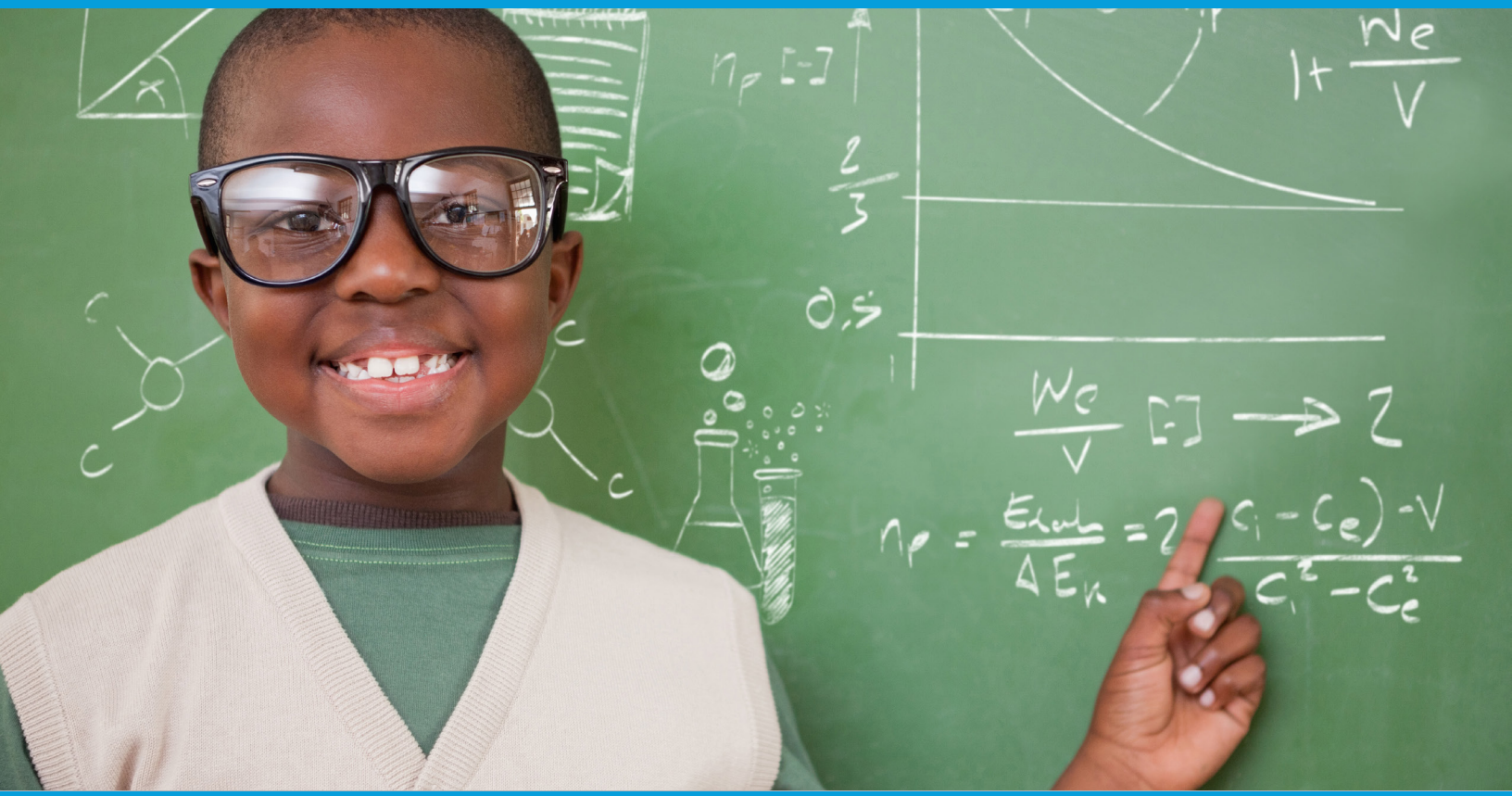
Policy Brief :

STEM education and inequality in Africa

JULY, 2022



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This policy paper has been drafted by Rumbidzai Adebayo, Programme Management Officer in the United Nations Office of the Special Adviser on Africa (OSAA) and greatly benefited by reviews and written inputs provided by the members of OSAA's Africa Knowledge Network, Cluster 4 on Science, Technology and Innovation (STI) - Sub-working group on Science Technology Engineering and Mathematics (STEM), in particular; Dr. Beatrice Khamati Njenga, Deputy Vice Chancellor, Institutional Advancement, International Leadership University Kenya (former Head of Education Division, African Union Commission) and Professor Marlien Herselman, Chief Researcher at Council for Scientific and Industrial Research (CSIR), South Africa.

It has been developed as part of OSAA's mandate to undertake analytical, advisory and advocacy work, in particular its efforts to leverage Science, Technology and Innovation (STI) to advance implementation of the 2030 Agenda for Sustainable Development and Agenda 2063 in Africa, including through raising awareness of the role STEM education can play as an enabler for sustainable development.

For more information, please visit www.un.org/osaa or contact osaa@un.org

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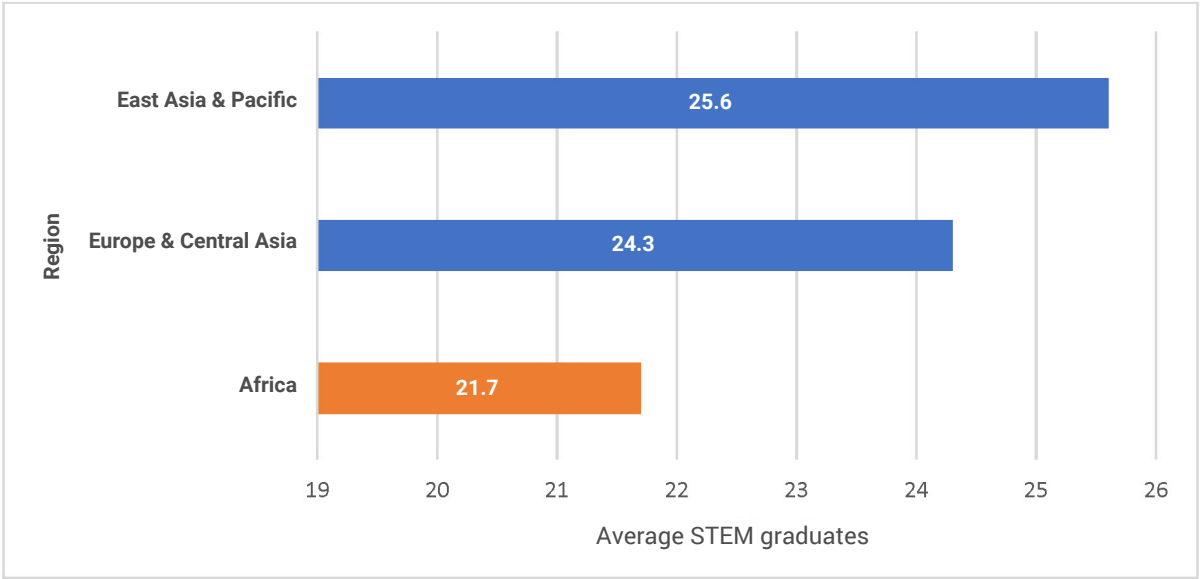
Policy Brief
STEM education and inequality in Africa

