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What is Next for Africa's Youthful and Useful Population? STREAM Education for Global Inclusivity

Olalekan Taofeek Badmus*[a] & Loyiso C. Jita[a]

* Corresponding author
E-mail: badmus.OT@ufs.ac.za
a. Faculty of Education, University of the Free State, South Africa.

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ABSTRACT
The world is a global village today undoubtedly due to advances in science, technology, engineering and mathematics (STEM) disciplines and their education. The knowledge from these disciplines influences various aspects of human daily affairs, career choices and the type of education acquired by citizens. STEM literature across the world has put Africa at the tail end of development. Africa's underdevelopment may not be argued owing to empirical literature in the direction of poor development. However, the global demand for competence in STEM disciplines continues to rise at a rate developed countries find difficult to keep up due to shortage of man power as against demands. This surge in demand creates a gap that must be filled in pursuit of sustainable growth. Science, technology, robotics, engineering, the arts and mathematics (STREAM) education remains obscure among countries in Africa, with the paradigm shift to aesthetics with arts and automation in robotics globally calling for redirection in developing regions. South African and Nigerian curricula have been moderated to accommodate coding and robotics as well as physics in technology, with green energy and elementary automation, respectively. This manuscript explores education as the panacea for poverty alleviation, sustainable growth and equality among citizens. The current state of affairs of STREAM education in Africa and its potential for a youthful and useful population are also explored.

KEYWORDS
Globalisation; Africa; youth; STEM education; STREAM education; unemployment.

INTRODUCTION

The absence of food, shelter and clothing portends an inability to meet basic needs (Tilak, 2002). The word *poverty* is usually associated with these absences. It refers to the state of being in which individuals lack the requisite income to provide the basic needs for themselves and, by extension, dependants. Poverty is a global issue, with each and every country in the world, including both developed and developing countries, having some percentage of its citizens suffering from it. A global attempt to aggregate a workable definition of poverty produced the term *poverty line* (United Nations Department of Economic and Social Affairs [UN DESA], 2019a; UN, 2014; World Bank, 2020a). *Poverty rate* is described in the context of a percentage among a demographic group in a defined geographical boundary whose income is beneath the poverty line. There are itemizable causes of poverty which are not necessarily general but geographic-location specific – inadequate arable land, lack of fresh water, conflict/war, natural disaster, and bad governance, among other causes (Lakner et al., 2022; Tikly et al., 2018; Varga, 2020). Poverty is a revolving trap that requires education, good healthcare, sanitation, employment opportunities, clean and usable water and, most importantly, good governance to break (Shrider et al., 2021; World Bank, 2020a, 2020b).

The United Nations (UN) through their sustainable development goals (SDGs) has prioritised the eradication of extreme poverty by 2030 (UN, 2014). The intension is to reduce the world poverty population to at least 3% of the world's population (Atamanov et al., 2020; World Bank, 2014). Reducing inequality within countries and among citizens is important primarily to alleviate poverty (Lakner et al., 2022; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020). Education has proven to be instrumental towards alleviating and remediating societal ills (Kor et al., 2013; UNESCO, 2015). The need for a concerted effort to eradicate poverty through basic education remains paramount. Using intellectual support in organising laudable approaches to combat poverty has proven to work in China and Asia-Pacific (Eryong & Xiuping, 2018; Chu, 2021; Chu et al., 2019). Inaccessible education in poor communities has been identified as major hindrance to people getting out of poverty, especially in rural areas (Kor et al., 2013; Lakner et al., 2022). Scholars have stressed the potency of education as a tool for poverty alleviation and anti-poverty policy implementation (Eryong & Xiuping, 2018; UNESCO, 2015, 2020). It has become imperative for nations and governments willing to eradicate poverty to embrace education to reduce inequality and promote economic growth (Chu, 2021; Shrider et al., 2021).

