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SUB-SAHARAN AFRICAN BRIEF HISTORY OF MATHEMATICS DEVELOPMENT AND SUB-SAHARAN ENERGY DIVERSIFICATION AND SUSTAINABILITY USING MATHEMATICAL TOOLS FOR ANALYSIS

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ABSTRACT

This paper reviews a brief history of mathematics in some selected countries in the sub-Saharan African. Having considered the indispensability of mathematics towards the world's technological and science development, the history takes a closer look at the students' teacher ratio for effective teaching and learning. The paper also condemns in totality the rote learning system which is characterized by elementary school methods of memorization rather than critical analysis. It considers, the usefulness of mathematical tools in critical economic analysis of the Gross Domestics Products GDP of some selected countries in the sub-Saharan with the their energy diversification; Energy Mix Concentration Index (EMCI), to check the growth rates of the country involve. It was discovered that the GDP growth rate has negative correlation with energy diversification.

INTRODUCTION

Mathematics should not be treated with levity, since it has to do with everything about life; top-performing companies - like Google, Facebook, WhatsApp and many more recruit the best mathematics graduates to create the complex algorithms that define world's digital relationship. Elementary school, mathematics is too often taught by rote learning methods that favour memorization rather than critical analysis, independent reflection or creativity, which are the real keys to excellence in mathematics and science. Artificial intelligence, smart cities and smart communities are the paths to prosperity mapped out by mathematical algorithms. Mathematics and science have formed the basis of every modern technology. If Africa remains the consumer, not the producer, of the technologies it needs, it will remain underdeveloped and it will be controlled from the outside. Its economy will be based solely on the exploitation of its natural resources. Africa will not free itself from its dependence on international aid until it builds its own capacity to develop.

This is what motivates the existence of the Pan-African Institute of Mathematical Sciences (AIMS, for African Institute for Mathematical Sciences), a network of training centers across the continent. It was created to empower bright young Africans to become agents of change through advanced mathematics and science. The slogan, which affirms that the next Einstein will be African, marks the height of the ambition. By bringing the world together in Africa, the Next Einstein Forum will make an important call for a new approach to Africa's development - which encourages made in Africa innovation based on excellence in mathematics and science. Computers, telecommunications and advanced medical technologies are the modern engines of commerce, prosperity and social welfare. Africa will remain on the sidelines in these areas unless it trains its own experts, pioneers and innovators. It is also the driving idea of the first Next Einstein Forum which took place in March 2016, bought together 500 brilliant scientists and international leaders in Senegal (http://nef.org/fr/rencentre-internationale-2016). The objective is to support scientific innovation and collaborations, at the service of human development in Africa and in the world. In Africa, the choice to study mathematics is often seen as the choice to shut you in an ivory tower, and to conduct studies unrelated to the real world. University mathematics departments are often the most dilapidated on campus and, for many students, it is only a secondary subject.

MATHEMATICS IN SUB-SAHARA AFRICA

Africa history helps us to understand the cultural heritage, not only through the applications of mathematics that has to do with astronomy, physics and other sciences, but also because of the relations to such varied fields as art, religion, philosophy and the crafts (Struik,1980 and Benty, 1977). Aside from Struik's general arguments, there exist important additional considerations which make the study of the history of mathematics in sub-Saharan Africa even more indispensable. Most histories of mathematics devote only a few pages to ancient Egypt and to northern Africa during the 'Middle Ages.' Generally they ignore the history of mathematics in sub-Saharan Africa and give the impression either that this history is not knowable/traceable or even stronger still, that there was no mathematics at all south of the Sahara (Lumpkin, 1983; Njock, 1985).

