

## Challenges and Countermeasures for Women and Girls' Education in Sub-Saharan Africa

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### Abstract

### Review Article

The authors of this article report the findings of an investigation of the challenges faced by Sub-Saharan African governments in promoting women and girls' access to Science, Technology, Engineering and Mathematic (STEM) education. They further report the countermeasures of the challenges which the governments put in place to overcome them in the efforts to promote STEM education and the achievement reached so far. This study is partly in response to the growing recognition that countries in Sub-Saharan Africa have been facing an uneven distribution of STEM education access to women and girls across different sub-regions. The design and implementation of STEM education curricula that are gender inclusive and flexible will go a long way to help governments to bridge the gap that exists between male and female in accessing STEM related subjects and careers. The findings recorded from secondary sources reveal a plethora of challenges. These are cultural beliefs, lack of expertise in STEM curriculum design and teaching practices, and administrative laxity. On the other hand, Sub-Saharan African states have also embarked on a series of reforms to effectively promote women and girls' access to STEM education with East African states being a shining example. The authors conclude the article with a number of suggestions that would positively affect the curriculum design, implementation, and monitoring of STEM education in Sub-Saharan Africa.

**Keywords:** STEM education, curriculum, career, policy, challenges, countermeasures.

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## INTRODUCTION

The globalization of education in the 21st Century has brought tremendous changes in educational systems across the world. The United Nations Educational Scientific and Cultural Organization - UNESCO hereafter - has not only targeted education for all but also the education of all citizens of the world. This has, therefore, made different actors of the educational industry to take bold steps in reforming their educational system as a whole and, more specifically, the curriculum. This shift of paradigm in designing innovative curricula that do not only focus on the needs of learners and but also a response of the technological and economic advancements which have contributed to diverse fortunes worldwide. Africa and, particularly, Sub-Saharan Africa, henceforth SSA, has not been left out of this toned of designing the curricula aligned with the recent advancements in developed societies. The secondary sources<sup>[1]</sup> in the course of

conducting this investigation, the curriculum reforms nowadays aim at aligning educational outcomes with the societal needs and the general philosophy of each nation. The same holds true with the strong correlation that exists between the new curricula and the 21<sup>st</sup> century needs on the one hand and the needs of the job market on the other. These facts, as may be recalled, are not isolated from the curriculum designers. They are bound to agree with the framework couched by UNESCO which advocates the design of the curricula which are inclusive, skill-based. The framework also gives a top priority to science related subjects as earlier as in kindergarten up to university. It is from these reasons that, than ever before, most countries drive all their energy to build up the economy of knowledge that promotes science, technology, engineering, and Mathematics. This investigation was required to an increase in women and girls' participation in STEM Education. The findings of the investigation provide information on the challenges that limit women and

<sup>1</sup> Findings presented in this work were gotten from secondary sources which include different reports, books, articles that dealt with STEM education in the world and more specifically in SSA. These secondary

sources were collected from online databases of different organizations in charge of the promotion of education in the world as well as on some scientific reviews and journals websites.

girls from fully benefiting education in the SSA. To begin with, and the article, first and foremost, focuses on some background information that surrounds women and girls' accessing STEM Education in SSA.

### **The Background of Women and Girls' Accessing STEM Education in Sub-Saharan Africa**

The focus in this part is three-fold. First is the background information on the international facts that epitomize women and girls' participation in STEM education. In this part, each of the following aspects will be taken in turn: the situation in developed countries, the state of the art in developing nations and the analysis of similarities and differences of women and girls' participating in STEM education. Second, some historical background of STEM education in SSA will be reviewed. The main focus in this part will be on the historical aspect perspectives on STEM education policy and practice development. The following parts will also be revisited while keeping an eye on the evolvement of STEM education: STEM education policy and practice before and after 2000, women and girls' changes in accessing STEM education, the current situation of women and girls' participation in STEM education in sub-Saharan Africa. This last aspect will further consider the current regional situation of the implementation of STEM education, the need for the implementation and expansion of STEM education and finally women and girls' current condition in accessing STEM education.

### **The International Context of Women and Girls' Participation in STEM Education**

#### **The Developed Countries**

The economic growth and prosperity that most developed and developing countries in the world have been enjoying from the late turn of the 20<sup>th</sup> Century to the early phase of the 21<sup>st</sup> Century could be closely linked to the strong will of their central governments to align educational outcomes with the inclusive curricula. The latter, in such countries, are geared towards even access to quality education to all and for all through the development of curricula that are flexible. Such flexible curricula take into account the new trends of the world economy and include subjects that enhance women's and girls' capability to take part in STEM subjects (see, for instance, the 17 Sustainable Development Goals). As far back as in the 1990's, Japan, Korea, and Taiwan experienced rapid growth in the manufacturing capability. Thanks to the strategy of importing and building on established technology from abroad [2]. Every year, the United States invests billions of Dollars in STEM education and development, knowing that

<sup>2</sup> This World Bank Report, published in 1991, clearly establishes the relationship between educational reform choices of some countries and the boom of their technological advancements as well as their implications on sustainable economic growth.

over 70% of their domestic and international jobs will require those core skills: science, technology, engineering and Mathematics. From this current situation, it follows that while these countries developed curricula which facilitated the inclusion of STEM education, other countries from other parts of the world are still focusing on knowledge-based curricula.

