THE MATHEMATICAL ANALYSIS TO ECONOMIC CRISES OF THE SUB-SAHARAN AFRICA AND THE WAY FORWARD TO SUSTAINABLE DEVELOPMENT

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ABSTRACT
This paper aimed at identifying the economic crises in the Sub-Saharan African region and some of the possible solutions to alleviating poverty in the region. This paper also outlines the importance of Mathematics Education for Sustainable Development and how mathematics education can support the realization of Sustainable Development objectives.

INTRODUCTION
Africa is sometimes nicknamed the "Mother Continent" due to its being the oldest inhabited continent on Earth. Humans and human ancestors have lived in Africa for more than 5 million years. Africa, the second largest continent, is bounded by the Mediterranean Sea, the Red Sea, the Indian Ocean, and the Atlantic Ocean. (https://en.wikipedia.org/wiki/africa/enymology). The continent has 40 percent of the world's gold and up to 90 percent of its chromium and platinum. The largest reserves of cobalt, diamonds, platinum and uranium in the world are in Africa. It holds 65 per cent of the world's arable land and ten percent of the planet's internal renewable fresh water source. (https://en.wikipedia.org/wiki/africa/enymology). The African continent has a unique place in human history. Widely believed to be the "cradle of humankind," Africa is the only continent with fossil evidence of human beings (Homo sapiens) and their ancestors through each key stage of their evolution. Sub-Saharan Africa, home to more than 1 billion people is a diverse continent offering human and natural resources that have the potential to yield inclusive growth and eradicate poverty in the region. With the world's largest free trade area and a 1.2-billion-person market, the continent is creating an entirely new development path, harnessing the potential of its resources and people. The region is composed of low, lower-middle, upper-middle, and high-income countries, 22 of which are fragile or conflict-affected. Africa also has 13 small states, characterized by a small population, limited human capital, and a confined land area. (https://en.wikipedia.org/wiki/africa/enymology). Economic growth in Sub-Saharan Africa (SSA) slowed to 3.6% in 2022, from 4.1% in 2021; and economic activity in the region is projected to further slow down to 3.1% in 2023. The persistent sluggishness of the global economy, declining yet high inflation rates, and challenging global and domestic financial conditions amid high levels of debt explain the downgrade. Growth is estimated to pick up to 3.7% and 3.9% in 2024 and 2025, respectively—thus signaling that the slowdown in growth should be bottoming out this year. Growth conditions, however, remain insufficient to reduce extreme poverty and boost shared prosperity in the medium to long term. The slow recovery of per capita income growth, at 1.2% next year and 1.4% in 2025, still falls short of accelerating poverty reduction to the region's pre-pandemic path.

The economic growth in Sub-Saharan Africa is not uniform across sub-regions and countries. The GDP growth of Western and Central Africa is estimated to decline to 3.4% in 2023, from 3.7% in 2022, while that of Eastern and Southern Africa declines to 3.0% in 2023, from 3.5% in 2022. The region's performance is still dragged down by lower long-term growth in the largest countries on the continent. Economic activity in South Africa is set to weaken further in 2023 (0.5%) as the energy crisis deepens, while the growth recovery in Nigeria for 2023 (2.8%) is still fragile as oil production remains subdued. Among the 10 largest economies in Sub-Saharan Africa —which represent more than three-quarters of the region's GDP—eight are growing at rates that are below their long-term average growth, including Sudan, Nigeria, Angola, and Ethiopia. https://www.worldbank.org/en/region/afr/overview.

Public debt in Sub-Saharan Africa has more than tripled since 2010. The war in Ukraine halted the fiscal consolidation process of many countries in the region that started in the aftermath of the COVID-19 pandemic. As countries increasingly resorted to measures such as subsidies, temporary

waivers of tariffs and levies, and income support for the most vulnerable people—in an effort to limit the rise of food and fuel prices—the fiscal deficit of the region widened to 5.2% of GDP in 2022, up from the estimated 4.8% of GDP in 2021. Weak growth combined with a fast accumulation of public debt has pushed the median public debt-to-GDP ratio from 32% in 2010 to 57% in 2022 (56% in Western and Central Africa; 64% in Eastern and Southern Africa). The number of SSA countries at high risk of external debt distress or already in debt distress stands at 22 (up from 20 in 2020). https://www.worldbank.org/en/region/afr/overview.