Over the years, African economies have undergone considerable transformation, with consistent and robust growth, in sharp contrast to decades of slow or even negative growth, which characterized the 1970s into the 1990s. While the region's economies slowed down from an average of 5.6% during the period 2002-2008 to 2.2% in 2009, in the wake of the global financial crisis; Africa promptly recovered, with an average growth rate of 4.6% in 2010 and 6.2% in 2012, as well as 4.0 and 4.3% for 2013 and 2014, respectively. In Sub-Saharan Africa, economic growth is even more robust, averaging about 6% over the past decade. This development has made the region to be acknowledged with the second highest economic growth in the world in recent times. However, contemporary economic growth in Sub-Saharan Africa is largely unaccompanied by employment generation or increased livelihood opportunities. Consequently, poverty levels across the region remain relatively high, at 48% of the population. The challenges posed by lack of inclusive growth are particularly evident in Angola and Nigeria, countries that feature economies driven by the petroleum industry. Therefore, the major objective of this paper is to shed light on the challenges associated with lack of inclusive growth in Sub-Saharan Africa. **Uzoma (2021),** employs empirical data to analyze Angola and Nigeria which reveal both countries as resource-rich economies featuring relatively high economic profiles, devoid of widespread employment opportunities, with grave consequences for endemic poverty. Consequently, the paper presents a policy framework, grounded in poverty reduction strategies, enterprise development and capacity building aimed at promoting broad-based economic growth as the cornerstone of African economies. **Uzoma (2021).**

AFRICAN SUSTAINABLE DEVELOPMENT TO UNLOCK POTENTIALS

According to Sakariyau, Ojeniyi, and Makinde (2021), Sustainable development is the hub of global economic policy. It focuses on inclusive or broad-based growth sustained over time. It also places emphasizes on environmental, economic and social considerations of developing countries to have a fulfilled wellbeing. The account of Africa in terms of new sustainable development is inundated with good and bad. Bearing it in mind that Africa as a continent happens to be one of the fastest growing economies in the world. It is blessed with a favorable weather and large landmass for agriculture, couple with the needed large resources in terms of human and natural resources. Therefore, it follows that African is seen as land of outstanding. Additionally, the real estate potentials are not well managed and as such real estate decay is already taking its toll, these and many others issues have thus inhibiting African new sustainable development. As the world felt impeding fall in sales-price of petroleum products and just recover from the loss suffered from the Covid-19 Pandemic, Unlocking the potentials of real estate is a veritable tool for sustainable development of developing nations like Nigeria. Nigeria is in economic tumult due to inefficiency on the side of government and individual to explore real estate potentials, high rate of corruption and over-reliance on oil and gas incomes among many others Sakariyau, *et.al* (2021). Real Estate has the potential of releasing the much needed fund for our sustainable development. An approach is urgently needed; the one that is able to respond in a systematic and integrated manner to this key development goal is unlocking real estate potentials. Exploring real estate potentials therefore happened to be the solace to achieving Africa new sustainable development.

MATHEMATICS HISTORY IN SUB-SAHARAN AFRICA DURING POST INDEPENDENCE

Mathematics in Africa 2014, Summary Report Prepared for the International Congress of Mathematicians (ICM) In Seoul, Korea August 13-21, 2014 extracts the following exerts :(http://www.mathunion.org/fileadmin/IMU/Report/Mathematics_in_Africa_Challenges___Opportunities.pdf).

The history of mathematics education in Africa has been the subject of diverse publications concerning varied countries.

Ethiopia

Ethiopia is making a determined effort to improve both primary and secondary school education in mathematics. For instance, all first-cycle and second-cycle primary school teachers (Grades 1-4 and 5-8) must be diploma graduates, and high school (9-10) teachers must have a bachelor's. For university preparatory classes (11-12), the Ministry of Education has begun to train teachers for a master's degree. In addition, the Ministry has recently revised mathematics textbooks. At the same time, progress in learning continues to be limited by continuing problems, such as sporadic distribution of materials to rural schools, low levels of teacher motivation and preparation, societal problems, and overcrowding. By one informal count, the ratio of mathematics teachers to students is 1:280 in primary school and 1:120 in secondary school.

Ghana

Ghana has relatively strong programs in teacher education and mathematical physics, and strong development in primary and secondary education. Areas of specialization include optimization, differential equations, and mathematical physics. The teacher-student ratio in primary schools is about 1:130, and in secondary schools 1:70. The required qualification for mathematics teachers at the primary level is a post-secondary teacher training certificate, and at the secondary levels a bachelor's degree. Career opportunities for mathematics graduates are mostly limited to teaching in schools and higher-education institutions. Initiatives to encourage mathematics students include distance learning centers to upgrade non-degree mathematics teachers and a mandatory PhD program for all university mathematics lecturers. Challenges include a loss of talented mathematics students to other professions, given the lack of opportunities in mathematics.