Education and training have been used in an attempt to alleviate poverty (Ricci et al., 2021; Si et al., 2015). Becoming educated in a particular field may not sufficiently equip an individual with the requisite skills needed on the job (Alvarez & Barney, 2014; Bruton et al., 2015). Oftentimes, most industries utilise training in the field to acclimatise employees to their job description. While on-the-job training is easier in some climes than others, the most important thing may be to master the skills required in any field, and that can only be done through consistent practice that comes during training (George et al., 2012; Rojewski, 2002).

Globally, developed countries have certain advancements which developing countries are bereft of. Such advancements include science and technological might, which eventually muscle the economies of such nations (Jaimovich & Siu, 2017; Kerr & Kerr, 2020). The legitimacy of any education lies in its beneficiaries' ability to solve daily challenges confronting society (Aslan et al., 2020). However, the education taught in many African schools may be said to be directed towards Western and/or European societies in terms of applicability (Garba, 2010; Ogbuanya & Chukwuedo, 2017; Ogundele et al., 2012). The aforesaid is premised on the fact that not all education acquired from faraway countries is applicable to the African continent (African Union [AU], 2020; Ogundele et al., 2012). However, education acquired on the continent of Africa remains useful outside the continent for direct employment or by extension retraining for job placement. The basis for the position held in this paragraph will be elaborated below.

The population of Africans on the continent was estimated at 1.3 billion in 2017. Between 2008 and 2017, the population increased by 28.8%, a percentage that could increase in the coming years (UN DESA, 2019a, 2019b). Africa has five subregions, namely Central Africa, comprising of 9 countries; Eastern Africa, with 14; Northern Africa, with 7; Southern Africa, with 10; and lastly, Western Africa, with 15. West Africa is the most populous subregion, with 30.5% of the entire population of the continent. Eastern, Northern, Southern, and Central Africa comprise 27.8%, 15.7%, 14% and 12% of the continent's population, respectively. Nigeria is the most populous country in Africa, with an estimated population of 197,572,281 according to a spatial distribution of African populations by the African Union (AU, 2020). The population growth in Africa is reported to be driven by international migration and urban migration. The people from, and on the continent of Africa are on the rise but not at the same rate across the continent (UN DESA, 2019a). With the population growth in Africa, the continent cannot boast with prolific STEM industries, unlike the US, Japan, South Korea and other developed countries (Beegle et al., 2016; De la Briere et al., 2015). The implication is that goods and services from such industries are brought into the African market at an expensive rate or below standard, which may be attributed to why the continent has a consumerist economy (Card et al., 2018; Devarajan, 2013).

Globally, STEM leading industries (Microsoft, Samsung, Apple, Hewlett Packard, IBM, Hitachi, Hon Hai Precision, Sony, Amazon and Google) are domiciled in the US, Japan, Singapore, Taiwan and, recently, China – all of which except China are considered developed countries (Chu et al., 2019; Forbes, 2014). The US stands out, however, as a leader in this respect, due to the fact that the headquarters of major STEM companies are resident in the US. Consequently, a great deal of expertise is required to fill skilled positions to stay in the lead and compete economically with other giant economies. However, these industries lack the competent workforce in places where their offices and factories are located. To cater for the shortfall in expertise in STEM and non-STEM disciplines, there is a general resolve to establish a pathway for skilled individuals to fill the needed positions through migration (Ricci et al., 2021). Countries across the world explore three ways to remediate the skilled-labour challenge. The first is

scholarships to students with useful capacity and the second direct migration of experts for work purposes (Ricci et al., 2021; Sandoz, 2020). The third is providing asylum/visa lottery to individuals who are facing persecution in their home country but have the capacity to contribute meaningfully to the economy of the country they are joining. The capacity, here, may differ in terms of expertise, potential and economic tendencies (Van Riemsdijk et al., 2016; Wehrle et al., 2018).