#### **The Developing Countries**

This has been the case worldwide and sub-Saharan countries in particular whose facts about the curriculum outcomes still remain questionable at various levels. For instance, only 17 women in the world have won a Nobel Prize in Physics, Chemistry or medicine since Marie Curie in 1903 as compared to 572 men. Only 28% of the world's researchers' population consists of women. This statistics compounds the situation of women's unequal access to science and technology education. Furthermore, too many girls are held back by discrimination, biases, social norms and expectations that influence the quality of education they receive from primary to tertiary levels and the specialties they choose. As a result of the facts mentioned above, girls' under-representation in STEM education is deep rooted and puts a detrimental brake on the progress towards sustainable development[3]. In the foreword to this, in the UNESCO's 2017 key report on STEM, Irina Bokova maintains that there is a need to understand and target the particular obstacles that keep female students away from STEM. We need to stimulate interest from the earliest years, to combat stereotypes, to train teachers to encourage girls to pursue STEM careers, to develop curricula that are gender-sensitive, to mentor girls and young women and change mindsets. This statement by the UNESCO Director-General is pregnant with the hope and prospects as far as STEM education is concerned for sub-Saharan countries and beyond. A critical look into this statement prompts any researcher in education in general and STEMS education in particular, to lay more emphasis on the understanding of the failure behind reforms in education. These are in favor of the promotion of women and girls' access to STEM education by the respective governments. Africa does not rich strategic plan on STEM policies, or the understandable structure for implementing them. It is not even clear if some national leaders understand their

<sup>3</sup> The UNESCO 2017, right from its title Cracking the code: girls' and women's education in science, technology, engineering and mathematics (STEM), is one of the latest publications in women's and girls' participation in STEM education. It gives a good picture of the ongoing situation that obtains in countries which are implementing STEM curriculum across their school systems. The report further provides a global snapshot of girls' under-representation in STEM education programmes, the behind it and examples of how to improve girls' interest, engagement and achievement in these fields.

importance or meanings. Furthermore, the exploitation of Africa's natural resources, such as bauxite in Guinea and Ghana, to name but these few do not always profit domestic economic needs. If the governments had a clear strategy on STEM policies, there would be more homegrown cartographers drawing maps, more trained engineers operating machines and building railroads. If African states invested more in research and development, their own scientists would be able to prevent diseases such as Ebola, cholera and malaria. If Africa invested in tech entrepreneurs and innovators, she would be able to resolve local problems with local solutions [4].

### **Women and Girls' Conditions of Participation in STEM Education**

A cursory look at the influence of science and technology on the overall development of any 21<sup>st</sup> Century global citizen introduces us into the role of the seventeen Millennium Development Goals[5]. Owing to the fact that the gap between girls and women and STEM education in SSA still persists, the problem that has been identified in this work through and thorough investigated is that of girls and women's low access to STEM Education in Sub Saharan Africa. The current situation in sub Saharan Africa is replete with educational policies that focus more on the acquisition of knowledge. The curricula give more priority to the development of the knowledge about things but scarcely develop students' know how and skills needed in the 21<sup>st</sup> Century. The same holds true with the cultural norms and values that do not include the girl child and women in the implementation of STEM curriculum.

### **The Historical Background of STEM Education in Sub-Saharan Africa after 2000**

STEM education in Sub-Saharan Africa has recently taken a different twist as compared to the late part of the 20<sup>th</sup> Century. Despite this qualitative move, there is still a mismatch between the training offered and the demands of the job market. This has always led to the outsourcing of infrastructure which has been destroying the ability of African governments to invest in STEM skills for the future. Currently, in Africa, most jobs generated by STEM training are performed by or outsourced to multinationals from countries that have mastered their STEM education curricula and practices. A good example is the arrival of 87 construction teams

<sup>4</sup> The findings related here are from Marieme Jamme's viewpoints. As the founder and chief executive officer of Spot One Global Solutions she critically presents the situation of Africa STEM education policy and implementation in one of her posts on her blog. She is bitter about the international organizations' visions like UNESCO who, according to her, have failed the African education system in conspiracy with African governments.