Malawi

Mathematics remains a challenging subject for many Malawian pupils, especially in secondary school. Based on student performance in national examinations, the pass rates in mathematics have been lower than in many other subjects. The Malawi Institute of Education is currently reviewing the secondary school curriculum. The aim is to narrowing the gap that exists between secondary school and first-year undergraduate mathematics courses, as evidenced by the poor performance of first-year university students in mathematics. Through funding from the African Development Bank, a bridging course in mathematics and science is being organized by the University of Malawi (Chancellor College and the Malawi Polytechnic) and Mzuzu University, with the hope of retaining many students, especially female students, in mathematics and science.

Nigeria

Nigeria, like South Africa, has high-quality university education in mathematics, both pure and applied, with viable research centres, (Ochuche, 1978; Shirley, 1980). Nigeria also has strong secondary and elementary mathematics education, again of similar quality to that of South Africa. The teacher-student ratio in primary schools is 1:35 and in secondary schools 1:100. The qualification needed to teach mathematics in primary schools and in junior secondary is a certificate in education. In senior secondary schools, a Bachelor's degree. There are no commercial or specialized career opportunities for talented and well trained mathematics students.

South Africa

South Africa shows weakness at the primary and secondary levels, but considerable strength in post-secondary mathematics. At the school level, achievement is inadequate, with a low number of students going on to university with a mathematical background over the last 20 years. Rural mathematics education in South Africa is very poor. The target values for the teacher-students ratio in primary schools is 1: 30 and in secondary schools 1: 25. The normal qualification to become either a primary or secondary school teacher is a three-year diploma. Bachelors degrees are not required, and many mathematics teachers do not have a Bachelors degree. There are also some programs to support the educational progress of talented mathematics students, but these talented students are not accelerated in schools.

Tanzania

Students in Tanzania achieve below-average results at all levels of mathematics, as evidenced by the results of students who participated in the 2011 and 2012 national examinations (http://www.necta.go.tz) The Tanzania Ministry of Education is considering the recruitment of additional teachers, and preparations are in progress to purchase essential books. The MSc in Mathematical Modelling has graduated over 50 MSc in various applied mathematics fields, and most of them are now employed as faculty and staff in the region of southern Africa. The program has brought International professors who have trained future leaders and improved the quality of dissertations. The program has not only benefitted staff members who are training at universities, but has also resulted in research work and joint supervisions which have identified strengths and weaknesses of mathematics departments in the region, (Mmari,1978; 1980;1991, Pythiam, 1971 and Seka, 1987). Some efforts for continued MSc support include CIMO, the Center for International Mobility, of Finland, which offers training support for MScs and PhDs in mathematics for Uganda, Rwanda, Tanzania, Zambia, and Ethiopia (http://www.maths.udsm.ac.tz/cimo).

Uganda

The East Africa University Mathematics Program (EAUMP), initiated in 2002, has received funding from ISP4 and SIDA5 for the last 10 years and is aimed at training university staff in pure mathematics. Seven PhD students have graduated from the program – though not all studied pure mathematics because of low interest in the field – and more than 50 MSc students have graduated. The African Mathematics Millennium Science Initiative (AMMSI), in conjunction with London Mathematical Society, has supported a Mentoring African Research in Mathematics (MARM) scheme that has proven helpful. Since 2008 it has provided a pure mathematics mentor to teach an intensive three-week course for MSc students and to co-supervise research projects. Follow-up scholarships for graduates of this program are limited to those who proceed to a PhD in pure mathematics.

Navez (University of Burundi) has been researching the evolution of mathematics curricula at the secondary school level in Burundi. An interesting theme in the recent history of mathematics education in Africa, which seems to deserve study, is that of the emergence and evolution of continental and regional mathematics curriculum development projects, such as the African Mathematics Program (Wilson,1981; Lindblom, 1930; Lumkin, 1983; Lynch and Namoratunga, 1983; Mapap and Uaila, 1993), School Mathematics Project for East Africa, Joint Mathematics Project, East African Regional Mathematics Program, and West African Regional Mathematics Program. The history of mathematical associations and journals, of mathematical departments and schools, are other possible research topics. The introduction and spread, in sub-Saharan Africa, of new mathematical research areas and related fields such as statistics, informatics, and computer science in relation to the introduction and spread of new technologies, such as computers, have not been studied as yet, nor have their implications for the countries involved, Gerdes (1994).

