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STEM Education: A Ray of Hope for African Countries

Andrew Mutsvangwa[1]✉, Nicholas Zezekwa[2]

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[1]Faculty of Education, North-West University, South Africa
[2]Faculty of Science Education, Bindura University of Science Education, Zimbabwe

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Abstract

Globally, the provision of robust education in Science, Technology, Engineering and Mathematics (STEM) is viewed as a vital ingredient in the economic success of any nation. Studies suggest a strong correlation between advances in the STEM fields and superiority of the leading economies of the world. Unfortunately, Africa seriously lags behind in the provision and delivery of quality STEM education. The purpose of this study is to review and consider the role that STEM education plays in the attainment of sustainable livelihoods for the African continent. The study also outlines and explores current challenges facing the delivery of STEM education in the schooling systems in Africa, with a sharp focus on sub-Saharan Africa. This study primarily utilized the conceptual analysis method and review of literature from research articles and scientific reports related to STEM education. The study revealed that the main issues that hinder the growth of STEM education in Africa include, the shortage of qualified STEM teachers, overcrowded classrooms, lack of resources, outdated curricula and inadequate teachers' content and pedagogical content knowledge. In particular, of all the African students enrolled in higher education institutions, less than 25% of them are pursuing STEM qualifications, and of those students, only 30% are female. Several recommendations are suggested to the relevant stakeholders to address the challenges established in order to empower sub-Saharan Africa through solid STEM education.

✉ Correspondence Author:
E-mail: andrew.mutsvangwa@nwu.ac.za

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INTRODUCTION

It is well-documented that countries at the forefront of scientific and technological innovations have enviably stable economies. There is a correlation between advances in technological prowess and the productivity of these economies. At the centre of economic growth of countries lies the promotion of the Science, Technology, Engineering and Mathematics (STEM) subjects as they are key cogs in the advancement of human endeavours. According to the Southwest Regional STEM Network (2009), STEM education is an interdisciplinary approach to learning where precise concepts are linked with real-world practical lessons as learners apply Science, Technology, Engineering and Mathematics in contexts that link the school, work and the global environment. This definition places great emphasis on the integrated perspective of STEM education and this view is the one adopted in this study.

Africa is generally bedeviled by persistent famine, diseases and incessant conflicts that threaten the very existence of its populace. Natural disasters such as cyclones and flashfloods have also not spared the continent, in addition to the multiple manmade challenges such as wars and ethnic antagonisms flaring as xenophobia. It is quite puzzling to learn that despite the fact that the continent is endowed with numerous precious minerals and other important natural resources, the continent lags behind in material development and hosts some of the poorest people on the planet. According to the United Nations Environment Programme Report (2018), Africa is the youngest continent with an alarming youth unemployment rate. The report observes that Africa needs to create at least one million jobs every month to balance the scales: an impossible feat. In addition, about 60 % of the continent's population is below the age of twenty-five and this is in sharp contrast to a mere 27 % of Europeans in the same age bracket. Although notable strides have been made towards access to clean water, Africa, and sub-Saharan Africa in particular, still lags behind in comparison to other regions of the world. It is important to note that sub-Saharan Africa population doubled during the Millennium Development Goals (MDG) era. On the other hand, the populace's access to clean water sources only improved by a mere six percentage points over the same era (Armah et al., 2018). Poor access to clean water and sanitation services undoubtedly lead to disastrous consequences. School-going children are certainly likely to have their studies disrupted whilst they gather clean water. This does not spare communities that are perpetually plagued by diseases if their access to proper sanitation facilities is constrained. It is also evident that hunger continues to stalk communities since poor access to water invariably leads to low crop yields that compromise food security. According to Corfee-Morlot et al. (2019), sub-Saharan Africa has the least access to energy on the planet where only about fifty percent of the population is connected to erratic electricity grids and a staggering 890 million utilize traditional fuels to prepare their meals.

In addition, access to electricity in over ten countries in sub-Saharan Africa is less than 25% and this is in sharp contrast to the developed world. According to UNESCO (2019), of all the African students enrolled in higher education institutions, less than 25 % of them are pursuing STEM qualifications, and of those students, a mere 30 % of them are female. Despite Africa being home to approximately 17 % of the world's populace, its STEM education endeavours trail the rest of the world. This is the obtaining scenario despite the fact that STEM education is largely viewed and appreciated as a key driver of economic growth and job creation (STEMpedia, 2019).