in Kenya from China to ensure the construction of the Standard Gauge Railway. This led to the discovery that Kenya could not provide skillful workers with good aptitudes in different required fields. The same holds true with the Cameroonian National Employment Fund which could not provide skillful workers during the realization of the Chad and Cameroon pipeline project in the late part of the 20th century. The inadaptability of STEM education curriculum with current job market demands in Africa prompts African governments to sign infrastructure contracts with the West instead of demanding that the future labor force to be skilled in impressive for development. Despite the mad rush that characterizes developed nations in designing and implementing STEM curriculum, the term STEM is not yet widely understood among African leaders. Its implementation in education systems is catastrophically poor, despite the fact that many Information and Communication Technology ministers collect millions for the programme related to these subjects. In fact, African states are nowhere near achieving what needs to be done for their youth. Over the next decade, African employers can look ahead to have many hundreds of career openings which require the basic STEM literacy, and more people will need advanced STEM knowledge. For years, many scholars and educationists have been advocating for good education policies in Africa and the real implementation of STEM subjects in education systems. South Africa is the only country to have successfully looked at this subject. In the related vein, in March 2014, ministers agreed on a Joint Call for Action in Kigali to adopt a strategy to fuel key investments in science and technology and catapult Africa toward a developed knowledge-based within one generation. The represented part of the Partnership for Applied Science, Engineering, and Technology (PASET), an initiative of the World Bank that supports efforts by African governments and their associates construct up the role of practical science, industrialized, and technology in the development programme. The ministers commonly recognized the need for exact measures to improve relevance, quality, and excellence in learning, and research in higher education [5].

### **Women and Girls' Changes in Accessing STEM Education in the 21st Century**

<sup>5</sup> This statement corroborates a report on a decade of STEM research in Africa. The report is part of a broader, ongoing effort to provide more evidence and analysis on the supply of and demand for skills, education, and research within Science, Technology, Engineering, and Mathematics (STEM) for Africa's socioeconomic transformation and poverty reduction under the aegis of the PASET. The report focuses on research output and citation impact, important indicators of the strength of a region's research enterprise. These indicators are correlated with the region's long-term development and important drivers of economic success.

Following recent positions taken by different governments in the SSA, a considerable change in policy and practices with regards to women and girls' access to STEM education has been made. From a mere signature of different conventions with international bodies and stakeholders of the educational sector, we nowadays see a strong will by governments to encourage the participation of female folks in STEM education. In Cameroon, for instance, many female educationists and researchers have been championing the cause of women and girls' participation in STEM education by organizing summer STEM camps for girls [6] The aim of such camps is to engage teenage girls in a hands-on experience in the STEM disciplines, combining lectures, tutorial, experiment and field activities in an environment proposed to be helpful, inspiring and most prominently fun. Same activities are reported to be carried out in the different sub regions across SSA. Also, the establishment of different scholarship schemes for female high school and secondary school students for encouraging them to take STEM education has been noticed in countries like Cameroon, Nigeria, Kenya and Tanzania. This scholarship scheme entails the training of young talented female STEM education pioneers domestically as well as abroad. With these inciting measures put in place, girls and women have changed their position and they are more likely to accept STEM education.

### **The Current Situation of Women and Girls' Participation in STEM Education in Sub-Saharan Africa**

#### **The Current Regional Situation of STEM Education**

East African states STEM education strategic plan remains by far the yardstick against which other SSA states should measure their design and implementation of women and girls' access to STEM education. The uneven application of STEM education policy for women and girls in SSA could be gauged from many angles. The reasons could be cultural, political and financial. There is another reason which is closely related to accountability. While Kenya could be cited as shining examples to be emulated, countries within the central and West African zones are still lagging behind. The reasons behind this being the lack of political will of governments and the cultural resistance of people who are not open to change. Despite these challenges, most of these governments while relying on foreign aids to upgrade their STEM

<sup>6</sup> Dr Josepha Foba of the University of Buena has been organizing summer STEM camps for girls within the premises of the University of Buena since 2011. The camp is open to girls and aims at raising their awareness on the importance of participating in STEM education and the STEM careers. She invites many female alumni from other university in the world and during the weeklong activity camp; girls' misconceptions about STEM education and careers are deconstructed.

educational policies have been involved in different reforms. The most important ones are within the framework of aligning educational goals and outcomes with the global which is market and technology-driven. A case in point is the projects of the construction and equipment of new vocational and technical schools in Cameroon. The project also aims at equipping the existing vocational training centers with updated laboratories and machinery.

### **The need for STEM expansion and the Implementation of STEM education**

Actors of the educational sector know that the need for STEM expansion and implementation cannot be overemphasized. STEM education has now become a top priority of most governments. This is because Science, Technology, Engineering, and Mathematics (STEM)-related research output and impact are related to a region's long-run economic development [7]. From this, it is evident that the long-vision development goals of SSA states must heavily rely on the effective implementation of STEM education which is inclusive and gender flexible.

### **Women and Girls' Current Conditions in Accessing STEM Education**

The current conditions of women and girls' accessing STEM education are mixed. While some are passionate about these subjects, others show some negative attitudes towards them. For these two perceptions to be broken, women and girls have to rethink their vision of the world and come up with fresher insights. Despite the beliefs about STEM education, women are gradually recognizing that they can play an important role in the development of the region and the world by large. Following these facts, a number of questions could be raised to further understand the problem underpinning this investigation. What are the challenges faced by Sub Saharan African countries as concerns the promotion of Girls and Women's access to STEM Education.