1. Introduction and rationale

Science, Technology and Innovation (STI) are expected to play a significant role in the success of the United Nations (UN) 2030 Agenda and the African 'Union's (AU) Agenda 2063. Both are very articulate about sustainable development being underpinned by science, technology, innovation and scientific research. As experienced during the response to COVID-19, technology is a powerful tool to increase the resilience of our societies and promote growth. Innovations are powering the fourth industrial revolution and have become indispensable for thriving in a fast-changing world with new and emerging challenges and opportunities. These technological innovations have something in common: they are anchored on solid scientific knowledge, cutting edge technology, advanced engineering and mathematical skills, which can be acquired through Science, Technology, Engineering and Mathematics (STEM) education and training.

Over the last three decades, there has been a global wave of market liberalization that has led some nations to enhance how they master and

CHART 1 – AVERAGE % OF STEM GRADUATES (2015-20)

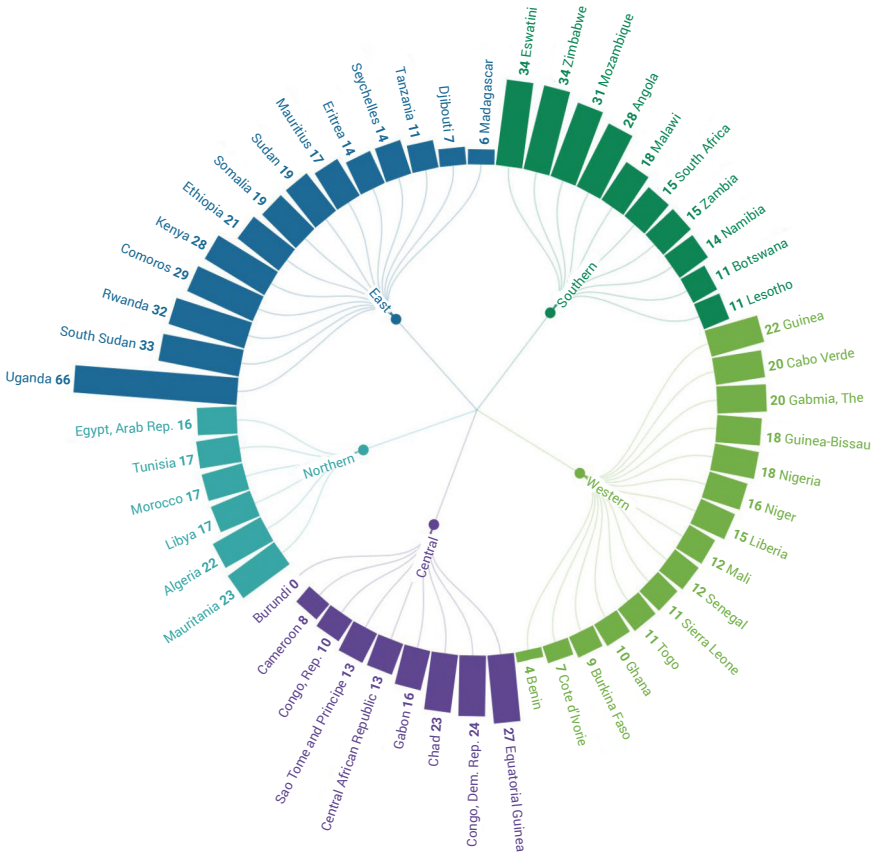


Source: UNESCO UIS School closure data (This calculation is based on 25 African countries, 47 EAC countries and 14 ECA countries)

utilize STEM as key determinants of economic growth, development, and security[1]. In response, most African countries have developed national policies that promote STEM education. Though educational policies that promote STEM education are often coherent with national development visions, there is often a gap between policy and practice. As a result, African countries still fall behind in STEM education outputs compared to the rest of the world (see chart 1). Moreover, the lack of implementation of STEM plans in African countries has further exacerbated the economic development gap between Africa and the rest of the world, undermining African countries' innovation capacities.

One of the main challenges for implementing these plans is that most of Africa's education and training programs through which STEM fields are taught suffer from inequalities and exclusion at all levels, poor resourcing, inadequate teacher development programs, limited access to electricity and internet, and inadequate infrastructure for STEM teaching and learning. According to UNESCO, most African countries have attained universal primary

CHART 2: NUMBER OF WEEKS - SCHOOLS CLOSED AND PARTIALLY CLOSED IN AFRICA DUE TO COVID-19



Source: UNESCO School closure data set (as of March 2022)

1 APR – Education Youth Development, STEM education and African development, Author Nkem Khumbah

education in the last few decades with 'Africa's current primary school enrolment rate above 80% on average. However, even though there has been high primary school enrolment, inequalities and inefficiencies persist in this sector. A large number of children are still out of school, despite the significant increase in the number of children with access to basic education. What's more, there is very limited access to STEM education in primary schools.

As noted in the 2021 report of the United Nations Secretary General on the Promotion of durable peace and sustainable development in Africa, African countries still face considerable deficiencies in reaching Sustainable Development Goal (SDG) 4 targets related to secondary, tertiary and vocational education, often with marked disparities along socio-economic, gender and geographical (rural and urban) divides. These disparities undermine efforts to achieve SDG 4 and have the potential of becoming root causes for unrest and conflict. At the start of the COVID-19 pandemic, school closures (See Chart 2) deepened the existing inequalities, most especially the digital divide, which affects children who were already at risk of being excluded from a high-quality education. Countries in Eastern, Western and Southern Africa had the largest school closures due to the pandemic.

Considering the foregoing scenario, for STEM education to become a more significant driver for Africa's global economic competitiveness, African countries need to address the existing inequalities embedded in the education sector and that undermine the strengthening of the continent's human capital. Based on this premise, the Office of the Special Adviser on Africa (OSAA), in line with its Strategic Agenda, is advocating and providing advisory support to increase the level of knowledge and STEM-related skills amongst the African youth a critical enabler to spur development in Africa.

