of social engineering (Teichman, 1991:133). On the same line of thought, other differences, for example, in the skin complexion, or body structure in different individuals is said to be genetically determined running with families and not an aspect of nurture.

4.0 THE REALITY OF GENDER AND SEX DIFFERENCES IN

SCIENCE AND TECHNOLOGY

With the increased knowledge and awareness on the differences between gender and sex, many scholars now agree that the socialisation process has a lot to do with what women and men do and become and their aspirations and pursuance of life goals. Women have not just proved but have also been accepted to be as gifted as men and hence what is needed is to have mechanisms in place to make all of them appreciate this and compete together, Time Magazine Vol. 163, No. 3 of Jan 19 (2004:34).

There has not been any conclusive study to show that women are genetically or naturally disadvantaged in intelligence and will-power to perform as compared to men. In fact, studies in Kenya have shown that girls out-perform boys in lower primary classes. This view is confirmed in a report of achievement tests administered to class five pupils in selected primary schools across Kenya, in a joint project of Kenyatta University, Rockefeller Foundation and the Ministry of Education Science and Technology (2004). The project was launched in 2002 and its aim was to put up in place strategies to enhance performance of girls in science, mathematics and technology. Achievement tests were administered in five subjects offered in the Kenya Certificate of Primary Education, (KCPE). The results from the project schools (single sex) indicated that girls performed better in all subjects except in Kiswahili, as demonstrated in Table 1.

SUBJECT	MEAN GRADE OF GIRLS	MEAN GRADE OF BOYS
Science	32.63%	32.53%
Mathematics	24.63%	24.3%
English	43.53%	42.13%
Kiswahili	44.77%	45.53%
C.H.C.	54.93%	54.53%
C.R.E.	27.6%	26.93%

Source: Wasanga (2004), "Results of achievement tests administered to class five pupils", Kenyatta University Report 6: KU and MOE Project on Enhancing Participation of Female Students in the Participation and Performance in Mathematics, Science and Information Technology.

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wisdom is wrong and unrealistic as girls can and often do as well as boys in all disciplines.

What is required is a change of attitude of those around them and a gender-responsive teaching and learning environment in the schools and the classroom in particular, so that all the girls are comfortable and challenged to learn and perform to the best of their potential.

As early as 1998, the National Research Council of United States of America (NRCUSA), citing evidence from a number of studies established that there was no difference in the performance of male and female students who had taken equal advantage of similar opportunities in any areas of study, including that of science and technology. This adds value to the current argument that there is no convincing evidence of innate natural differences in science, mathematics and technological ability for males and females. It is the beliefs that girls do not do well in these disciplines that erode the girls' sense of self-confidence in their interests and abilities in these areas. The understanding is based on both the science and gender dimension in terms of the competition between nature and nurture, UNICEF (Nov. 2007), where the latter over-rules.

Despite such controversial views, education is a major factor in shaping human development and social change. It is expected that through the education process, creation of a just society where issues of gender equity and equality prevail, is possible. The World Conference on Education for All (WCEFA) of 1990 in Jomtein emphases that education for development should equip the learners with adequate and relevant knowledge, skills, attitudes and values to empower them to bring about fundamental changes in their societies(Ombaka, 2004). Hence, participation in science and technology in the process of education serves as an important criterion of selection and allocation of positions in the 'world of work'(Ombaka, 2004).

5.0 NEED TO REDRESS THE SITUATION FOR AN INCREASED FEMALE PARTICIPATION IN SCIENCE AND TECHNOLOGY

According to the Commission of the Advancement of Women and Minorities in Science and Technology Development, (CAWMSTD) (2000), until 1970, African women had never featured prominently in science and technology and development plans. They had until then, been perceived, especially in western theories of development as housekeepers who needed to operate largely within the domestic sector. In contrast, men were perceived to be the breadwinners, producers and legitimately good in science and technology. The insignificant position of women was reflected in the type of education provided for girls and boys. They were taught domestic skills and home science as the most relevant to their domestic role as housekeepers, wives and mothers. It was not until the early years of the 1970s that, with the understanding of the significant role-played by women in the development process, women began to make an appearance in the area of development, in both theory and practice, Kabeer (2003).