How do SSA states curb the problems that prevent girls and women from accessing STEM Education? These research questions guided the authors in writing this paper. The answers to the questions inform the extent of the coverage made so far by different states. Some sub regions are selected as the case nations. Before mentioning the case nations of this study, it is hypothesized that SSA countries that have STEM education oriented curricula which are flexible towards girls and women's access to STEM Education have made remarkable progress at different levels: social, cultural, economic and educational. In a bid to

<sup>7</sup> This is one of the proposals from a brief on the state of STEM research in Sub-Saharan Africa. The other maintains that science is an international enterprise and research collaboration remains an important driver of success.

come up with the scope of this work, two dimensions have been selected. These two fall under two scopes namely; the thematic scope and the geographical scope.

The geographical scope relates to the sub regions where our case nations are located. For the purpose of convenience, the geographical scope corresponds to Sub Saharan Africa in general. Specifically, there are two sub regions which will be considered. The first sub region consists of West Africa and includes countries like Cote d'Ivoire, Nigeria, Sierra Leone, and Cameroon. Within the East Africa sub region, the focus will be on Tanzania, Malawi, and Kenya.

As far as the thematic scope is concerned, emphasis will be put on two main aspects to wit: challenges faced by governments in promoting girls and women's access to STEM Education and measures taken by governments to encourage girls and women's participation in STEM Education. From the clear statement of the scope of this study, it is worth mentioning some of the studies. In fact, there are many previous studies which focused on the analysis of educational policies in relation to STEM Education, STEM Education and the state of the art in sub Saharan Africa as well as TVET education [8]. The present study, unlike the previous ones, aims at exploring and describing the challenges which governments face in implementing their STEM Education policy in Sub Saharan Africa and the countermeasures which such states have taken so far in order to improve on the situation of girls and women's access to STEM Education.

Our main contribution will be to explore and give a detailed account of the current situation of STEM education in Sub Saharan Africa with focus on the case nations that constitute our sample.

### **The Challenges and Problems Faced by Women and Girls in Participating in STEM Education in Sub-Saharan Africa**

There are multiple and overlapping challenges and problems which influence girls' and women participation in STEM studies in sub-Saharan Africa. In order to better explain these challenges and understand the interrelations among them, this part suggests a framework which compiles and presents SSA countries

<sup>8</sup> The World TVET database is an online collection of approved reports on TVET in countries where TVET is being implemented. The world TVET Database Cameroon, for instance, that was published in 2015 traces the path covered by actors of education as concerns the challenges and success stories. Similar reports were also published on the same database concerning the same problems in other countries in Africa and the world.

which find so many difficulties to facilitate women and girls' access to STEM education.

### **Economic**

This challenge is widespread in many SSA countries. This makes one of the reasons why girls and women cannot access STEM education. For instance, 28 million girls are out of school. Therefore, poverty is the most barriers to accessing education in developing countries. In SSA, more than 21 million, equivalent to 38% of the lower secondary school age group, adolescents did not attend any school in 2007. The region's secondary enrollment ratio was the worlds lowest at 34% in 2007. The country levels ranged from less than 11% in Niger to more than 97% in Seychelles and South Africa.

Furthermore, there is a lack and insufficiency of infrastructures. This comes as a result of: Because of poverty faced by, sub-Saharan African countries. In fact, are facing a lack of the infrastructure, such as lack of a medical laboratories in medicine, engineering workshops, and training tools are not available or better still the existing ones are not well equipped with updated tools. This constrains women and girls to embark on STEM education and graduate which constrains the learning young girls and women in the stem education in which at the end, do not allow them to be updated on the technological advance of the world skills which do not match the current advancements in the globalized.

Besides, there is poor finance administration from different governments. The problem for promoting girls' access to STEM education in SSA has become a global concern. Many countries have been benefited from financial aids and subsidies from international organizations in order to ensure the evolution of the countries in need. Many leaders have been misusing of funds for their personal fulfillment [9] this situation cause their countries to fail in reducing poverty.

### **Geographical**

There is also a wider gap between boys and women in rural areas. For example, the influence of gender on education outcomes is not the result of simple direct gender discrimination but it takes to some

<sup>9</sup>The united nation educational scientific and cultural organization give opportunity to be educated in general and to receive a good STEM education published in 2017 by UNESCO , it should a chance that should be given to all social groups regardless of sex. Even by equality of sex. This is because through the learning the education that we acquire receive help us to build bodies of knowledge and also construct skills that will empower us we benefit from knowledge, build to build a future career for our own evolution of our families as well as the development and the wealth of our entire nations.

places on the intersection of gender and extra matters such as family circle prosperity and geographic setting. The report written by Warnes *et al.* [1] shows a wider gap between boys and girls in rural areas compared to urban areas, especially in developing countries. The direct and indirect costs of education affect girls disproportionately. For example, in Tanzania, some girls and women are from poor households. Those experiences greater disparities in terms of access to education, compared to those from richer households. Some families favor boys than girls in accessing education; this also shows disparities among children in getting education. Warnes *et al.* [1] revealed that most of the families in SSA used to favor sons rather than in getting education.