This policy brief aims to assess how inequalities in the education sector undermine Africa's capacity to leverage the potential of STEM education for sustainable development. In this regard, it assesses structural problems that limit the impact of education policies and analyses inequality from a triple perspective: income, geographic location (urban/rural divide) and gender. It proposes recommendations on how to advance and strengthen the implementation of STEM education in Africa by addressing these inequalities.

2. Structural issues in education policies in Africa

Children these days are very intelligent and brilliant, they are enthusiastic in nature. We need to grow their knowledge, understanding, and curiosity using the STEM education." -*Bamigboye Olurotimi* (**Photo:** UNICEF-Zimbabwe-2021 by Kudzai Tinago)

a) The challenge of public expenditure

African governments have long appreciated the importance of investing in human capital by promoting science and technology for 'Africa's accelerated growth and development. As part of this commitment, most African countries have developed national policies that promote STEM education through domesticated AU

Science, Technology, and Innovation Strategy for Africa (STISA-2024). However, even though most African Government development policies and national plans mention STEM (usually called as Mathematics and Science) policy implementation has remained a challenge.[2]

Some of the causes of poor implementation include the inadequacy of budgeted implementation strategies and lack of clarity when it comes to monitoring and performance evaluation indicators. The high cost of establishing STEM-friendly schools also means that efforts in this area will take time, considering that governments already generally spend significant proportions of their national budgets on education but it has not been emough. It is necessary to find innovative resourcing, and also enhance governance and accountability in service delivery. Furthermore, as public budgets have come under severe stress due to pressure to increase spending in response to the COVID-19, fiscal space to promote and implement medium-to-long-term development policies, such as the required development of STEM education plans has diminished for the current COVID 19 / post COVID 19 season.

It should be noted that even prior to the COVID-19 pandemic, education expenditures showed challenges linked to prioritisation among equally important inputs. For example, most African Governments have essentially allocated a significant amount of funding to the all important and needed infrastructure for schooling (school buildings, textbooks) and less to other equally important inputs such as nutrition, early childhood education or teaching effectiveness which, if not adequately addressed, have a negative impact on learning outcomes.[3] In other cases, public funds do not reach the intended groups. For instance, an analysis of the African Development Bank (AfDB) showed that 60% of funds allocated in Cameroon never reached schools.[4]

According to UNICEF, a substantive increase in funding for education is required if many African countries are to achieve SDG 4. The UN Framework for Action on SDG 4 recognizes the diversity of national contexts, but recommends the following education expenditure global benchmarks for national education funding:

- allocating at least 4 to 6 per cent of GDP to education and/ or
- allocating at least 15 to 20 per cent of public expenditure to education.

African countries would benefit from considering these benchmarks and making commitments toward meeting them. Contextual benchmarks should consider the level of wealth of African nations, the continent's lag in education and training, and especially the large proportion of young people.[5]

Based on Chart 3 below, more than half of African countries' expenditure on education is below 4 per cent of the country's GDP and school-age population. Countries such as Nigeria and Egypt, with the highest school-age population, have a low per cent of the country's GDP on education. The regions of the continent, the figure varies from less than 2 per cent for countries such as South Sudan, Central Africa Republic and Mauritania to above 7 per cent for Namibia, Lesotho, Tunisia

2 OSAA Policy paper – STEM as an enabler for Development and Peace, 2022

3 Africa Development Bank, The Bank's Human Capital Strategy for Africa (2014-2018) Oshd Department, AfdB, page 7.May 2014

4 Africa Development Bank, The Bank's Human Capital Strategy for Africa (2014-2018) Oshd Department, AfdB,

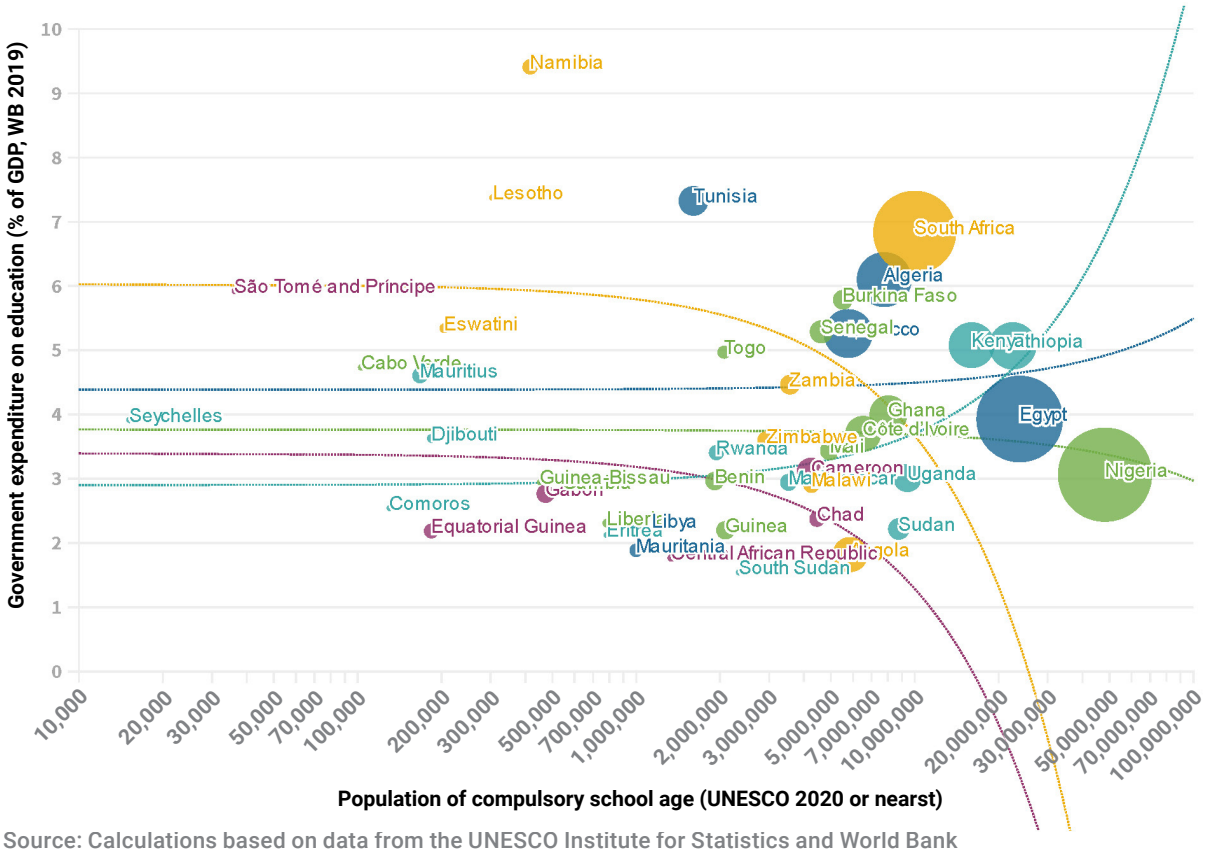
5 UNICEF, Transforming Education in Africa: An Evidence-Based Overview and Recommendations for Long-Term Improvements

and South Africa. According to UNICEF, for these countries, the scope for increasing public resources for education lies in improving the 'government's mobilization of domestic resources. These countries also have room to increase both the government budget through improved tax collection efficiency and the share of the national budget devoted to education.

