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**Key policy initiatives and capacity-building on gender
mainstreaming: focus on science and technology**

**MAKING SCIENCE AND TECHNOLOGY
ATTRACTIVE FOR GIRLS***

by

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*The views expressed in this paper are those of the author and do not necessarily represent those of the United Nations.

The low participation of women in Science, Technology, Engineering and Mathematics (STEM) activities has been a long standing, international phenomenon, even in countries generally regarded as progressive. Observations of the higher participation of males in Science were made as early as 1869 by Lydia Becker. This observation has, over the decades, triggered speculations about the possible reasons for this disparity. The extent of this science gender gap may vary from one region to another as is the progress that has since been made in narrowing it. Women are generally underutilised by society in STEM activities.

Every nation needs to popularise and embrace STEM and encourage every child to want to be exposed to it. Many reasons have been advanced for this science gender gap. Since women make up slightly above half of the world's population and since STEM is an important tool for development and competitiveness in this knowledge-based economy, strong efforts must be made to redress this glaring brain drain by including women in knowledge generation. All productive human resources regardless of sex must be harnessed for development and to guarantee success in today's global marketplace. Science and development are interlinked. The survival of each nation depends to a large extent on the quality, novelty and diversity of its productive sector. Success in these areas will depend on the continuous innovation in product range which can only be achieved through each nation's research and development output.

Historically, women have been involved in numerous scientific activities. In traditional societies, women engaged in brewing and baking (fermentation technology); medicine and midwifery (indigenous knowledge systems); food production and preservation (agriculture and post-harvest technology), basketry, weaving and house decor (requiring the mastery of geometry and the chemistry of colours), to name a few. Since the early twentieth century, several women have excelled in a hostile atmosphere, to become Nobel laureates in fields considered the realm of men such as Physics, Chemistry and Medicine. In Chemistry, there are Marie Curie (1910), Irene Joliot- Curie (1935), Dorothy Crowfoot Hodgkin (1964) and Ada Yonath (2009). In Physics, examples are Maria Goeppert-Mayer (1963), Marie Sklodowska –Curie (1903), and numerous in medicine such as Gerty Theresa Cori (1947); Rosalyn Sussman Yalow (1977); Barbara McClintock (1983); Rita Levi-Montalcini (1986); Gertrude B. Elion (1988); Christiane Nusslein-Volhard (1995), and Elizabeth Blackburn and Carol Greider (2009).

Yet, some school of thought is quick to advance theories that women's low participation and low achievement in STEM results from an innate difference between girls and boys. Many of the variability theories (based on biological-genetic, hormonal, physiological or psychological differences) provide explanations which have either not been scientifically proven or which have been refuted. Those who oppose the variability theory ascribe the disparities mainly to societal gender roles and stereotypes. The science competency of women is demonstrated by the above-mentioned accomplishments of women and by the general observation that, given the chance and encouragement that boys are given, girls may even out-perform boys in Science. Some men will even go to the extent of killing women who have broken into the "realm" of men by obliterating them from the earth as was the case in the Montreal massacre of 1989 where 14 female engineering students were killed by a male who could not comprehend why women were taking up the spaces of men at the polytechnic.

Women face numerous challenges in their progression in science due to their multiple roles. In many families, they carry the poverty burden, and issues relating to their reproductive

health including their greater susceptibility to HIV and AIDS and other diseases, sexual harassment at school and at the workplace and various forms of violence against them contribute to their dropping out of numerous activities resulting in a gendered work force. STEM programmes are regarded as challenging and hence, they end up with larger gender gaps in participation than in other fields.

There are many causes of gender gaps in STEM activities. In many societies, Science is associated with men and the liberal arts, with women. Such stereotypes derive from a multiplicity of sources. Socio-cultural norms, particularly in patriarchal societies, reinforce gender differences which may result in girls opting for the softer courses that relate to nurturing and caring. Some of the traditional laws may reinforce these stereotypes. Such stereotypes can also affect or influence attitudes, participation, aspirations and achievement of girls in science subjects. Teaching materials can also spread negative perceptions about engendering the Sciences such as the practice of using male figures in books to illustrate scientists. In addition, lack of proper mentorship and exposure to uninformed (or wrong) advice by teachers and parents leads to negative attitudes to STEM careers. Such misconceptions must be addressed. The “stereotype threat” can influence individual performance and aspirations and result in national sex differences in science participation and achievement. The research and development output of women and their internet usage is also affected leading to detrimental consequences for career progression. The home and learning environment and workplace must be enabling. Girls must be informed about careers, encouraged, inspired, mentored and motivated to feel that they can do as well as boys in science. The attitude factor can be a great determinant in one’s career options. The importance of role models at school (female teachers/professors), public office and industry cannot be overemphasised. This can be linked to the attachment of young women to experienced ones. The former can benefit greatly from being observers in such job shadowing training experience. These attachments can lead to confidence development and exposure to existing networks resulting in career opportunities that would otherwise have been missed.