### **Challenges and Problems Faced by Central Governments to Encourage Women and Girls to Participate in STEM Education (Policy Enactment)**

The lack of attention and supporting policies either force women to stagnate or drive them away from their careers. Policies do not address the marginalization of women in their fields. In other instances, women are not effectively playing the role of engineers in their communities, as holders of informal local knowledge of environmental sustainability and recycling and there is no effort to recognize their expertise and education which is necessary to change the situation so that formally trained female engineers to become accepted in the societies [2].

The Free Basic Education Policy used by central governments which have been enacted by the WORLD BANK [3] has been adopted in Sub-Saharan Africa. The main aim is to ensure every child gets primary education which is considered basic as well as subsidized secondary education but the challenge is gender parity. This is one of the problems that affect equity in education. Worldwide, 64% of illiterate people are female [4]. In Sub-Saharan Africa, the gender parity for primary education is less than 0.85 indicating that for 100 boys fewer than 85 girls are enrolled. The World Bank [5] indicates that girls are more disadvantaged and it is very common in Sub-Saharan Africa.

Another challenge faced by different institutions in the governments in encouraging women and girls to participate in STEM education is the education policy which does not allow pregnant girls to attend or continue school. The education system does not allow girls to return to school after the birth of a child [6]. For example, one would conclude that education policies in Kenya were planned to keep girls from attending schools. Like most teenage, mothers coming from poverty, these teenage girls go on to have more children as they seek love and comfort from men. They also face stigmas of having children. These disadvantages against girls are mostly influenced by the

community itself ethnic groups and religious beliefs. Also, some family members, particularly fathers and brothers, disown their sisters. In many cases, these girls with children are viewed as outcasts, thus forcing them to work as housemaids for employment [7].

Early marriage is another challenge which is closely linked to higher levels of adolescent fertility. Although Governments have laws to establish a minimum age at marriage, which is usually 18 for women, these laws also generally allow marriage at an earlier age with parental consent. In the countries where no minimum age is stipulated for women marrying with parental consent, the percentage of young women before age 15 varies markedly. This evidence suggests that legislative action is not sufficient to reduce the prevalence of early marriage among women. This seemed a challenge for the government to encourage them to participate in STEM Education.

Federal STEM education policy concerns on issues that are related to STEM education as well as the governance of the federal and broadening participation of under-represented populations. They are also concerned with specific to STEM education at the elementary, secondary, and postsecondary levels. Governance concerns focus on the perceived duplication and the lack of coordination in the federal effort; broadening participation concerns tend to highlight achievement gaps between various demographic groups. Analysts suggest a variety of policy proposals in elementary, secondary, and postsecondary STEM education. At the K-12 level, these include proposals which address on the quality, accountability, and standards. At the secondary level, proposals center on the efforts to remediate and retain students in STEM majors.

Policies such as the structural adjustment programmes seem to encourage the developing countries to spend less on education indirectly but Sub-Saharan African countries spend more money every year paying back loans and interest rates to the World Bank than they spend on social services to their population [8].

Apart from the economic hardship, provision of education to women in Sub-Saharan Africa has remained a challenge. These challenges include parental and community attitudes of a boy's education being more important than a girl's. This tradition has kept many African women from accessing adequate education and curriculum. Many African states have developed national policies on STEM education. Common issues in these policies include demystifying science and technology, encouraging the enhancement of targeted funding to the sector, promoting female in STEM education, building science and technology institutions and human capacity, protecting and promoting indigenous knowledge systems.

Despite the enabling policy environment and many initiatives that are implemented to promote women's education in SMT disciplines, a number of social-cultural and institutional barriers continue to prevent girls and young women from attending schools and universities and from performing equally to their male classmates. Generally, female students continue to lag behind in the educational achievement and access, especially in secondary and tertiary levels, where girls' enrolment, completion, and achievement rates are lower.

If we take the case of, the state's development agenda has prioritized science and technology within the educational and development policies. At the same time, believes that gender equality of the country may act to further exclude female students unless additional actions are taken to promote women's participation in these fields. Addressing gender equality in the education system, with a focus on improving girls' educational performance and outcomes, this is crucial to meet the development goals and protect women's human rights within the country. Another systemic barrier to governments is the policy where there may be a lack of capacities, few resources or incentives to innovate, or strong pressures to maintain STEM Education. In the contexts where significant reforms are very difficult to implement, aspects of innovation, such as prototyping and experimentation should be encouraged.