An analysis of African countries' spending reveals interesting patterns. As shown from Figure 1 below, countries with a high expenditure of GDP, such as Angola, Egypt, Malawi, Morocco, Rwanda and Tunisia, only spend relatively less on education, falling in the range of 0-14% even though they allocate a larger share towards government expenditure. Conversely, countries such as Namibia, with a lower share of Government expenditure in GDP, spend considerably more on education. Financing education must remain a top political priority, as the African continent is dependent on its human resource for development, including tackling future crises.

African 'Governments' education spending on the continent has also contributed to the lack of optimal efficiency of the expenditure.[6]

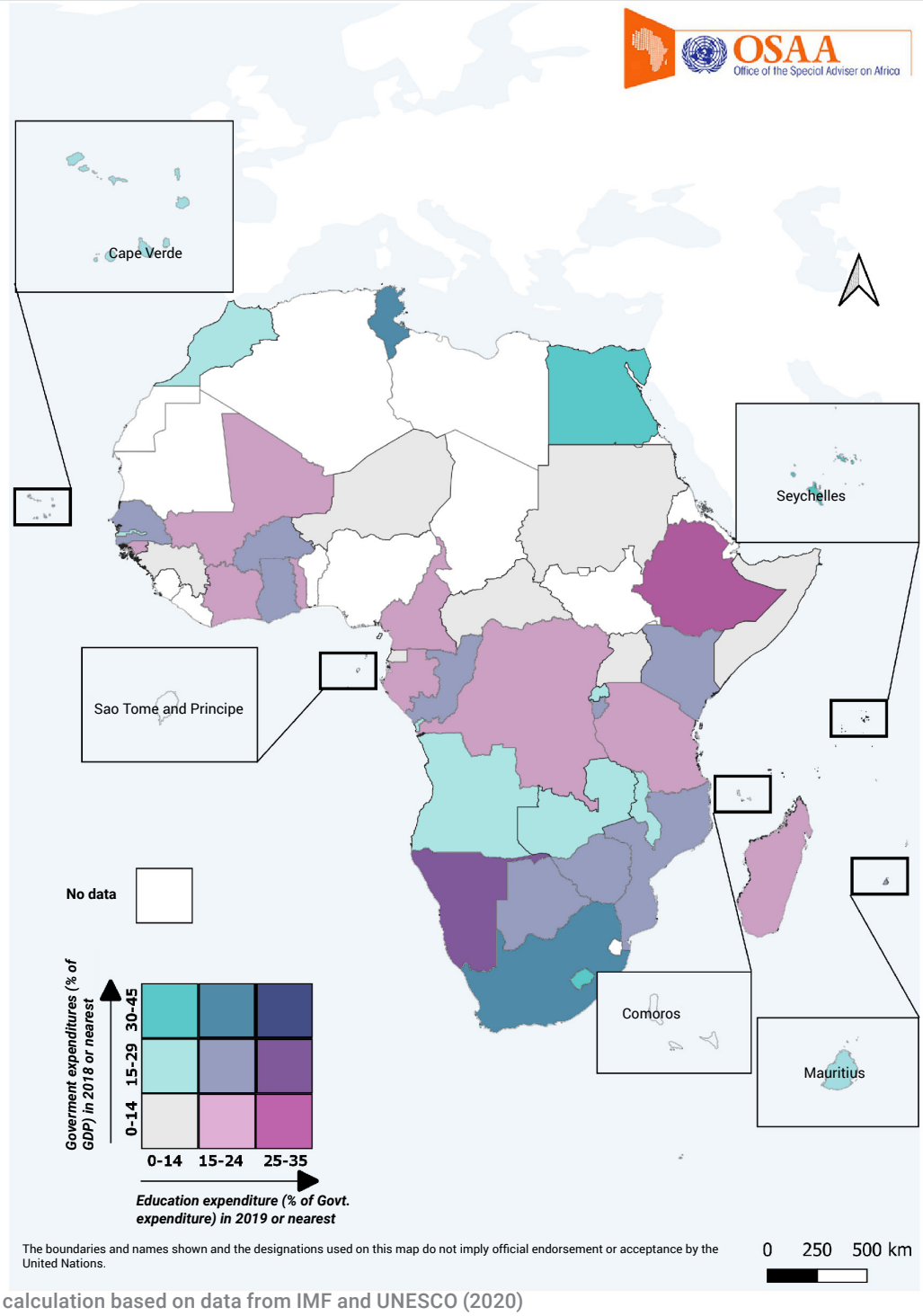
CHART 3: COMPARISON BETWEEN EDUCATION EXPENDITURES WITH THE SIZE OF GDP AND SCHOOL-AGE POPULATION



Source: Calculations based on data from the UNESCO Institute for Statistics and World Bank

6 African development review – Article - Does government education expenditure affect educational outcomes? New evidence from sub Saharan African countries by Adesoji Oladapo Farayibi and Oludele Folarin

FIGURE 1 – PUBLIC EXPENDITURE AS A PERCENTAGE OF GDP AND EDUCATION EXPENDITURE AS A PERCENTAGE OF TOTAL GOVERNMENT EXPENDITURE OF AFRICAN COUNTRIES



Source: calculation based on data from IMF and UNESCO (2020)

Research findings have shown that the effect of government education spending on educational outcomes in Sub-Saharan Africa (SSA) was driven by the measure of educational outcome used. For example, to deliver on commitments on universal access to basic education, government spending in SSA has targeted mainly on primary and secondary education and not on tertiary education. Higher education in Africa has been less responsive to the changes in global knowledge and labour market demands due to the reduced allocation of funds in tertiary education. Therefore, it is imperative that the policy agenda for government education spending should equitably target all educational levels to improve human capital development in the region.