According to Sichangi (2018), poor classroom teaching and learning strategies have led to a scarcity of adequately trained and skilled STEM professionals on the African continent. This yawning gap poses a serious risk to sub-Saharan Africa as industries cannot function optimally, forcing the continent to import most of its consumables. Such a precarious situation triggers a snowball effect of socio-economic demise of the continent. This grim scenario calls for decisive and purposeful intervention to break this vicious cycle of poverty. The African Development Bank's 2020 African Economic Outlook report (African Development Bank, 2020) notes that although a significant number of sub-Saharan African countries have significantly improved access to basic education, there is a misalliance between the skills set acquired and what the job market requires from the youth after years of schooling. The report further places emphasis on the need for the African students to pursue STEM-related qualifications in order to meet the demands of the obtaining job market.

STEM education research that focuses on the African continent is still in its infancy and thus there is limited literature available on this promising niche area. This article therefore attempts to fill-in the gap by exploring and discussing the STEM education status quo and come up with practical suggestions and solutions to the challenges that currently bedevil the provision of quality STEM education on the continent. If the proposed suggestions and solutions are implemented, STEM education will hopefully become a ray of hope for African countries in tackling a myriad of socio-economic challenges that presently afflict them.

This study aims to try and answer the following questions: What is the present status of STEM education provision in African countries, and sub-Saharan Africa in particular?;What are the main issues and challenges that are preventing Africa from realizing quality STEM education in order to improve its economic status?; How can these challenges be overcome?

Objectives of the study

The paper is designed with specific objectives crafted to: explore and discuss STEM education provision in Africa, with a sharp focus on sub-Saharan Africa; discuss and analyse the challenges that hamper the development and growth of STEM education in Africa; provide suggestions and recommendations that are key to addressing the challenges that hinder the provision of quality and relevant STEM education in Africa.

Conceptual analysis approach

By using a conceptual analysis approach, scholarly research articles, scientific and technical reports related to STEM education are utilized to provide an understanding of the status quo of STEM education provisions and the accompanying challenges in Africa in general, and sub-Saharan Africa in particular. In addition, systematic approaches that might be used to support the provision of quality STEM education in Africa are presented and also anchored on a conceptual analysis approach.

The need for STEM education

According to the Australian Department of Employment, Skills, Small and Family Business' (2020) analysis of employment figures for the period between 2014 and 2019, employment in the STEM fields grew by 19.7%, and this figure is nearly twice higher than the growth rate for other fields. Information released by the United States of America's Bureau of Labour Statistics (2014) projected that between 2010 and 2020, employment in the STEM fields would grow by 18.7%, compared to about 14% for all employment fields. Figure 1 shows the projected growth in STEM and non-STEM employment in the United States for the period 2014 – 2024 (Economics and Statistics Administration, US Department of Commerce, 2017).

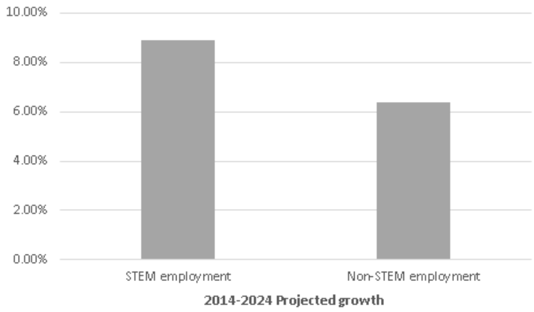

Figure 1. Projected growth in STEM and non-STEM employment in the US
(Source: Economics and Statistics Administration, U.S. Department of Commerce, 2017)

Figure 1 reveals that employment in the STEM fields is on an upward trend and it currently clearly outpaces non-STEM occupations. This implies that countries need to develop and promote the provision of quality STEM education in order to meet the demands of the present and future job market.