### **The Challenges and Problems Faced by Local Government in Encouraging Women and Girls Participation in STEM Education**

The leading challenge is classroom climate and gender dynamics. The climate in the science subjects or science classroom can also constitute a barrier to women in STEM subjects. Bottia *et al.* [9] reported that, while there have been some improvements in the atmosphere in science and other STEM subject classrooms, studies show that "many STEM fields are still characterized by a 'cold climate' that is unwelcoming to girls in high school and young women in college" (p. 16). Another study [10] reports that the "gender gap is likely reinforced by the fact that high school science teachers spend significantly more time addressing the boys in the classroom" (p. 1639). Though there are more textbooks that equally attribute sexes and also more teachers who are aware of the gender divide, female students often feel outnumbered, intimidated, and isolated in their classes [11]. Dingel [12] show that women's and men's understanding in science classrooms through participant interviews, recognized three possible accessible gendered dynamics: the 'normal' scientist is considered male while females are seen as the exception, or 'other'; men (not women) are most often known as the authority and the ones with competence as a scientist. Women feel they have to do everything perfectly and understand every detail in order.

### **Scarcity of Female Science Teachers in Many Schools**

The absence of those teachers in some areas of the sub Saharan countries in schools discourage STEM education to women and girls. Example, the lack of female Mathematics teachers and other science subjects may discourage the interest among the girls to study science subjects. Take an example of some areas in Ethiopia where they have started to improve women and girls participation by working at the very beginning at the primary and secondary education. If students' ability, attitudes and beliefs can be improved at the primary and secondary education, the number of students enrolled to STEM will increase.

### **Absence of Transformative Reform within the Education System**

Due to the absence, most girls and women lose direction in their attempt access to achieve STEM education. This includes making girls education a priority within the sector plans strategic objectives and STEM teachers in primary and secondary education. This is noted to be a great problem in Somalia.

### **Traditional Practice in Various Societies**

In Kenya, Female Genital Mutilation (FGM) and early childhood marriage have a large and negative impact on the girls attending to school; at the end of the day, the local government fail to provide good report to the government on the situation for girls and women in STEM education. For instance, in Kajiado area of Kenya, FGM is still widely practiced by the Maasai communities. FGM is seen as a precursor to marriage by the Maasai. Most often, once circumcised, girls are married off. This effectively ends their education. With children as young as 12 being circumcised, this issues is obviously militating against girls education.

### **Poor Parental Perception of Education to Women and Girls**

In general, lack of school enrolment and completion with rural children, example in some areas of Kenya, is due to their parental views that education is not valuable, or that it is not unsuitable for girls. From a young age, girls are socialized into sex roles, which they internalize and as such they end up believing that they do not belong in school [13]. At the end of the day, the government fails to make allocation of teaching and learning materials in various schools because of poor information of those students enrolled to the school system.

### **Poor Infrastructure**

This seems to be a huge problem in sub Saharan countries with their local governments in

promoting access to STEM education to women and girls under the implement of STEM education policy. For example, in Kenya, distance from home to school makes students from pastoral families reluctant to allow their children attend school. They fear that the long distance would expose children to risks. These concerns erode parents' confidence in sending their children to school [13].

### Gender Differences

Promotion of STEM education to the women and girls in sub Saharan countries is still characterized by the issues of gender differences. There are some reasons that hinder the local government to fulfill its determination on the huge number of gradutors on women and girls side. For example, in Malawi, gender differences are encouraged through segregated activities at home, and continued at school. Girls were tasked to collect water for teachers if the school did not have its own taps. Schools had fewer female teachers; so, girls did not have role models and female teachers were often allocated infant classes.

### The Reasons for the Gender Differences Problems in Sub Saharan Africa

Challenges for encouraging girls and women's participation in STEM Education need to be considered firstly in the context of the female gender overall access to and participation in education. While access to education for girls and women has globally improved, huge disparities still exist within the African region. In this part, the authors discuss the major reasons for these persistent problems which affect women and girls' access and participation in STEM Education in the Sub Saharan African context. For the purpose of this paper, the reasons have been classified into the following:

#### Historical and Traditional Reasons

The historical dimension of gender inequality in education in Sub Saharan African has metamorphosed overtime, Some African scholars have argued, in time past, the way and the manner for the formal education was introduced into the continent by the colonial rulers, greatly influenced their perception on education, generally, and as such amounts for the reluctant embrace of education in the region.

The African society has been spotted with strange of cultural practices that are potentially hurtful to women's liberation. These include forced marriage, wife-inheritance and widowhood practices, for instance. Daughters are considered as females with their mother and sisters, and sons as males with their father and brothers. Gender stereotyping becomes institutionalized within the family unit. In addition, the dominant narratives of religion in both colonial and post-colonial Nigerian privilege men at the detriment of women. This is also true with educational accessibility. Various cultural and social values have historically

contributed to gender disparity in education especially STEM orientated.

Denga [14] revealed that it is better for a woman to stay home and learn to attend her family instead of attending school. To explain the fact that more boys than girls participated in education, Nigerian researcher [15] identified that a host of constraints with 'African tradition' is named as top of the list. The 'African tradition' was explained as a tradition that attaches a higher value to a man than a woman, whose place is believed to be the kitchen.