When the advancement of women in institutional hierarchies is hindered by attitudes, stereotypes or bias at the workplace, reference is generally made to the “glass or cast iron ceiling” at the workplace. This refers to barriers to women’s advancement. Many such organisations lack enabling career policies, procedures, programmes or systems that allow for flexibility in the workplace required for the multiple roles of female employees. Some organisations end up with gender pay gaps that discourage a positive work disposition. For instance, it is common practice in many Universities when promotions are considered that women have to have more publications than their male counterparts. Such hostile practices perpetuate gender science gaps at the workplace. The public sector seems to be the worst culprit in this regard since the absence of pay equity legislation in many countries perpetuates the problem.

While there is some progress in the cracking of this glass (or cast iron) ceiling in some regions, such advancement has been slow and it is not universal. Reports on the narrowing of the performance /participation gap in Biology, Chemistry and Physics in high schools in the US have been made (NCES 97-982). In Botswana, in 2003/4, there were 21,019 girls out of 41,056 primary level learners. During that year (and the trend has not changed), girls outperformed boys in science, social science, mathematics, English and Setswana. At the junior secondary level, girls marginally outperformed in mathematics (23.5% versus 23.2%) while boys performed better than girls in integrated science (27.8% versus 28.7%). At the senior secondary level, male learners led in participation and performance in Physics,

Chemistry, Biology and Mathematics. Clearly, the gender stereotypes seem to affect progression of girls from one level to another in STEM subjects as they advance in the education level.

In the Faculty of Science (FoS) at the University of Botswana, out of an enrolment of 1044 learners (2003/4), only 340 were girls. This matches the female staff ratio in the same Faculty (around 30%) which indicates the absence of role models for the learners. This “leaky pipeline” in the sciences is of great concern and was the reason the University of Botswana, in collaboration with the Ministry of Education and the Education Democracy and Development Initiative (EDDI) launched a Women in Science Project that was based in the FoS and Faculty of Education. In addition, the University established the Gender Policy and Programmes Committee (GPPC) to oversee the engendering of its programmes, to ensure that gender-sensitive materials are used and to monitor the teaching and learning environment. One of the successes of this committee was the establishment of the sexual harassment policy at the university.

Comprehensive strategies need to be employed at all levels (internationally, regionally, nationally, locally, at the home and the individual level) to achieve, in the long run, equity in representation of women in STEM activities. The involvement of some non-governmental organisations and community-based organisations is also critical because of their experience and networks. Many of them are a great influence on grass roots women and can be useful allies in programmes that demystify the sciences resulting in changed attitudes at the household level.

A commitment should be made at the highest level to level the playing fields and to redress the existing science gender gaps. Governments must lead the way by mainstreaming gender in their policies, programmes, projects and systems to address firstly the general disparities in women’s participation rates in the labour market but specifically their engagement in the sciences. It is critical that, through research on the peculiar challenges women face in society, strategies be implemented to bring them into the mainstream of all activities including STEM so that the existing discrepancies be looked into and long lasting solutions be found.

Internationally, some initiatives to close the gender gaps are being advanced. To name a few, the Millennium Development Goal 3 seeks to “promote gender equality and empower women”, the World Conference on Science, held in Budapest, which adopted a declaration of intent, the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) and, recently, the setting up of UN Women are clear signs of commitment. The Commonwealth has introduced the Gender Management System that presents structures, mechanisms, processes for Government policies, programmes and projects. There are many more. The challenge is always operational. Little follow up action takes place in many countries.

At the continental level, the African Union adopted the Solemn Declaration of 2004 with commitments on improving the cause of women. Regional organisations (such as the Southern African Development Community (SADC) and the New Partnership for Africa’s Development (NEPAD)) can be effective in working together to advance the women’s agenda because of a common culture. The Organization for Women in Science for the Developing World (OWSDW) [formerly Third World Organization for Women in Science (TWOWS)] has played its role in encouraging STEM output amongst the women of the third world. We

cannot complain about any gap in the number of organisations, conventions or declarations against the discrimination of women.