Furthermore, the African Development 'Bank's 2020 African Economic Outlook report notes that although a significant number of sub-Saharan African countries have greatly improved access to basic education, there is a disparity between the skills set acquired and what the job market requires from the youth after years of schooling. It is estimated that millions of students graduate not having the necessary skills and knowledge to progress to further education or the workforce.[7] One of the missing links is the extent to which STEM education has been implemented, besides also having intentional links between school and industry. It is imperative that the significant investments in education are directed towards ensuring relevance to enhance employability in STEM careers in industry, given the number of young people in 'Africa's workforce set to increase to 375 million by 2030.[8] Knowing that more and more employment opportunities are STEM based, it is clear that the unemployed will be those without STEM based skills and knowledge. Syatematic linkages between education development and industry are indispensable in ensuring relevance.

b) Educational curriculum

In addition to the distribution of expenditures among levels of education, another structural challenge is in ensuring that the education curricula are responsive to the national development vision, relevant to the times and meeting the needs of the populations. African countries have been consicious of the need to significantly change their curricula since the beginning of the African unity. As early as 1960 at the first pan African conference on education, referred to as the Addis Ababa Conference, the African leaders questioned the relevance of colonial education for Africa's development needs and called for review towards ensuring that education produces human level expertise and graduates able to utilise technology for social economic development and wealth creation. The process would therefore include strengthening the teaching and learning of scientific subjects, and developing mindsets towards social economic development. However, implementation has proved to be difficult, considering the investment needed to overhaul initial and continuing teacher development programmes, reviewing school curricula at the different formative levels, equipping the schools and providing amenities including electricity, water and internet access, and establishing links between education and the world of work. In spite of continuing much effort, curricula in public education in Africa are yet to be optimised for STEM education, both in terms of pedagogies and approaches, as well as the individual STEM subjects. Many countries like Kenya, Egypt and Rwanda have STEM schools where

7 Mastercard Foundation, Leader in Teaching

8 Mastercard Foundation. https://mastercardfdn.org/all/leaders-in-teaching/

the STEM ideal is exemplified both for producing STEM oriented graduates and for providing an example that may eventually be replicated.

It has to be noted that the issue is not replacing Social Sciences with STEM, but first using 'STEM' approaches in teaching and learning; second, ensuring that STEM literacies are achieved by all children in school; and thirdly ensuring that more students study actual STEM subjects and STEM fields. STEM education has to be redefined to include creativity, entreprenurial and critical thinking, African values, and social communication and language. Current curriculum review processes in African countries include the incorporation of these. Development plans are replete with references to ensuring education produces human resources and knowledge product that will contribute to economic growth and indurtialisation. With the fourth industrial revolution already a reality, failure to prioritize STEM education will impact the ability of African countries to be globally competitive. The digital divide as a source of inequality between Africa and the rest of the worldy, also contributes to inadequacy of implementing STEM based curricula[9].

In recent years, many African Governments are reviewing their education curricula towards a project/competency-based curriculum aimed at promoting creativity and innovation, as well as skills that are more relevant for the labor market. However, the development and implementation of such curriculum reforms are demanding and expensive, leading to deepening of the inequalities between richer and poorer regions and populations.

One of the major setbacks for the successful rolling out and effective delivery of a project/competency-based curriculum in Africa is the lack of the necessary physical and material resources, and the problem is particularly acute in previously disadvantaged communities, including rural areas. Due to their nature, STEM subjects require dedicated resources in addition to the generic ones required for any other school subject. These resources include laboratories, laboratory equipment (e.g. oscilloscopes, microscopes, and spectrophotometers) and consumables. In addition to a lack of basic resources, most STEM learners on the continent do not have access to computers and related ICT infrastructure. There needs to be collaboration among academic institutions, industry, private sector, government, and non-governmental organizations to achieve this. Industry's role cannot be over-emphasized since competence-based education is about relevant competence for industry and life.

"We can't get the future we wanted if we fail to take advantage of the STEM education, we must open students all over the world to it, in order for us to get the future we can all be proud of." -*Bamigboye Olurotimi* (**Photo:** UNICEF)

c) The Teacher gap

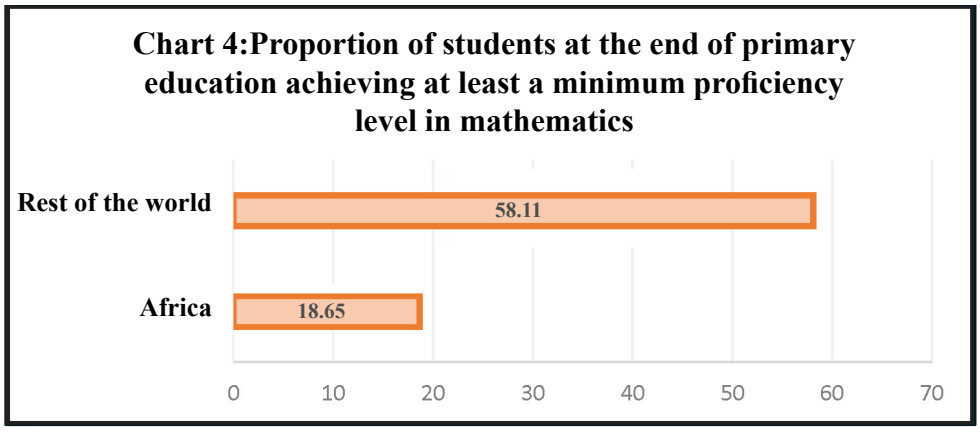
A successful STEM education will be reflected in learning outcomes, which in turn reflect teacher quality as well as the overall teaching and learning environment. While Africa's enrollment figures in primary and secondary level

9 More information can be found in the OSAA Policy Paper on STEM as an enabler for Development and Peace

education have been increasing, the quality of learning remains very low. Over 200 million children and adolescents who were in school in 2018 were not achieving minimum proficiency levels according to the UNESCO Institute for Statistics (UIS)[10]. There is a pressing need to improve the quality of teaching and learning in primary and secondary education on the continent. Sustainable models for regular capacity building of teachers of STEM subjects exist and are operational in some countries including Kenya, Uganda, Zambia, and Nigeria. According to the Association for the Development of Education in Africa (ADEA) continuous research on innovative pedagogies in STEM education should be adopted to assess on what is working or not working, in order to ensure continuous improvement of pedagogical practices[11].

STEM education can become instrumental in improving the quality of education in the continent and its role in strengthening the skillset of the 'continent's workforce. However, the performance of African students in mathematics and science on international assessments is persistently lower than international averages, for the few countries that have participated (See chart 4). Furthermore, the poor performance in primary education, especially in basic mathematics and literacy, becomes a bottleneck for students to specialize in STEM subjects in the secondary level.[12] Hence, the quality of STEM education is considered poor in Africa.