On the global scale, according to the 2020 Report of the World Economic Forum (WEF), STEM clusters are projected to provide 1.7 million jobs in 2020, and 2.4 million in 2022. The report focused on what the WEF referred to as the "seven professional clusters" (Powers, 2020). The clusters are: (i) Care Professionals, (ii) Data &Artificial Intelligence, (iii) Engineering and Cloud Computing, (iv) Green Professions, (v) Marketing, Sales and Content, (vi) People and Culture, and (vii) Product Development.

It is not surprising that issues concerning participation in and motivation for school STEM subjects have significantly affected school curricula, pedagogy and resourcing (Freeman et al., 2019). The role and importance of STEM education need not be overemphasized in this era as the world population grows and with that growth, new challenges emerge calling for innovative solutions from astute problem solvers. With the world currently grappled with one of its most innocuous and devastating plagues in living memory, the corona virus (covid-19), the need for well-trained and skilled medical personnel and scientists could not be more dire. In addition, with four billion people owning a cellular phone compared to about 3.5 billion people who use a toothbrush, the quest for the training of dedicated innovators is undoubtedly crucial (*The STEM Imperative*, 2016). Since we live in the information age, the current and future citizens of the world need to be literate and functional. It is therefore imperative to adequately prepare future leaders to tackle challenges by planning and providing them with a solid curriculum that empowers them to solve the novel challenges. Therefore, the future generation of leaders should be able to: Prioritize and make sound decisions with regards health and safety concerns of the populace. Engage in pertinent policy decisions that promote human prosperity and advancement. Manage human activities that increasingly depend on technology. Design and develop practical solutions to the challenges that face citizens of sub-Saharan Africa.

STEM education on the African continent

The statistics of children of schooling-going age who are not in school in Africa is worrisome, specifically when we look at the numbers in sub-Saharan Africa (Barakabitze et al., 2019). Figure 2 paints this gloomy picture of the number of children who do not attend school. The reasons for this sorry state of affairs vary from poor socio-economic backgrounds to lack of access to schools, and this is in sharp contrast to the ideals privileged in the SDGs. In particular, the Incheon Declaration emphasizes inclusive and equitable quality education as a driver of economic and social development (UNESCO, 2015).

The African Development Bank estimates that less than 25% of African tertiary education students are studying towards a STEM qualification, with the bulk of students studying towards social sciences and humanities qualifications (STEMpedia, 2019). In contrast, the percentage of students pursuing STEM subjects in developed parts of the world is almost double that of African students. Table 1 shows the percentage of students in tertiary education enrolled in STEM education programmes from other continents (UNESCO, 2018; OECD, 2017).

Although most education systems on the continent offer elementary sciences and mathematics to learners in primary and lower secondary school levels, the situation changes as the learners enter the upper levels of secondary schooling. Mathematics and science subjects are generally not compulsory in the senior levels of secondary education and a significant portion of leaners never study these subjects beyond lower secondary education level. Reasons for this unfortunate development vary from country to country, but there are some generic challenges as amplified in the following section.

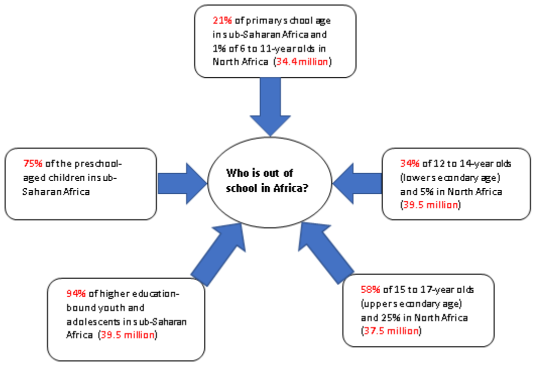

Figure 2. Population of children who do not attend school in Africa.
(Source: Barakabitze et al., 2019)

From the information presented thus far, it is not surprising that most African schools do not specialize in STEM subjects. African countries need to focus on the provision of quality STEM education in order to mitigate poverty and improve the quality of life of their citizens.

The information presented in Table 1 about students in other parts of the world studying towards a STEM qualification is in sharp contrast to the percentage of African students pursuing STEM qualifications which stands at a paltry 25 % as of 2019 (UNESCO, 2019).