Countries must make a commitment to change the status quo through gender mainstreaming in all national affairs. Legislation that prohibits any form of discrimination against women is critical and systems should be in place to compel organisations to comply. While many countries are signatories to conventions that support women's rights, very little action is observed on the ground. Inadequate (or no) resources are set aside to address these concerns due to lack of appreciation of the gains that could be made if women were involved in STEM activities alongside the men. It is therefore important that adequate infrastructure and teaching materials be provided in the schools. Consideration should be given to the private sector that wishes to support women's empowerment activities through rebates and other considerations. Government policies on equal access to education, hiring, promotion, retention (in STEM, in particular), should be in place to guide institutions in their determination to close gender gaps. Governments must use databases of women scientists when they make senior appointments in government and parastatal bodies to increase the pool of role models, nationally. To appreciate the extent of each country's gender gap, efforts to publish disaggregated statistics on women's participation in STEM is necessary to quantify the required remedial action. This may necessitate various forms of affirmative action.

The strategy for success is to start early in the life of the girl child, at the pre-school level and to progress through the educational hierarchy popularising science. Progress has been slow and women must now break (rather than crack) the glass ceiling.

Institutions, in collaboration with the Government, community-based organisations (CBOs) and non-governmental organisations (NGOs) can play an important role in positioning women for equity. Activities include the following;

- Popularising STEM using all forms of media to reach out to the parents and the girls (as early in life as possible since socialisation takes place in the home, at school and in society). Science should be made interesting and enjoyable rather than being made mysterious.
- Lobbying for free and compulsory education.
- Timely implementation of home-based care and orphan support programmes to relieve women from tasks that overburden them and prevent them from pursuing careers in STEM.
- Promotion of sexuality education and life skills among young children.
- The education system should take into consideration the specific needs of women by creating a conducive learning and work environment. The school syllabi should integrate outreach applications of STEM so that the benefits of science can be appreciated by society. The curriculum should include topics such as HIV and AIDS to assist the learner to be prepared for life challenges.
- Opportunities should be created for re-entry into the school system for girls who dropped out due to pregnancy or other family constraints.
- Mainstream gender in the curriculum of teacher training colleges to adequately prepare the teachers.
- The internet penetration rate should be increased and its usage by women encouraged, including in the rural areas. The ICT infrastructure should be expanded and training should focus on information gathering or generation rather than using computers, for instance only to be good secretaries or filing clerks.

- Flexible training modes should be in place such as the promotion of distance learning, use of various media for educational programmes and the encouragement of informal training opportunities and inclusion of in service training to help the women advance their careers.
- School visits by women scientists to inform, encourage, inspire and motivate girls to embrace STEM are useful in persuading undecided groups to opt for science subjects.
- Career guidance and counselling play a major role in exposing girls to possible career options.
- Exposing girls to various career options through job shadowing.
- The creation of special bursaries or financial support for girls at secondary and tertiary level who want to pursue STEM careers.
- Publications of profiles of women scientists (particularly those from their localities) should be placed at school and public libraries to present role models to girls and women. Such women could be approached to mentor others. Mentorship programmes of learners and workers should be encouraged through reward systems for the mentors.
- Lobbying for research and development funds with special funds set aside for female researchers to facilitate their career advancement.
- Creation of funds for scientific research and development, inclusion of research themes on women's specific needs and encouragement of women to carry out more cutting-edge research and creating special Chairs for women in STEM disciplines.
- Publications for parents should be produced in the indigenous languages to educate them on the advantages of having their daughters pursue STEM subjects.
- Science open day activities, science fairs and science competitions.
- Field trips to expose girls to the culture of making observations and enquiry about nature.
- Science clubs and clinics where girls are encouraged to embrace STEM challenges.
- Removal of obstacles to hierarchical advancement of women in organisations such as the introduction of a flexible work environment, and embracing leadership training with equal access to men and women in organisations, leave (and feeding time) for nursing mothers, paternity leave, and the consideration of merit in promotions.
- An enabling work environment that encourages productivity. Examples are flexible working hours, childcare facilities at work, policies on sexual harassment at school and the workplace and on any form of violence against women can be enriching to the workplace culture.
- Working towards a culture of peace and justice is critical.

In conclusion, global statistics show that women are out-numbered by men in STEM activities and this has been the case for many centuries. More women than men drop out of science fields during studies or in their careers, the so called "leaky pipeline". There is no evidence to prove the variability theory on women's capability to follow STEM programmes. Therefore, the premise is that upbringing, conditioning and the societal gender roles are a large contributing factor to the science gender gap. All efforts including affirmative action must therefore be made to redress this situation for the benefit of all. The message should be made loud and clear that girls together with boys must **STEM** out poverty from this earth.

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