While several factors impact 'children's performance, such as nutrition and overall health, there is an undeniable fact: the quality of education cannot exceed that of its teachers, and Africa faces structural problems both with regard to the number and the qualifications of its teachers. According to UNESCO Institute of Statistics (UIS), the African continent is the most affected by teacher shortage. The UIS estimates that by 2030, the continent will require hiring about 19 million teachers, and the situation is a major concern for SSA, which accounts for almost 90% of the projected number of additional educators required to achieve universal primary and secondary education (UNESCO, 2016). In addition, Sub-Saharan Africa is the region with the lowest proportions of teachers



Source: UNESCO[13]

10 UNESCO, 2018

11 ADEA,Report on the Situational Analysis of the Status of STEM Education at Basic Education in Africa

12 University of Bristol Working Paper in Education (2018), Supporting Secondary School STEM Education for Sustainable Development in Africa, - Professor Leon Tikly Marie Joubert Dr Angeline M. Barrett Dr Dave Bainton Leanne Cameron Helen Doyle

13 Based on available data from UNESCO. 19 out of 54 African countries was taken

with minimum required qualifications to teach. In 2019, just 65% of primary and 51% of secondary teachers were trained to the required level.[14]

The general shortage of qualified teachers in sub-Saharan Africa is acutely felt in the STEM subjects. This disproportionate shortage of qualified STEM teachers is caused by several factors and dominant amongst them is that talented STEM graduates tend to pursue more renumerating and attractive careers as opposed to teaching. Another factor contributing to the shortage of qualified STEM educators is the general low uptake of these subjects by high school learners, which could be attributed to the vicious cycle of the shortage of qualified teachers.

The gaps in the number of trained and qualified teachers, including STEM educators, relate to several factors, including policy, resources, and capacity of teacher education institutions to train sufficient numbers of teachers, and effective management structures and strategies to support and retain them in the profession. These issues need particular attention, given the crucial role teachers play in the provision of quality of education. Given the fact that it is the region with the fastest growing school-age population, urgent action is needed to mitigate the teacher gap. In this regards to STEM education, teachers need to possess advanced skills as learning facilitators and instructional designers in all STEM subjects. This calls for African countries to prioritize teacher training and development in schools, including skills for STEM fields. Furthermore, they need to prioritize redesigning their teacher development programmes at all levels, including STEM skills for learner-centred, inclusive quality education. This requires, among other things, the revision of teacher training curricula to build the capacity of teachers.[15] Much of this is already happening, with institutions like Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) supporting teacher capacity building in over twenty African countries. CEMASTEA's work in the delivery of quality STEM education through teacher training has built a basis for education and the supply of quality workforce in support of UN 2030 Agenda and the AU Agenda 2063. The agency has been able to provide guidelines and support in STEM Education that are applied in African countries and take into consideration the local context of the instructions as well as aspects of adaptability, gender, equity, global trends and sustainability.

3. Inequalities in education

"The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge." - *Seymour Papert, South African mathematician and computer scientist* (**Photo:** UNICEF)

a) Socio-economic and geographic inequalities

Socia-economic difference has long been linked with illiteracy and school drop out. Many African countries have declared free and universal primary education- and some include secondary education. This is going a long way to bridge the

14 UNESCO COVID-19 Education Response, A snapshot of educational challenges and opportunities for recovery in Africa, 2021

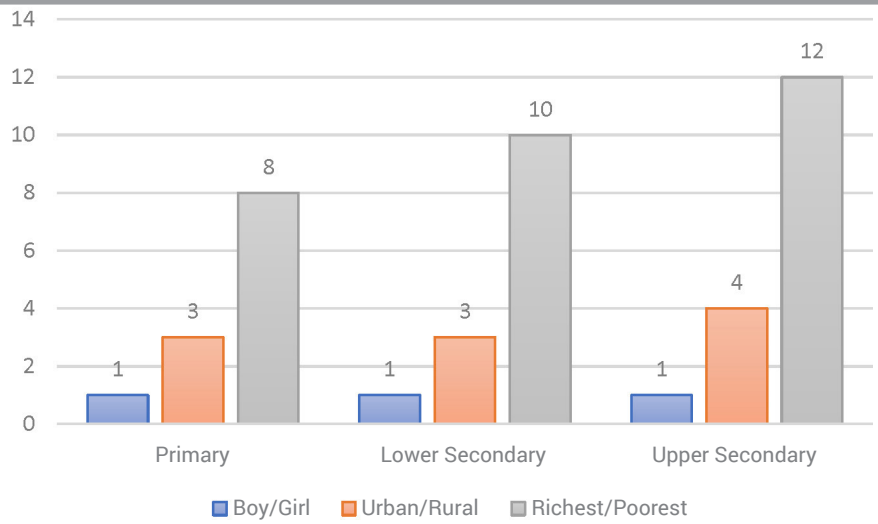
15 UNICEF, Transforming Education in Africa: An Evidence-Based Overview and Recommendations for Long-Term Improvements, 2021

divide between rich and poor accessing education. There, however, remain any peripheral contraints that keep children from poor households home, and keep them from succeeding in school. Although school be tuition free, many still require uniforms and other contributions from parents. This is because government capitation is in many cases not sufficient to cover all the associated costs. Furthermore, hungry children are unable to learn and succeed, but where there are school feeding programs, school attendance has increased and so has retention and success. In Kenya for example, the government has legislated 100% transition from Primary to Secondary, theoretically making all of basic education free and universal as called for in the Continental Education Strategy for Africa (CESA). With inadequate capitation from government for ensuring access, UNICEF found that a child from the richest quintile of households is eight times more likely to complete primary school, and 12 times more likely to complete upper secondary level, than a child from the poorest quintile (see chart 5). Based on their economic background, on the average, two in five African children from the poorest families complete primary school, compared to four in five from the richest families. At the secondary level, only 6 per cent of the poorest children complete upper secondary school, compared to 46 per cent of the richest.

By location, only 12 per cent of children living in rural areas complete upper secondary education, compared to 34 per cent living in urban areas[16]. Universalisation of basic education will help, but only with commensurate investment. In countries with devolved government, more resources are going into rural development, including schools, hence reversing the traditional trend.