Challenges inhibiting STEM education growth in Africa

There are numerous obstacles that hamper the development and growth of STEM education on the African continent. In this article, we focus on the main drawbacks for the realization of successful STEM education in the African schooling system. The challenges which inhibit the growth of STEM education in Africa can be discussed under the following subtopics: STEM teachers' qualifications, overcrowded classrooms, teaching and learning resources of STEM, STEM curriculum, teachers' content and pedagogical content knowledge, language of learning and teaching, perceived difficulty of STEM subjects and gender disparity in STEM education. Based on available literature, these challenges are viewed from a global perspective since several countries the world over currently face or faced almost similar challenges in their quest for quality STEM education.

STEM teachers' qualifications

According to UNESCO Institute of Statistics (UIS), the African continent is the worst affected by teacher shortage. The UIS estimates that by 2030, the continent would require to hire about 19 million teachers, and the situation is even dire for the sub-Saharan Africa which accounts for almost 90% of the projected number of educators to achieve universal primary and secondary education (UNESCO, 2016). Figure 3 shows the said teacher shortage projections.

The general shortage of qualified teachers in sub-Saharan Africa is acutely felt in the STEM subjects (Barrett et al., 2019). This disproportionate shortage of qualified STEM teachers is caused by a number of factors and chief amongst them is that talented STEM graduates tend to pursue more rewarding and attractive careers as opposed to teaching. Another factor that contributes to the shortage of qualified STEM educators is the general low uptake of these subjects by high school learners, and this could be due to the vicious cycle of the shortage of qualified teachers.

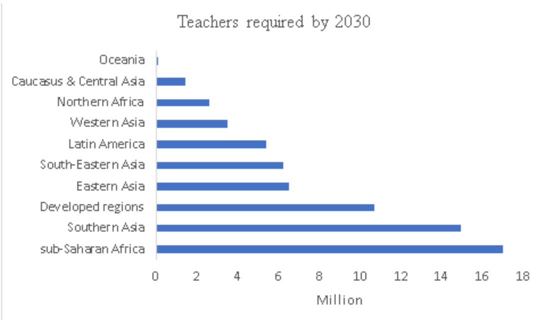

Figure 3. Number of teachers required by 2030 (Adapted from UNESCO Institute of Statistics, 2016)

Overcrowded classrooms

The average ratio of trained educators to pupils in primary schools of sub-Saharan Africa is 1:60, this is in sharp contrast to the global average of 1:27. The scenario at secondary school is slightly better with an average of 44 learners per trained teacher compared to a global average of 20 learners per teacher (UNESCO, 2019). These figures indicate the serious challenges for STEM educators when they conduct practical sessions in laboratories where ideally each learner should be in a position to manipulate the apparatus in order to enhance full comprehension of concepts being explored. Learners end up being grouped to "conduct" the experiments and the hands-on aspect of experimentation for each learner is severely compromised, making the practical sessions plainly inadequate.

Lack of resources

One of major setbacks for the successful rolling out and effective delivery of STEM education in Africa is the lack of the necessary physical and material resources, and the problem is particularly acute in previously disadvantaged communities (Ndihokubwayo, 2017; Shitaw, 2017; George, 2017; Maila & Ross, 2018). Experimental work in science subjects enhances learning since learners are most likely to comprehend and recall things that they would have done as opposed to those narrated to them. Due 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 (Barakabitze et al., 2019).

Currency and relevance of curricula

The curricula in most African countries appears to be moribund and out of sync with the modern trends in the teaching and learning of STEM subjects (Chisholm, 2005; Jacobs et al., 2004; Pedzisai et al., 2014; Booi & Khuzwayo, 2019; Mkandawire et al., 2018; Westbrook et al., 2013). To worsen the situation, the curricula does not include the diverse and culturally rich African Indigenous Knowledge Systems. This inadvertently misleads learners into believing that STEM education knowledge is beyond their immediate cultural spheres and thus alien to them. This is further buttressed by the bulk of the prescribed and recommended textbooks in these subjects that are written by authors domiciled in the developed world where the examples and illustrations in such textbooks do not resonate with African learners' lived experiences.