STEM disciplines are numerous and still expanding in width and scope based on the evolution and developments in these disciplines. Recently, the new dimensions of the arts and robotics have been incorporated to form science, technology, robotics, engineering, the arts and mathematics (STREAM) (Badmus & Omosewo, 2020; Chu, 2021). The arts component, often referred to as aesthetics, is still debated among experts. STREAM comprises a variety of disciplines. Computer-based fields include programming of numerical control machines, computer systems, software development, and computer-assisted and/or related fields. Physical science-based fields include astronomy, mathematics, space science, atmosphere science, geology, chemistry, physics, and statistics. Furthermore, life- and medical science-based fields include food and agricultural science, conservation, forestry and marine science, medical science, life and biological science and evolving new areas. Lastly, engineering-based fields include petroleum and geological engineering, materials and metallurgical engineering, civil engineering, electrical engineering, mechanical engineering, automobile engineering, chemical engineering and aerospace engineering. Nevertheless, STREAM disciplines are not limited to the aforementioned as new areas are evolving daily (Badmus & Omosewo, 2020; Hanson & Slaughter, 2016).

Globally, STEM experts are considered to be key drivers of economic growth. Their contributions cannot be overemphasised. Where a shortage is experienced in terms of STEM expertise, this is where labour migration comes in to fill the vacancies for sustainability (Kerr & Kerr, 2020). Labour migration has subsidiaries, such as refugee migration, individual migration, skilled migrants (high and low) and migrant entrepreneurs (Beckers & Blumberg, 2013; Kerr & Kerr, 2020). While these types of migration are mostly symbiotic, it is often viewed as parasitic (Card et al., 2018). Immigration policies have been structured to dishearten migrants, who are often paid below the expected wages (Manning, 2021). These unfavourable policies exist due to pressure from citizens feeling deserving of positions they most times are unqualified to occupy (Brown et al., 2018).

STREAM Education

History has it that the term STEM emanated from the National Science Foundation (NSF) in 2001, an organisation based in the US. The acronym has gained global recognition by experts and policymakers across the globe over the years, including AU member states (Hallinen, 2021). STEM training and education on the African continent have been reported to fall short of the desired when compared to what is obtainable on other continents. According to Tikly et al.

(2018), less than 25% of higher education students pursue a career in STEM-related disciplines. The same cannot be said of the social sciences and humanities. The consequence is a shortfall of skilled personnel resident in African localities for STEM jobs. This manuscript wishes to highlight the shortage of workforce in various STEM disciplines across the continent of Africa, as is the case in the developed world. With that said, the migration rate of skilled experts in these disciplines is unprecedented globally (Hanson & Slaughter, 2016). This may be attributed to poor remuneration for services and innovations, unpleasant conditions of service, insecurity and neoliberal ideology of human freedom to choose and explore regardless of borders and boundaries.

According to UN DESA (2019a; 2019b), the world population stands at about 7.7 billion currently. In about a decade, this figure is expected to rise to about 8.5 billion. By 2050, the world population on earth is expected to hit 10 billion. At present, the current world population may not afford most continents the youthful population to drive the needed economic reality onwards. Africa's youth population of less than 25 years of age is 60% of the total population compared to the 19% of world population of persons between the ages of 15 and 24 years. As such, Africa stands strong with a population of young people capable of transforming the economy of not only Africa but the world at large. It is estimated that by 2035, the world working population will be less than that of the population in sub-Saharan Africa. Ageing evidently seems to be an issue for the populations of other continents as time progresses (UN DESA, 2019a, 2019b, 2019c).

In the 1990s, Africa was depicted as a continent of war, famine and poverty. However, things have shifted for the continent in the 21st century as it has seen an average of 4.5% economic growth each year, an accomplishment deemed promising. What has brought about this situation is that Africa is rich in most of the known natural resources. Many of these resources are in commercial quantity too. Logically, resources are expected to be a correlate of economic growth and meaningful development. The reverse is also the case, as greed and poor management have been reported to be the root cause of poverty in Africa (Beegle et al., 2016; De la Briere et al., 2015). Until recently, population growth seems to have been a curse for Africa. Poverty and population growth are usually in tandem (Rutstein, 2005). Similarly, the continent is prone to lacking sufficient statistical data due to education, poor policy direction and limited access to data (Deverajan, 2013). This tide may have turned in favour of the continent as youthful populace is the new order.