Apparently, in many African countries, there is little evidence that education investments are being used to address underlying socio-economic inequalities. This limites the capacity of education to become a development tool. The distribution resulting from the structure of government expenditure by level of education, and the schooling profiles of different categories of

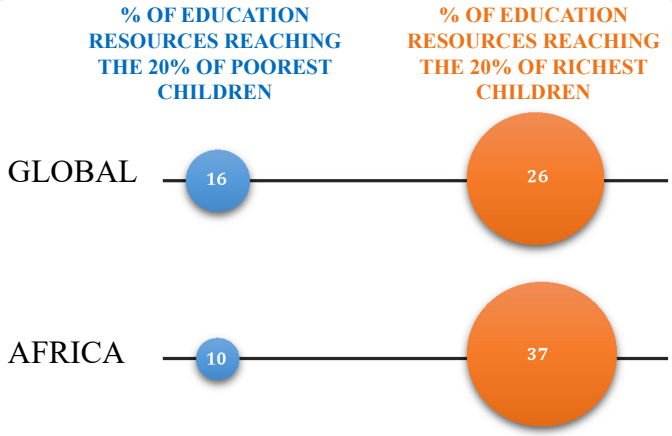
CHART 5: ODDS RATIOS ON COMPLETION RATES IN AFRICA



Source: UNICEF, Transforming Education in Africa: An Evidence-Based Overview and Recommendations for Long-Term Improvements: Calculations based on data from the UNESCO Institute for Statistics, page 31

16 UNICEF, Transforming Education in Africa: An Evidence-Based Overview and Recommendations for Long-Term Improvements, 2021

CHART 6 - AVERAGE SHARE OF PUBLIC EDUCATION RESOURCES FOR CHILDREN FROM THE POOREST AND RICHEST QUINTILES, 2019



Source: Calculation based on data from the World Inequality Database on Education and the UNESCO Institute of Statistics

the population, is so inequitable that children from the poorest households are allocated as little as 10 per cent of public education spending or less. For example, in Guinea and the Central African Republic, the poorest quintile of children benefits from only 5 per cent and 8 per cent of public education spending, respectively. In Senegal and Cameroon, the figure is 9 per cent. In comparison, children from the richest 20 per cent of households are getting 37 per cent of the public education spending, almost four times that of their poorest peers. As shown in Chart 6 the by-wealth disparity in public education resources in Africa (10 per cent vs. 37 per cent) is much larger than the global average (16 per cent vs. 26 per cent).[17]

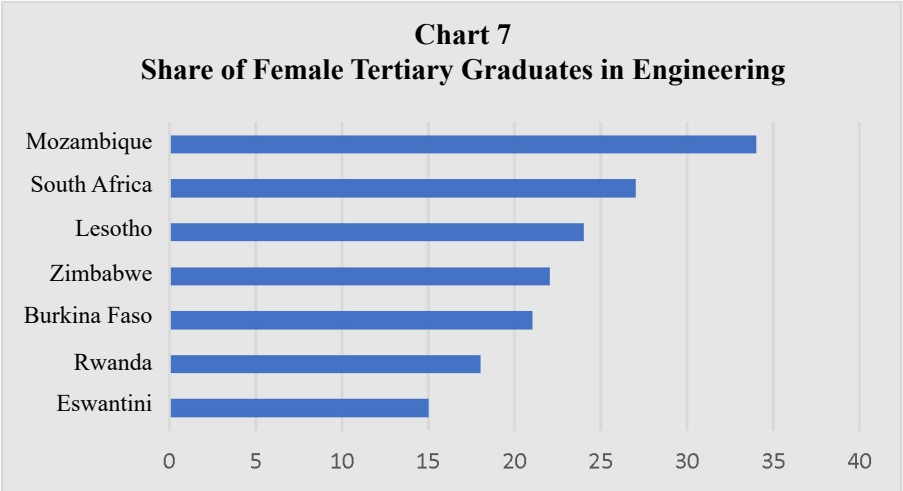
The teacher gap somehow enhances this socio-economic and geographic divide. Well-trained and experienced teachers are unequally distributed at subnational levels with remarkable differences between urban and rural settings and socio-economic strata.

Generally, most rural schools have not only less qualified teachers but also not enough teachers for the number of school children. The cause for these low numbers of teachers in rural areas is attributed to poverty, other inequalities, and socio-economic conditions.

These inequalities in education investment do negatively affect the implementation of STEM education. The emphasis on STEM education at the policy level in most countries is yet to be accompanied by sufficient funding for relevant interventions to be implemented at the grass root level, especially in rural areas, which in some cases, lack the most basic infrastructure due to several factors such as the inequality in the prioritization and distribution of resources available to increase access to education over quality education.

b) The Gender gap

17 UNICEF, Transforming Education in Africa: An Evidence-Based Overview and Recommendations for Long-Term Improvements



Source: UNESCO Science Report: Towards 2030, 2015

Progress has been made toward closing the gender gap in STEM education. Policies to address the gender gap in STEM do exist but they are hardly implemented.[18] While women representation in STEM has remained low, it is worth noting that regional women institutions such as the Forum for African Women Educationalists (FAWE) have made efforts to address the issue, using a multi stakeholder and multi-faceted approach. STEM interventions using the FAWE approach were implemented in Burkina Faso, Gabon, Gambia, Kenya, Madagascar, Nigeria, Mali, Nambia, Somalia, Tanzania and Uganda. The approach used in these countrues is based on strategies which included among others: encouraging female leaners and teachers to participate in special programmes, mentorship, capacity building in digital technologies and e-learning, exposition, sharing opportunities and using the demonstrable to push for policy reform.[19]

The gross representation of women in the STEM fields remains low globally, with SSA being the worst. Chart 7 shows, the share of females graduating from tertiary education engineering fields is below 30% for many SSA countries. According to UNESCO, the gender parity index is below 1 (Africa's gender parity stands at 0.58 and 1 would be full parity), showing that fewer girls are enrolled across all levels than boys.[20] The gender disparity grows at higher levels of education in SSA.

Though major efforts have been made by African countries and the donor community in the past decades to reduce the gender gap in STEM education, major inequalities still remain. As a result, both women and girls continue to face many challenges in enrolling, accessing, and maintaining their roles in STEM fields. This is unfortunate because women's untapped human capital can enhance the STEM workforce, given that women represent half of the

18 The African Academy of Sciences (AAS), Mukhwana A.M., Abuya T., Matanda D., Omumbo J., Mabuka J., Factors which Contribute to or Inhibit Women in Science, Technology, Engineering, and Mathematics in Africa (2020)

19 FAWE, Annual Report, 2020

20 Global Partnership for Education (GPE); Article : One of the greatest threats to Africa's future: gender inequality

world's population and more than 50% of its college bound population[21]. A major concern for most countries is the number of girls attending school and the limited educational pathways available for girls that attend school.[22]

Many African countries still face challenges in retaining female students in STEM disciplines as well as in STEM-related careers.[23] While data showed that in countries with universal primary education and near universal secondary education (Botswana, Mauritius, Seychelles, and South Africa), girls marginally outperformed boys in mathematics by the end of primary school[24], there seem to be existing challenges that limit women embarking on STEM careers. For instance, in Southern Africa, even though the enrolment of girl in secondary education is higher than for boys, many of them drop out before completing their secondary education. Moreover, most of those who complete secondary education lack the required proficiencies in numeracy, science and the digital skills necessary to enroll in STEM related programs at the tertiary education level (World Bank).