Teachers' content and pedagogical content knowledge

Several studies conducted in South Africa, Malawi, Zimbabwe, Sierra Leone, Nigeria and Ghana indicate that the majority of science teachers have limited content and pedagogical content knowledge (Rollnick & Mavhunga, 2014; Ijeh & Nkopodi, 2013; Ogunniyi & Rollnick, 2015; Nworgu, 2013; Nadelson et al., 2013; Stohlmann et al., 2012). This trend appears to cut across all the STEM subjects and it is a serious cause for concern.

Teachers' content and pedagogical content knowledge refers to knowledge of the discipline that a teacher is qualified to teach. Pedagogical knowledge may be viewed as specialized knowledge of teachers that is essential for creating effective teaching and learning environments for all learners (Guerriero, 2016 ; De Clercq & Shalem, 2015). In essence, the role of a teacher is to impart knowledge to the learners so that they acquire skills, knowledge, values and other desirable competencies, which benefit them in life outside the school environment. To accomplish these ideals, the educators should be well-grounded in their respective teaching subject specializations (Lekhu, 2013; Poti, 2020).

Language of learning and teaching

Vygotsky's theory privileges the role that language plays in the development of crucial cognitive skills essential for how children learn (Pempek & Lauricella, 2017). It is therefore not difficult to appreciate that learning any subject using a language that is not one's mother-tongue is problematic. STEM subjects are therefore no exception to this challenge that has faced the education fraternity of most developing countries for generations. Educators often resort to "code-switching" and explain some key STEM concepts in the local vernacular languages in an effort to address the language problem (Barrett et al., 2019). This approach is unfortunately cosmetic as the learners normally struggle to link related concepts that would have been taught in the official language of learning and teaching to those explained in their vernacular language. The learners' woes are further worsened when they eventually sit for important summative assessment activities such as national certificate of education examinations where the questions are in the official language of instruction.

The perceived difficulty of STEM subjects

STEM subjects are generally viewed by many learners as boring, challenging and difficult to comprehend and ultimately, impossible to achieve good grades (Roberts et al., 2018). This narrative discourages learners from studying these subjects since most education systems emphasise the attainment of high examination scores, thereby eliminating the pursuit of STEM subjects. Success in STEM subjects is often met with cynicism and widely associated with labels such as "nerdy" and "uncool" (Skamp & Logan, 2005). In popular youth culture, success in STEM subjects is viewed as not worthwhile since most of their icons venture into musical, acting and related careers are successful and well-rewarded. Some of these young icons even brag that they dropped out of school and never pursued difficult STEM subjects whereas they made it in life (Moses et al., 2017; Spaull, 2015). Such utterances certainly have a bearing on the number of learners who enrol for the STEM subjects and this calls for concerted efforts to dispel myths that portray these subjects as unnecessarily difficult and unrewarding.

Gender disparity

Despite global efforts to narrow the gender gap in education and economic participation, women remain underrepresented. This gender disparity in STEM education for African women is particularly concerning and the divide is even greater in sub-Saharan Africa (Acheampong, 2014; Chikunda, 2014; Elu, 2018). Several factors contribute to the lack of significant representation of women in STEM fields, foremost the socio-cultural practices and systemic institutional cultures engender this disparity (Stoilescu & McDougall, 2011). In particular, parents tend to believe that girls are less likely to succeed in STEM subjects compared to boys in the family. Education institutions generally present hostile environments to female STEM students and this leads to few females enrolling and succeeding in these fields (Schulze & van Heerden, 2015). For STEM education in Africa to be truly inclusive, decisive measures need to be designed and implemented to remedy the underrepresentation of women in these subjects that are pivotal for the economic progress of the continent.

Discussion

For the African continent to reap the rewards embedded in the successful implementation of STEM education, the aforesaid challenges need to be carefully addressed. It is time for the continent to take advantage of its abundant natural resources and favourable climatic conditions to spearhead and consolidate progress made towards the promotion of the STEM fields. To achieve these ideals, purposive and visionary leadership could unlock the potential that the continent possesses.