The UN report of 1990–2015 on the millennium development goals (MDGs) put Africa at the rear in terms of achievement in the set targets, while other developing regions in Asia, such as India, Taiwan and China, were most successful in achieving initiatives (UN, 2015). A similar and most recent initiative is the SDGs by the UN to eradicate poverty by 2030, with a focus to eradicate poverty in Africa (UNESCO, 2015). To this end, data were analysed holistically to draft a laudable roadmap for the explicit integration of the SDGs. With the population advantage for

Africa as enumerated in the previous paragraphs, weaponizing this multitude for functionality in STREAM disciplines seems to be the most potent route towards economic empowerment.

Economic empowerment is a deliberate and conscious effort that can be directed by policy. In the US, over 200 bills were drafted between the 100th and 110th congresses for the promotion of STEM education. These bills cogitate directed policy efforts to stakeholders in the areas of national security, immigration, workforce review and other science-moderated projects. Before 2012, the US Government held the belief that it was performing poorly in STEM education, the rest of the world saw a strong STEM nation. Before 2012, experts established over 252 STEM education programmes across the US through 15 federal agencies with a budget exceeding $3 billion (Gonzalez & Kuenzi, 2012). Efforts from the Department of Education, NSF and Health and Human Services to STEM education in the US remain critical to the growth experienced in STREAM education. These appendages of government ensure that policy direction and implementation are aimed at the growth required in terms of global competences in STREAM. In areas of need, these agencies facilitate acquisition of visas for foreign workers and scholarships in STREAM disciplines and provision of adequate funding to researchers domiciled within and outside the US (Granovskiy, 2018). The need to objectively review the policy direction of governments across Africa to manage the present predicament becomes imperative for global inclusivity.

Asia is a continent boasting 60% of the world's population, with diverse cultural, ethnic, political and socio-economic affiliations. This continent had similar problems to Africa in the not-too-distant past. In the wake of the millennium, Asia had over 625 million illiterate people, amounting to 71% of the world population, of whom 64% were women and girls of marriageable age. From 2000, Asia has covered vast grounds in terms of global relevance, competence development and life expectancy indices compared to Africa over the same period. A growing body of research suggests the implementation of science, technology, engineering, the arts and mathematics (STEAM) education across Asia since 2012. Publications on STEAM disciplines in Asia have been underrepresented due to supposed challenges in writing of such manuscripts in English. Nonetheless, this does not invalidate the developments in STEAM works that have taken place on the continent (Chu, 2021; Chu et al., 2019).

Chu et al. (2019) reported that between year 2000-2010 a decline in the interest of both high school and university students in learning science and its related fields in Asia. Government and relevant stakeholders in the region have also expressed concerns and the need for remediation as a result of the necessity to produce competent scientists, engineers and experts with creative thinking skills to spur the needed creativity and innovation. In an attempt to activate learners' interest, an inquiry-based pedagogical approach was employed integrating arts- and culture-related content into science, hence STEAM. The current manuscript exposes STREAM education approaches from various governments and institutions, as well as highlights to the AU and its member states the routes to follow for sustainable growth.

Prospects of STREAM Education for a Youthful and Useful Population

The world today has a STREAM-based economy (Sudarsono et al., 2022). Nations with enormous investment in STREAM continue to enjoy the dividends from their investment. The workforce required by STREAM-based firms is huge. Hundreds of thousands of experts are required to meet market demands on a daily basis. Companies such as Tesla, Apple, Siemens, Samsung, Amazon and many others rely on individuals with expertise to manage their production and maintenance lines daily. These global giants have headquarters on all the continents and are offering global services within and outside planet Earth. People from various nationalities are employed for the operations of these firms. These employments are not based on nationality but competence (Mujiono & Herawati, 2021). As long as an individual possesses the required competences, they can rise to be a chief executive officer of a STREAM-based firm. This gives hope to the African population. Among other companies, Microsoft, Google and Apple have set precedence to appoint aspiring individuals with the required competences.