The importance of 1970s as a turning point for the advancement of the women agenda in the development process was marked by the organization of the first International Women's Conference, which was held in Mexico, USA in 1975 and which culminated with the declaration of the International Women's Decade (1975-

1985). Within the decade, issues related to women's participation in socio-economic development were given lime light, a move that laid a firm foundation on the current gender agenda in the development process, CAWMSTD (2000).

Women have continued to be a missing link in the entire development process and particularly in science and technology, Dovi (2004). Since independence, the express purpose of education in Kenya has been to forge national unity and to reduce social inequalities and imbalances by ensuring that the individuals exploit their full potential for the achievement of self-fulfillment. To this effect Sessional Paper No. 10 of 1965 on ***African Socialism and its application to Planning in Kenya,*** had one of its educational objectives to 'Uphold social justice and to equalize economic opportunities among all the citizens'. Unfortunately, the socialization process of gender has resulted with a situation where girls and women have not had equal opportunities as boys and men in education, participation in the development process, especially in areas related to science and technology.

The Beijing Platform for Action (1995) in its focus on education identified improvement of women's access to vocational training, science and technology as a critical area of concern. In this respect, the platform proposed immediate action which included among others the provision of information to women and girls on the availability and benefits of training programme in science and technology; diversification of vocational and technical training and improvement of access and retention of women in science and technological programmes; and sensitisation against gender stereotyping which end up in channeling of girls and boys into specific and often limited fields of study, FAWE (1996).

The discrimination is not only in the gender disparities in access, participation and retention in the entire education system but in the choice of subjects that girls opt for in secondary schooling. Gender discriminating beliefs and practices regarding boys' and girls' abilities in science, technology and the related disciplines continue to be prevalent within the societies. This trend continues to the tertiary level, colleges and the university where girls are not well represented in departments and faculties, which require good foundations of science subjects, Kimani (2006). The result is that there are fewer female students taking science and technology in the university. Yet, the role of science and technology cannot be underrated especially with the current Kenya development goal of being industrialized by the year 2020, the achievement of the Millennium Development Goals (MDGs) and the realization of the Vision 2030, Ombaka (2004).

Although a full science curriculum is included in the Kenyan education system, there is a need to continually review the learners' participation and achievement in these subjects, the quality of the curriculum being designed and delivered and the participation of girls and women in particular, Republic of Kenya (2007). The low participation of female in science and technology is a global concern. The Association for the Development of Education in Africa (ADEA) and the United Nations Development Fund for Women (UNIFEM) (2007) observe that women form about 15% in the scientific fields in Africa and about one percent of them are in leadership positions.

As at January 2009, Gender Disaggregated Rapid Survey on the number of women and men academic staff in senior positions in a Kenyan public university, Kenyatta University revealed a very low participation of female in areas of science, Engineering and Information Technology. There were also no women in the positions of senior lecturers, associate and full professors in the schools of Health Sciences, Engineering & Technology and Agriculture, Kenyatta University Gender and Affirmative Action Unit (2009). This is despite the fact that women play a critical role within the community productive and reproductive life as they engage in agriculture and business enterprises as well as in the provision of health care and education. As they make 50.3 of the Kenya population, they should constitute a critical factor in the development process both as participants, producers and consumers, Kenya National Bureau of Standards (KNBS) (2007).