This section attempts to answer the main questions that guided this study and the questions are as follows: What is the present status of STEM education provision in African countries, and sub-Saharan Africa in particular?; What are the main issues and challenges that are preventing Africa from realizing quality STEM education in order to improve its economic status?; How can these challenges be overcome?; The following sub-sections address the above-mentioned questions.

STEM teachers' qualifications

In order to address the challenge posed by the shortage of appropriately qualified STEM teachers, the continent needs to acknowledge that teaching as a profession calls for competent and well-remunerated personnel like in other highly regarded professions such as engineering and medicine. Teachers in countries with strong STEM education systems are held in high esteem, well-remunerated and generously rewarded for outstanding performance. The current disparities in the compensation and rewards offered to teachers on the continent compared to their counterparts in other fields send a disturbing signal to would-be future teachers. Governments should allocate adequate resources for the training and retention of highly skilled teachers in these subjects, otherwise the undesirable status quo remains the norm in the foreseeable future. In the same vein, the responsible authorities should also raise the bar in as far as the entry requirements for teacher-training in the STEM subjects is concerned.

Overcrowded classrooms

Although the challenge of overcrowded classrooms is not peculiar to the STEM fields only in Africa, again, dedicated resources should be set aside for the erection and provision of the necessary STEM education infrastructure. The issue of overcrowded classrooms is also directly linked to the challenge of shortage of properly qualified personnel and thus both issues need the attention that they duly deserve. Since the financial resources required to embark on the building of dedicated STEM education infrastructure are logically high, the respective authorities may seek donations from the corporate world to fulfil this key requirement. In countries such as South Africa, symbiotic relationships between the government and the private sector in the infrastructural development of STEM education facilities are beginning to bear fruit.

Lack of resources

The problem of lack of the necessary equipment and apparatus for STEM subjects may be dealt with on three main fronts. The first one obviously requires the government authorities to provide equipment and related resources. Secondly, the governments may also rope in the corporate world to provide monetary and dedicated equipment and resources. Lastly, STEM researchers, educators and relevant government departments may develop innovative schemes for the local production of low-cost equipment and apparatus using available resources. This initiative was fairly successful in Zimbabwe immediately after its independence from Britain in the early 1980s in a project called the Zimbabwe Secondary School Science Project (ZIM-SCI). The project developed and provided the same scientific learning experiences to learners in remote and rural areas of the country as that provided to learners in urban settings where conventional scientific equipment was generally accessible.

Currency and relevance of curricula

Ongoing research geared towards the relevance of the curricula is paramount in addressing the constant challenges that bedevil numerous African countries in as far as school curricula is concerned. Although curriculum reviews are necessary and healthy for the well-being of any meaningful education system, the reviews should be guided by sound and solid research advice and not rituals designed to please the political elite. The curriculum reforms should seriously consider contextual matters and foster meaningful learning. In particular, the reviews concerning STEM education should include the vast wealth of information proffered by the indigenous knowledge systems of the different African cultures. The promotion of indigenous knowledge systems in STEM education should take centre-stage in all future curriculum reviews if Africa is serious about the advancement of its citizens. This initiative will certainly improve the fortunes of the continent and Africa will become a global giant in the STEM-inspired economy of the future.

Teachers' content and pedagogical content knowledge

In order to address the challenges posed by the inadequacies of teachers' content and pedagogical content knowledge, teacher-training institutions need to revamp and enrich their STEM curricula. Additionally, highly qualified and competent academic personnel should be recruited and retained by all teacher-training institutions. A careful balance need to be struck between the teaching of STEM content and STEM pedagogical content knowledge to student teachers in institutions of higher learning. More often than not, some teacher-training institutions tend to "water-down" the STEM content taught at the expense of "pedagogy" knowledge and thus the danger of producing teachers who are not well-grounded in their content. Another way of addressing the challenge of lack of content and pedagogical content knowledge is the planning and provision of ongoing in-service teacher workshops designed to address specific deficiencies. These workshops should deviate from the archaic "talk shows" and once-off activities: they should be thoroughly planned, interactive in nature and accredited by relevant educational authorities.