At the beginning of colonialism and Christianity, rigid ideals about gender perceptions were imposed on the African mind. Thereafter, the woman's role has come limited to sexual and commercial labor; satisfying the sexual needs of men, working in the fields, carrying loads, tending babies and preparing food. The disempowering colonial 'ideology of domesticity' as espoused by the practice of being a house wife provided the springboard for women's educational imbalance in parts of Africa. As such, the general human intensification in Nigeria is being slowed down by this jaggedness in educational convenience across gender categories.

#### Cultural Reality Reasons

One overarching approach to achieve cultural transformation, found necessary across gender equality interventions wide-reaching, is a cultural change. Changing culture is feasible but requires institutional changes, with enforceable policies and accountability measures. Jayachandran [16] argued that the engagement of formal and informal community groups who share vision and responsibilities can have an extraordinary impact in rule-setting and rule enforcement. Sustainable, long-term efforts are needed to disrupt the ingrained academic, culture and transform it to women friendly. Constructive customs can buffer the career challenges and susceptible transitions. Many interventions have shown to promote cultural change in all levels of education and employment worldwide, including but not limited to STEM academic. Data to monitor career progression, STEM is needed in developing the world. Data-driven actions and policies are needed to increase the rates of women faculty's hiring, retention, promotion, and advancement to leadership. This been said, the following are some of the cultural reality reasons why the challenges in encouraging women and girls participation in STEM Education

#### Policy Making and Implementation Reasons

The existence of culturally-rooted gender norms means that even when African countries advance to the level of the US. The GDP per capita might not advance in terms of their desire to have sons, the decision-making power of women, and so forth. Eliminating gender inequality might require explicit



policy intervention. Furthermore, one might not want to wait uncomplainingly as the difficulty of gender disparity resolves itself via economic growth. One category of gender-progressive strategy is surrendering legal rights to women. A powerful example of this tool is Kenya's move to reserve political seats for women. A division of seats at a range of levels of government is by authorization, held by women. The most direct impact of the law change on women's welfare has been to close the gap in women's representation; female leaders put into practice the policies that reflect the policy preferences of their female constituents [17]. Moreover, this reform has begun to reshape attitudes toward women as leaders [18] and raised the aspirations of and long-term investments in girls [18]. A restriction of lawful reforms is that enforcement is often weak. For example, the legal reform granting women rights to ancestral land in Kenya that was discussed earlier has some bite but it is far from universally enforced. Correspondingly, bans on prenatal sex strength of mind, offering, and child marriage are often minimally obligatory.

However, as with the region where gender disparity in STEM education is still a huge subject for discussion, Africa suffers not only in enacting deliberate policies to address the issues but also in terms of the 'lack of political will' to even implement the globally subscribed policies and action plans as issued by international education development organizations, such as the UNESCO.

### **Economic Development Reasons**

The economic backwardness alone accounts for gender disparities in enrolment and attainment in education must be studied carefully because it does not account for the gender gaps. Colclough *et al.* [19] stress that 'Children who do not attend school are overwhelmingly from poor households in poor countries.' In the absence, interventions would equally affect boys and girls in their enrolment and attainment. We would expect approximately the same number of boys and girls to be at school, although the overall enrolment rate may be low. Likewise, we would also expect their performance to approximately match each other. Poverty on your own does not tell us why there is a difference in numbers according to sex. In traditional communities, parents tend to invest more favorably in boys with the hope that their investment is not lost because they will benefit from it as social security at old age. This principle has been seen to operate particularly in the selection of children to be sent to school under unfavorable economic conditions. Dorsey [20] shows that when income is less and parents have to send children to school, they will opt to send boys at the expense of girls because "after marriage, a daughter's earnings will enrich another man and his family." One way of dealing with the situation by way of policy is to heavily subsidize education in very poor communities. If the element of money and educational expenses are

taken out of the equation, this should greatly improve the enrolment and attainment of the girl child, especially in the developing countries. Evidence shows that this policy intervention is effective. In 1980, when Zimbabwe gained its independence from Britain, the new government adopted a policy of education for all by abolishing school fees in primary schools. This resulted in massive improvements in primary school enrolment rates, accompanied by amelioration of the gender gap at primary school [20]. Swainson [21] points out that the same strategy was effectively applied in Malawi between 1993 and 1995.

UNESCO [22] argues that this problem is rampant in many sub-Saharan countries. This state of affairs is one of the reasons why girls and women cannot access STEM education. For instance, 28 million girls are out of school. Lack of money is the greatest obstacle to access an education. In sub-Saharan Africa, more than 21 million adolescents did not attend any school in 2007, which amounts to 38% of the lower secondary school age group. The region's secondary enrolment ratio was the world's lowest at 34% in 2007. The country's levels ranged from less than 11% in Niger to more than 97% in the Seychelles and South Africa. Furthermore, there is a lack and insufficiency of infrastructures. This comes as a result of poverty faced by sub-Saharan African countries. In fact, medical laboratories, engineering workshops, and training tools are not available or better still the existing ones are not well equipped with updated tools. This constrains women and girls to embark on STEM education and graduate with skills which do not match the current advancements in the globalized world.