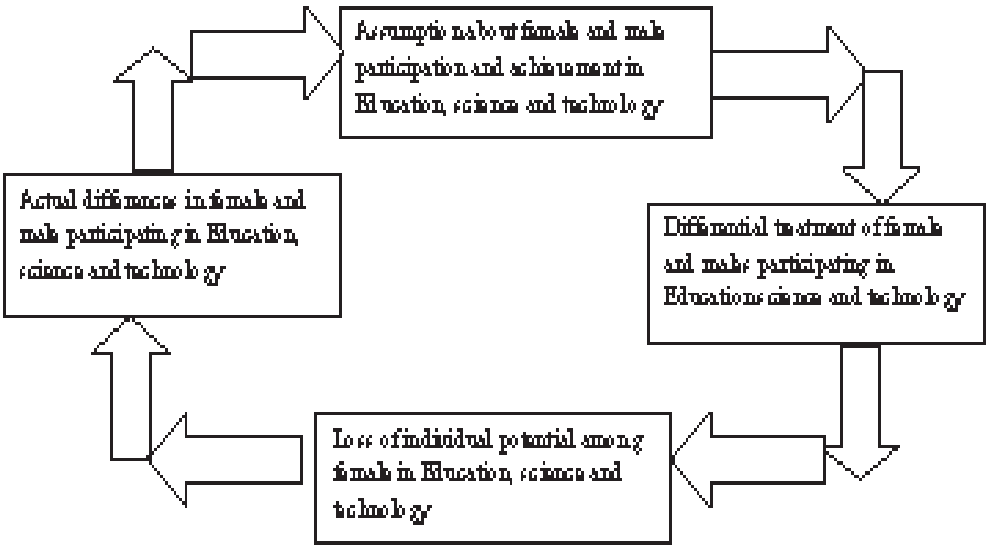
Studies from outside Africa report the same situation. The council on Gender Parity in Labour and Education in New Jersey, USA reports that gender inequality in science, engineering and technology fields is a workforce problem that inhibits the full utilization of labor forces, Time Magazine, (Jan 19, 2004). Of major concern to the council is that in America, despite the growth in science, mathematics and technology jobs, women are vastly underrepresented in related fields. The same magazine further observes that despite Europe's growing needs for scientific talent, many of its female scientists are still not getting equal opportunities. Although about 40% of the doctoral degrees recipients are women as are only 30% of the graduates in science and engineering, up from 25% in 1998, women made up only 15% of researchers in the private sector. The gender gap was observed to be biggest in Australia, where just 9% of the researchers were female and Germany where the figure is 9.6%. It is therefore a global issue that the science lab is traditionally a male dominated place, a situation that can be attributed to the commonly held stereotyped belief *"that science and technology is a reserve for male"*.

In a study done on *'Women in Science'*, in South Africa, Tracy and Mouton (2004), reported that South Africa women lag behind their male counterparts in public sector careers in mathematics, science and engineering. The study observes that although women have made significant strides since the advent of democracy in 1994, those in scientific community tend to be younger, earn less, receive fewer rewards and recognition than men, and are largely clustered in health sciences. In addition, two thirds of those who enrolled and graduated in natural sciences and engineering were men while almost half in the health sciences were women. On the research and teaching front, the number of women working in Universities and technical colleges in South Africa rose from 30% of the work force in 1992 to 40% in 2001. The highest ranks were still dominated by men. Only 7% of women became professors, compared to 26% of men. There is a significant difference in how often men and women publish science papers, which is a key measure of success in research. Less than one-third of all actively publishing scientists between 1990 and 2001 were women, and their average article output was reported to be lower than that of men.

A similar study done in Kenya revealed same disparities, Omutoko and Rugut

(2006). The study reports that in Kenyan public universities, female academicians are clustered in the faculties of Art, Social Sciences and in Education with few of them being found in programmes that have traditionally been known to be male dominated, namely, mathematics, sciences, Information, Communication and technology. The underlying reasons for the disparities lay with the gender rather the scientific dimension. The gender biased cultural assumptions that women are of less value and ability as compared to men as well as differential treatment of boys and girls in many societies is what mitigates against their participation in science and technology, pushing the women into the so-called 'feminine careers', Tracy and Mouton (2004).