Language of learning and teaching

Almost all countries that have robust STEM education systems use their native languages as languages of teaching and learning. Notable examples of such countries include Norway, the Netherlands, Japan, China and Russia. Some African countries like Tanzania and South Africa have made some steady progress in the use of local languages in the teaching and learning environment to elementary levels of their schooling systems with varying degrees of success. These initiatives should be applauded and given the necessary support. Although numerous challenges confront the effective and widespread use of native languages in the teaching of STEM subjects in Africa, creative ways should be sought to address the problems if the continent is genuinely committed to empowering its citizens. One radical way is to embark on a serious drive aimed at recruiting young talent in the respective African countries and teach that cohort the different STEM subjects in their local languages until they acquire the necessary research skills and qualifications. The pioneers of such an ambitious initiative would then be provided with the requisite resources to write textbooks and develop related material in their respective vernacular languages. The textbooks and other support materials should embrace the local indigenous knowledge systems and the contexts should be relevant to the target audience. Although such interventions may take long to perceive the rewards that they present, the continent does not have much choice if the language barriers are to be adequately addressed.

The perceived difficulty of STEM subjects

To dispel the negative perceptions that learners may have about STEM subjects, massive public awareness campaigns should be initiated to send the correct signals about the importance of the subjects. These campaigns should be well-coordinated and ideally targeted at young learners either in the school environments or as roadshows in collaboration with like-minded organizations and individuals. Popular culture influencers who share the views of the STEM campaign organisers may be invited to rally the cause. Government authorities in African countries may appoint popular professionals in the STEM fields as ceremonial "STEM Ambassadors" whose main role would be to campaign for STEM subjects in their communities of influence.

Gender disparity

Purposeful interventions to promote the participation of girls in STEM education on the African continent need to be urgently implemented. Examples of such initiatives may include affirmative action STEM programmes tailor-made to assist girls with a passion for the subjects but lack the requisite standard grades to pursue their studies at various levels of the education systems. Certain quotas may be set aside for such promising girls and this may be implemented from secondary school level all the way up to higher education institutions. Scholarships and bursaries dedicated for females who intend to pursue STEM education fields may be established to decrease the glaring disparity between genders that currently exists, especially at tertiary level. Higher education institutions should discard certain traditions that are hostile and discouraging to female students who pursue STEM fields. Again, responsible authorities may appoint ceremonial "female STEM Ambassadors" in their respective countries to serve as sources of inspiration to the young girls and women in general. Government authorities may also appoint respectable women to influential public portfolios such as ministers or principal officers of science, innovation and technology. This would boost the confidence of young women aspiring to venture in the STEM fields.

CONCLUSION

This paper explored the role that STEM education plays in promoting economic growth and prosperity. A global perspective was briefly presented on the need for a workforce that is literate in the STEM fields, and future projections of the scarcity of certain specialists' fields was discussed. Focus was also placed on the position of the African continent with respect to the advancement of STEM education. Challenges inhibiting the growth of STEM education in Africa were explained and discussed. The study revealed that the main issues that hinder the growth of STEM education in Africa include, the shortage of qualified STEM teachers, overcrowded classrooms, lack of resources, outdated curricula and inadequate teachers' content and pedagogical content knowledge, language of learning and teaching, perceived difficulty of STEM subjects and gender disparity. Lastly, proposals to address some of the observed challenges were presented and explained. The key proposals made to overcome the challenges include:

To address the challenge posed by the shortage of properly qualified STEM teachers, African governments should allocate adequate resources for the training and retention of highly skilled teachers in STEM subjects.

On the issue of overcrowded classrooms, the respective authorities may seek donations from the corporate world to fulfil this key requirement. STEM researchers, educators and relevant government departments may develop innovative schemes for the local production of low-cost equipment and apparatus using available resources in order to address the problem of lack of teaching and learning resources. To overcome the hurdles caused by outdated and lack of context in curricula, the promotion of indigenous knowledge systems in STEM education should take centre-stage in all future curriculum reviews if Africa is serious about the advancement of its citizens.

"STEM Ambassadors" whose main role would be to campaign for STEM subjects in their communities of influence may be engaged to dispel the negative image that is sometimes associated with the subjects. In the same vain, "female STEM Ambassadors" may also be roped in to promote the subjects amongst female learners whose participation is presently depressed as opposed to that of their male counterparts.

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