According to the Equality Equation Report[25], gender norms, stereotypes, biases, and sexual harassment remain the key drivers of low representation of women in STEM fields. Gender biases and expectations for different genders, in most cases put in place by society, culture, family, and the media tend to promote stereotypes, discriminatory practices, and policies that discourage girls from pursuing STEM careers and lead to women leaving STEM careers. Furthermore, gender disparities in Africa intersect strongly with poverty and rurality. Therefore, achieving gender equality in secondary school will depend on a long-term commitment to concentrated planning and resources within poor, rural contexts and disadvantaged groups. This will include ensuring that STEM education is relevant to poor, rural youth, for whom opportunity costs are high.

In this regard, the universalization of secondary education in Africa is probably the single largest and most significant step that can be taken towards achieving gender equality concerning STEM. It would lead quickly to gender equity in measures of learning outcomes in STEM. And, over a longer period of time, universal secondary education could increase representation of women in STEM-related professions, including graduate and postgraduate level occupations[26].

4. Conclusions and Policy Recommendations

The drivers of inequality in education through which STEM education is attained are many and complex, yet the response to these challenges is based on concrete policies for inclusive growth, the eradication of poverty and marginalization, increased investment in education and human development, as well as good governance to ensure a fairer distribution of assets[27]. African countries and their development partners should prioritize investments in key inputs that positively impact learning outcomes (nutrition, early childhood education, teaching

21 Reflections on Gender Disparity in STEM Higher Education Programs: Perspectives and Strategies, Enyonam Brigitte Norgbey

22 UNESCO Article, International Day of Women and Girls in Science: Addressing and Transforming the Gender Gap

23 UNESCO, https://en.unesco.org/news/new-unesco-report-sheds-light-gender-inequality-stem-education

24 Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ III)

25 The Equality Equation : Advancing the Participation of Women and Girls in STEM

26 Mastercard Foundation, Secondary Education in Africa: Preparing Youth for the future of Work : Background Paper – Approaches to Strengthening Secondary STEM & ICT Education in Sub-Saharan Africa

27 Africa Renewal: December 2017 - March 2018, Article: Africa grapples with huge disparities in education, by Zipporah Musa

effectiveness) and to more cost-efficient modes of service deliveryif they are to achieve the UN 2030 Agenda the AU Agenda 2063.

African Governments should prioritize policies that are aimed at reducing poverty in rural areas. This includes improving infrastructure, health and sanitation conditions, and modernizing the agricultural sector. Synergy between rural and urban development needs to be maintained for the quality of education in rural Africa to be improved.[28]

Therefore, the following policy agenda should be prioritized: (i) To improve the total human capital development indicators in the region, government education spending should equally target all education levels; (ii) there is a need for capacity building of government institutions for them to increase their level of performance and effectiveness.[29]

The following policy recommendations are believed to help Africa Member States address the issues of inequalities in education:

Universal quality basic education

- Increase efforts towards achieving universal quality basic education, which is an important way of building resilience in populations and actively transforming what could be a demographic burden into a valuable demographic dividend by building citizenship and creating a qualified and employable workforce that can match the needs of the labour market for particular skills and competencies.
- To enable learning, there is a need to provide all teachers with the needed quality pre-service training and continuous in-service teacher professional development programmes, a decent status and working conditions as well as professional support. Both SDG4 and the African Union Continental Education Strategy (CESA 2016-2025) have specific targets for addressing the teacher challenge: SDG target 4.c calls to increase the supply of qualified teachers considerably by 2030 and to enhance their working conditions, while AU/CESA Strategic Objective 1 calls African countries to revitalize the teaching profession to ensure quality and relevance at all levels of education by 2025.

Promotion of STEM at higher education and research level

- Prioritize the implementation of policies aimed at improving the quality and quantity of teaching of STEM at all levels of the education system, including research-based education.
- Increase support of STEM disciplines at the higher education through, for example: postgraduate scholarships, bilateral university collaborations, and encouraging regional and international firms/companies to contribute to the development of STEM capacity in Africa.
- Mandatory funding for infrastructure, equipment and teaching and learning processes for STEM education should be allocated in national budgets by African Governments.
- Promote the involvement of industry to stimulate STEM initiatives and support schools and teachers with equipment and infrastructure.

28 Brookings, Poverty, Inequality and Africa's Education Crisis

29 Africa Development Bank – Africa Development Review, Article titled: Does government education expenditure affect educational outcomes? New evidence from sub-Saharan African countries, Adesoji Oladapo Farayibi,Oludele Folarin

Educational curriculum and inequalities

- Curriculum reform at primary, secondary and tertiary levels is necessary to align with policy expectations and enhance STEM quality and learning to disabuse the notion that STEM subjects are too difficult. Curricula for Teacher preparation and continuous teacher professional development have to accompany overall curriculum reforms and stakeholder participation.

Addressing gender gap

- Develop enabling policies to reduce the gender gap in STEM at all levels of education and research; Increase the visibility, participation, and respect of women in STEM; Enhance capacity building for data collection on gender in STEM, and promote the implementation of national STI policies related to gender; and promote the development and implementation tools to measure the status of women and girls in science.[30]
- Promote interventions such as providing scholarships targeted at girls and women to pursue STEM programs should be a priority of African Governments and industries.
- Introduce various academic opportunities such as online education and short courses to increase accessibility to young women balancing many demands and promoting training for teachers on gender-sensitive instruction and how to engage girls in STEM.
- Provide financial support to 'women's and 'girl's youth-led grass root organizations that seek to address gender inequality in STEM should be a priority for African Governments.
- Government Policy makers on STEM must involve women in STEM in drawing STEM policy. This will go a long way in bridging the gender gap and some of the challenges faced by women in STEM.

Monitoring and Evaluation (M&E)

- It is essential to develop STEM M&E frameworks to map out the STEM education ecosystem sufficiently to appropriately direct investment and other interventions. It is challenging to create adequate interventions where data is not available or sufficiently granular to define situations clearly. This includes the matters of gender disaggregation, infrastructure and equipment, teachers according to specific STEM subjects, enrolments according to STEM subjects and so on.

"STEM education is the leveler for all to be successful in the future needs of humanity." -*Ian R. McAndrew, Ph.D.* (**Photo:** UNICEF)

30 Article on UNESCO STEM and Gender Advancement (SAGA), Improving Measurement and Policies for Gender Equality in STEM

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