The problem continues to be perpetuated within the continued socialisation process in which boys, girls, women and men go through various stages of their life, at home, community, education and work places. Kimani, (2004) observes that primary school teachers have a higher preference for teaching boys as compared to the girls and that teachers, girls and boys strongly believe that Mathematics and Sciences are easier for boys than for girls. Cultural stereotypes about appropriate behaviors are not the only barriers that girls face within the science, mathematics and technology domain. There exists gender discrimination in the classroom based on the perception that women and girls are less achievers. The implication of this attitude is a push-pull force for girls and boys into areas of study assumed to be 'traditionally fitting', mainly in humanities and social sciences. The result is a vicious cycle of assumed sexism and gender, which directly affects the aspiration, choice, levels of participation and achievement for girls, boys, women and men in mathematics, science, technologyand related disciplines. The vicious cycle of the assumed sexism follows an obvious gendered stereotyped pattern, as indicated in the diagram.



Based on the stereotyped sexism, children internalize beliefs and systems about the appropriate careers for them to enter at the youngest ages. They then carry these beliefs systems throughout their education career and adult job tenure. These beliefs are so ingrained in girls that as reported by the Commission on the Advancement of Women Minorities in Science, Engineering and Technology Development (CAWMSET) (2000) even in computer technology, girls tend to be differently interested in the computer as compared to boys. Dovi (2004) further observes that girls tend to use the computer more to promote human interaction through the Internet. Their major areas of interest tend to be email, word processing and database. On the contrary, boys are more likely to use the computer to play games and focus on its hardware aspect, especially the computer tools. This in essence means that women and men are not equally enjoying the benefits of science and technology. The result is a lack of role models and mentors for girls and women, pursuing related careers. Yet the role of the mentorship in creating a self image to young and adult individuals as females cannot be under-rated. The assumption is that mentorship in science and technology provides female students and career women with the ambition to become part of the profession.

6.0 CONCLUSION AND WAY FORWARD

The central issue in gender dimension in science and technology is pegged on the participation of girls, boys, women and men in a field of development that is so crucial now than ever before. In addition, from a human right perspective, the concern is not just that of participation but rather a matter of human justice. Gender bias and disparities in science and technology are so deeply rooted in the socio-cultural norms and values that radical change is required to overcome them. Such a change calls for a new thinking based on the principles of human justice and equality. It is only through the new thinking that women can became full participants in development that encourages true self-reliance of individual, the family and the community.

Awareness of the gender dynamics in the participation of science and technology, based on cultural beliefs and practices should lead to question the inclusion of all stakeholders of the economy at the household, local and national levels. This means being analytical and critical at all disempowering processes that block the road to the development of full potential of any group of human population. At the personal level, women and men need to question themselves as to what influences what they do with a view of developing strategies to overcome cultural barriers and begin to see changes in their own lives. Negative attitudes and perception of the people towards girls and women must also change to allow them to have equal opportunities and status with boys and men respectively. There is no doubt that the current debate at national, regional and global levels recognizes the importance of equal participation of female and male in the socio- economic development. All approaches and initiatives that aim at developing and institutionalizing positive attitudes that girls and women can perform and achieve in all spheres of development and in science and technology must be supported and encouraged. In Kenya, issues of gender equity and equality are well articulated in the Ministry of education, gender policy as well as in the *Kenya Vision 2030*. The two blue prints calls for programmes that encourage women and

men to work together as partners in the development process and to explore careers in science and technology.

There is also a need to address gender biases in classrooms at all levels of the education and labour force inequalities faced by girls and women. For girls and women to persevere in science and technology fields, teachers, policy makers, civil society organizations and parents need to demystify science and technology to make it acceptable to girls and women. This on the other hand calls for gender awareness raising and education. Although it may take time before significant changes take place, the efforts are justified more than ever before, as a long journey always starts with one step.

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