### **Countermeasures of Encouraging Women and Girls to Participate in STEM Education**

Since the initiation of the worldwide movement for Education for All (EFA) in Jomtien in 1990 followed by its reiteration in Dakar in 2000, most of the countries of the world have prioritized the inclusive and equitable quality education and the promotion of lifelong learning opportunities for all. Thus, many efforts are being made to ensure the reality of STEM Education in sub-Saharan Africa. Those efforts that aim at providing countermeasures to challenges faced by women and girls' access to STEM education can be seen at different levels and from different actors who are involved in the promotion of the education of the girl child and women. In this part of the work, we look at countermeasures from the central and local governments' level, from the organizational level, from schools and education sectors level and from other sectors level.

### **Countermeasures of Central and Local Governments**

#### **Make STEM Education Compulsory**

Sub-Saharan African governments are committed to making STEM education the African

language for invention and innovation. This is possible everywhere on the continent due to the technological advancement across Africa. This includes the online education platform, mass open online courses, have the potential to revolutionize education, with students who are able to access high quality learning materials, regardless of their geographic location, if they can connect to the internet. Many African researchers have had the opportunity to publish articles in African journals. There is a real need for consilience for the unity of knowledge and the African Journals for the development the original journal for research products that can help to realize and build knowledge while linking STEM with the social and human sciences. It provides the scholarly and intellectual reflective space to opening new approaches for redesigning and re-engineering all disciplinary knowledge closures.

### **Attracting Inspirational STEM Teachers (Teacher Professional Development)**

The importance of science, technology and innovation in the quest for Africa's rapid development is undeniable. However, many African countries experience shortage of STEM skilled graduates. The shortage of STEM teachers in some African countries runs into tens of thousands. One important way to address this is to better equip teachers to educate, engage and inspire their students in STEM subjects. Many initiatives for improving STEM engagement already exist worldwide.

### **Promoting STEM Participation and Encouraging more Ethnic Minorities and Girls into Science (Diversity and Role Models)**

The aim here is to foster the interest and participation of young people in STEM through role models, mentors, ambassadors and networking opportunity. Research into the participation of women and minorities in science has revealed that a lack of role models and mentors is perceived to be one of the underlying causes of minority status in this field.

## **GENERAL CONCLUSION**

The importance of women and girls participation in STEM education can never really be overemphasized. Many scholars have posited that STEM in no smaller measure amounts for over 80% of the world's development through its prowess in innovative thinking. Overtime concerns have been raised as to the underutilization of human resources arising from the long neglect and gender disparity that occurs in the multi-discipline field of STEM. This prompted the universal call for action to address this menace as seen in the most recent UNESCO report published in 2017 which deals with STEM education and women and girls' participation in SSA. Federico Mayor [23], a onetime Director General of UNESCO in one of his remarks posited that "on a worldwide scale, science is still a man's business". This situation according to him is no longer acceptable. It is

economically unacceptable because of the waste of human resources that it entails where half the world's population is able to contribute to the labor market; it is humanly unacceptable since it prevents half the population from taking part in building the world. It is intellectually unacceptable as it deprives scientific and technological research of the ideas and method, in a word, of creativity. Furthermore, it mortgages the future since it nullifies any prospect of a general mobilization in support of science in the service of a lasting peace and sustainable development.

Unfortunately, for Africa, the words of Federico were of no more value than the paper it was printed on. This is more than 2 decades in many nations which embraced to STEM education in its totality and saw it as a major driver in their quest for development. This, however, cannot be said for countries within SSA. For the purpose of this paper, we were able to identify challenges for all stakeholders in encouraging women and girls' participation in STEM education, countermeasures, as well as recommendations and suggestions for all stakeholders. This paper offers recommendations at the level of policy and practice to improve gender equality and encourage female participation in STEM education. A major contribution of this paper has been to emphasize the root causes and reasons why these challenges exist. Following this, it becomes imperative we understand the context in which the challenges operate. According to our findings, we are positing that socio-cultural beliefs and some archaic values and ideologies have served as an impediment to attaining sustainable increment in the quest for more female participation in STEM education. This paper discussed and described certain cultural practices that make gender inequality in African countries persistent even in the face of economic growth, such as patrilocality and male-centered rituals. These cultural norms help to explain the very extreme male skewed sex ratio in most SSA countries. Similarly, the anomalously low female labor force participation rate in Africa is likely rooted in the high value. These cultures place on women's purity. The cultural institutions favoring males might fade naturally, with economic modernization, enable gender gaps to close, but there is also scope for policymakers to expedite the process. It is also imperative to state, however, that NGOs are playing a significant role in changing the narrative and bring success in addressing these challenges being faced in SSA. Countries like Kenya, Nigeria and South Africa now have the opportunity to advance national development and social equity owing to the increasing call for action and eventual actions to increase women and girls' participation in science and technology. They are taking bold actions, and are demonstrating their commitments to learning across all subjects and to be gender sensitive in all domains. The said countries are interestingly setting examples for other SSA countries.

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