Competences is the denominator when considering a career in STREAM-based disciplines. Oftentimes, many Africans consider migration as the solution to acquiring such competences. Although such competences may be acquired through scholarship or job placement, it is pertinent for Africans to consider remote options as the panacea for self-development rather than migration (Makruf et al., 2022). Migration has become the new reality for most willing experts for job placement. It has been reported that there is a continuous rise in the population of people living in urban areas. From 1950 and 2015, urban cities experienced population growth of 30% globally. It is estimated that the figure for urban migration will rise to 66% by 2050. For Africa, the urban population is growing at an alarming rate, with a 27% increase in the 1950s to 40% in 2015 and a projection of 60% by 2050. The reality with urbanisation within and outside Africa is that it contributes significantly to socio-economic development. Each year, billions of dollars are paid in diaspora remittance from other continents into Africa by African (Teye, 2018; UN, 2014).

The preceding paragraphs showed the present direction and state of affairs. This paragraph wishes to aspire those hoping to enter any of the STREAM disciplines with the endless possibilities arising from the coordinated use of the internet. The advent of COVID-19 necessitated remote working and remote learning (Daniel, 2020). This limitation was brought to the fore as a result of the tenable restrictions established by various governments across the world (Garbe et al., 2020; UNESCO, 2020). The orchestrated challenges informed the emergence of this new reality – one of virtual attendance in both workplaces and classrooms. From the foregoing, it is imperative for hopefuls in STREAM disciplines to embrace remote learning to compensate for the inadequacies in the educational systems experienced in many African schools. With remote learning comes certification tenable for both remote and physical work. Prior to COVID-19, the experimentation with remote classrooms and workplaces suggested a promising future (Savić, 2019). Conversely, many African countries were unprepared for this

dawn, as no structural roadmaps had been in place to guide the monies expended on digital education.

LESSONS FOR AFRICA

Africa is seen and perceived by Africans and non-Africans as a continent ravaged by poverty, insecurity, war and other vices (Teye, 2018; Porter, et al., 2018). The continent of Africa has always been the engine room of the world in terms of natural resources, an undeniable fact registered in literature (Murphy, 2018). However, the new reality in terms of global population has handed the continent another lifeline in terms of its youthful and useful population. As it stands, STEM and its other affiliated disciplines have propelled the world to where it is now, as established in previous paragraphs. From estimations and forecasts from relevant world agencies, robotics is expanding as a field of knowledge. As such, it is sufficient to earn itself a place among the STEAM disciplines to become STREAM, with robotics as a standalone component. The afore-mentioned have been argued before now. Undoubtedly, Africa, with its aboriginal expertise, has been able to contribute significantly to the present-day growth experienced in STEM, STEAM and now STREAM.

Literature has established the deployment of robotics and automation to facilitate all spheres of the economy (Aghimien et al., 2020; Chigbu & Nekhweyha, 2022; Vernon, 2019). Developed economies have advantages over the developing ones due to advancements in technology achieved through education (Llale et al., 2019; Sutherland, 2019). This education is purpose driven and result oriented in terms of outlook and output (Marvin et al., 2018). Previous paragraphs in this manuscript have outlined government efforts in driving STREAM education in the advanced worlds, which ultimately reflect in the economies of such societies. The global focus on technology in recent times is automation and robotics and their education (Aiyetan & Das, 2022; Akinradewo et al., 2021; Ayentimi & Burgess, 2019). As reported in the study of Llale et al. (2019), automation and robotics in the construction industry are a necessity for the fact that modern architecture requires technicality only technology can resolve with little or no casualty. For automation and robotics to be used in construction, the adequate workforce and technical know-how are required. The implication is that education and training in STREAM disciplines are necessary to adequately excel in this discipline. Llale et al.'s (2019) study furthered that African construction is yet to explore the full potential of automation and robotics in terms of adoption, training and education.