SUB-SAHARAN ENERGY DIVERSIFICATION AND SUSTAINABILITY

The United Nations Development Program (UNDP) defines energy security as the constant availability of energy in sufficient and affordable quantities without any adverse economic and environmental impacts (UNDP 2004).

Diversifying the energy has been identified as a crucial strategy for achieving energy security (Vivoda, 2019). Diversity, thus, ensures security in that, when one energy source fails, a country can depend on other energy sources to meet its needs. Energy diversification offers a preventative measure against shocks in the energy supply system, ensures good adaption in the face of uncertainties (Stirling, 1999), and engender sensitivity to local and cultural contexts (Landau, Taylor, & Wright, 1996). Energy is critical in production processes, transport, job creation, as well as poverty reduction. Hence, for a country to become economically diversified in its production and trade, a reliable and secure supply of affordable energy is an absolutely necessity.

Akrofi, (2021), attempts to address Energy Mix gaps by applying the Energy Mix Concentration Index (EMCI) to examine the state of energy diversification and transition trends in ten of Africa's largest economies. The novelty of this study lies in the fact that it focuses on energy diversification rather than economic diversification, which has been the subject of many scholarly works on the continent.

Table 1

Correlations between GDP growth and EMCIs of various countries

Country	Pearson Correlation	Significance (2-tailed)
Nigeria	-0.140	0.581
South Africa	0.492	0.038
Egypt	-0.125	0.622
Morocco	0.214	0.393
Kenya	-0.438	0.071
Angola	0.459	0.055
Ethiopia	-0.203	0.418
Ghana	-0.063	0.805
Tanzania	-0.106	0.676
Algeria	-0.085	0.738

* Correlation is significance at the 0.05 level (2-tailed).

Source: International Journal of Energy and water resources (2021)5: pp8. (https://doi.org/10.1007/s42108-020-00101-5)

The subject of energy diversification has, received little attention in the continent. Akrofi's study is an attempt to shed light on the energy diversification situation and transition trends in Africa with a focus on the largest economies in the continent. Through an application of the EMCI method, the study finds that overall; Africa's major economies are gradually diversifying their energy mixes. Contrary to past assertions that the greater the variety of energy sources in the energy mix, the greater the diversity (Stirling 2008), this study finds that higher variety does not signify greater diversity.

Analysis from table1 discovers that Kenya and Morocco are the two most diversified among the ten countries, place 7th and 5th respectively in terms of GDP while Nigeria and South Africa which have the highest GDPs are among the least diversified countries. To test the relationship between GDP growth and energy diversification further, the Pearson correlation test within the SPSS package was used to correlate GDP growth rates with the EMCIs of the various countries from 2000–2017, Akrofi, (2021).

CONCLUSION

The role of Mathematics in Technological drive and sciences cannot be over emphasized; therefore, studying of the history of mathematics in sub-Saharan Africa is indispensable. Most histories of mathematics devote only a few pages to ancient Egypt and to northern Africa during the 'Middle Ages.' Generally they ignore the history of mathematics in sub-Saharan Africa and give the impression that there was no knowable/traceable history. Mathematical tools have been so useful in the analysis of day to day activity and the activities round the globe. Pearson correlation was used to determine the correlation between the Gross Domestics Product GDP growth rates with the Energy Mix Concentration Index (EMCI) of the various countries. The findings have shown that, no significant correlation was found between GDP growth and EMCIs. It should be noted that lower EMCI's indicate higher diversity (low concentration in the energy mix); hence, for GDP growth to drive energy diversification, the relationship between GDP growth rates and EMCIs must be inverse (negative), Akrofi, (2021).

RECOMMENDATION

African nations need more support for those who wish to become educators and researchers in mathematics, and more collaboration among institutions and people seeking to make this happen. Necessary steps include:

- Stronger teaching of primary and secondary students
- More direct government support for teachers, faculty, and infrastructure
- Strengthened and expanded training and research activities, especially regional networks of people and institutions
- Scholarships for graduate students and fellowships for faculty
- A clearer path to rewarding mathematics-based careers

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