Vernon (2019) exposed the state of artificial intelligence (AI) in Africa. While the author discussed the social and economic potential of AI in empowering developing countries, they placed further emphasis on the unemployment rate on the continent and the potential in STREAM education for poverty eradication and self-sustainability. Sutherland (2019) researched the Fourth Industrial Revolution (4IR) and its implications for Africa. The researcher explored the potential of engaging the 4IR – an umbrella term for 3D printing, AI, big data, industrial internet application and robotics. These areas are undoubtedly promising, with unlimited possibilities in terms of employment generation and economic returns. However, Africa has

been associated with a significant skills shortage, a problem that can only be improved through quality STREAM education. Chigbu and Nekhwevha (2022) investigated the collaborative work experience of robotics and human workers in the automobile industry in South Africa. They found that the implementation of technology in the automobile industry promotes safety, work collaboration and job satisfaction. Similarly, to minimise product imperfection as a result of human inconsistency and increase productivity, there is a need to adopt technologies to meet customer needs and improve satisfaction. However, emphasis has been placed on training and education of personnel to operate these technologies, which is inadequate at present.

Akinradewo et al. (2020) assessed the level of awareness of robotics and construction automation in Africa. They used a survey questionnaire to sample construction professionals, including quantity surveyors, project managers, architects, civil engineers and construction managers (STREAM experts). Analysis of data indicated that integration remained a challenge due to shortage of infrastructure and experts, as also relayed in previous paragraphs. The study of Adebola and Goldberg (2021) examined robotics in farming in Africa through polyculture. Robots were employed in the tending of farm gardens through simulation, sensors and camera data. While the aim of the study was to optimise yield and diversity and reduce water usage, it reported enormous opportunities in this direction for African farmers to transcend subsistence farming. However, education, training and skills acquisition remain a challenge for a discipline that has the potential to not only feed the continent but also employ millions of people as well as having a multiplier effect on the economy.

The literature has shown that STREAM education evidently has the potential to transform the economy of Africa. It is clear at the moment that the of Africa contributes inadequately in terms of needed education, training and expertise. The expertise required is often acquired as a result of personal struggle by interested persons through various efforts through education and training outside the continent in order to match the strong and emerging competences across the world. The surfacing paradigm calls for a deliberate effort by government, policymakers and relevant stakeholders to ensure Africa's youthful and useful population are not wastefully mismanaged as with its natural resources. What is needed at this moment is quality education of a global standard directed at STREAM from the elementary to the highest level of education possible to individuals based on their capacities. While the outcome of this investment may suggest increased emigration from the continent after the acquisition of such competences, it is without doubt a more reasonable route to follow. The alternative will be a multitude of people with potential but left to wither. The latter will frustrate the efforts by the UN, World Bank and even well-meaning citizens. The consequence of negligence in this matter among Africa's multitudes may likely be disastrous in terms of insecurity, banditry, insurgency and other social vices experienced presently. This must serve as is a wake-up call for value reorientation and redirection.

CONCLUSION

This position paper concludes that, taking into consideration the outflow of STEM graduates from Africa to other parts of the world, it is imperative to dualize curricular updates to accommodate local and international needs from STEM to STREAM education. Similarly, practical approaches must take centre stage in teaching and learning of STREAM disciplines in Africa for the acquisition of requisite skills required for global competence and competitiveness for poverty eradication. In the interest of globalisation, equality and universality, educational interventions from sister continents and agencies must be appropriately channelled towards remediating the gap in African education systems and governance for a more meaningful outcome. The potential of STREAM education is enormous and the possibilities are limitless. A directed effort will eradicate poverty and improve the economy and quality of life on the continent and beyond.

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