Stubbornly high inflation fueled by rising food and energy prices as well as weaker currencies and low investment growth continues to constrain African economies, creating uncertainty for consumers and investors. The number of countries with two-digit average annual rates of inflation increased from 9 in 2021 to 21 in 2022. Although headline inflation appears to have peaked in the past year and the number of countries with two-digit inflation is expected to drop to 12 in 2023, inflation in SSA is set to remain high at 7.5% for 2023, and above central bank target bands for most countries. Investment growth in SSA fell from 6.8% in 2010-2013 to 1.6% in 2021, with a sharper slowdown in Eastern and Southern Africa than in Western and Central Africa. https://www.worldbank.org/en/region/afr/overview.

Despite these challenges, a number of countries in the region are showing resilience amidst multiple crises. These include Kenya, Cote d'Ivoire, and the Democratic Republic of Congo (DRC) which grew at 5.2%, 6.7%, and 8.6% respectively in 2022. Economic growth in the region excluding large countries, such as Angola (projected growth: 2.6% in 2023), Nigeria (projected growth: 2.8% in 2023), and South Africa (projected growth: 0.5% in 2023), is estimated at 4.3% in 2023, and set to expand to 5.1% and 5.2% in 2024 and 2025, respectively. Non-resource-rich countries are projected to grow 4.2% in 2023 and to pick up to 5.1% and 5.3% in 2024 and 2025, respectively. The stronger performance of non-resource-rich countries can be attributed to gains enjoyed from lower import bills and an expansion in services. Real GDP growth in resource-rich countries will remain subdued, at 2.4% in 2023, but will rebound slightly to 2.9% and 3.0% in 2024 and 2025, respectively—still below the growth rate of 3.7% in 2021. Growth for this group of countries is dragged down by lower commodity prices, pointing to strong dependence on the extractive sector. Weak economic performance is expected among CEMAC countries in 2023 (2.7%), while growth of WAEMU countries is expected at 5.5% in 2023, and these countries will grow at a faster pace in 2024 (7.0%). https://www.worldbank.org/en/region/afr/overview.

Harnessing Sub-Saharan Africa Economy for Sustainable Development

Harnessing the potential of natural resources provides an opportunity to improve the fiscal and debt sustainability of African countries. Natural resources (oil, gas, and minerals) offer a huge economic opportunity for SSA economies during the low carbon transition. Tapping into energy resources can improve energy access. Africa faces a significant challenge to meet its universal, high-quality energy access goals. In 2022, 600 million people in Africa, or 43% of the continent, lacked access to electricity. However, Africa's resource base and associated investments could help accelerate progress by developing diverse energy sources. Because many natural resource projects are located in remote and rural communities, the scale-up of green energy investments and regional infrastructure could be leveraged to alleviate rural poverty and promote productivity gains.

African countries can leverage their resources to bring together gas and renewable energy to meet domestic needs. Prioritizing inward investments in newly discovered and underdeveloped natural gas reserves can mobilize export revenues and spur domestic energy production and access. In addition, regional integration and the implementation of a continental free trade area hold huge potential to spur economic transformation across SSA. A just transition for Africa will depend on successfully harnessing the economic benefits from oil, gas, and mineral resources, including good governance and sound macro-fiscal management of resource revenues, while also preparing for a low-carbon future. Effective management of natural resource wealth can unlock significant opportunities for job creation, value addition, and investments in human development. Given the extent of natural resource abundance, this wealth can play a central role in the transformation for Africa's economic future. https://www.worldbank.org/en/region/afr/overview.

Mathematics Education and Sustainable Development

There are about 17 Sustainable Development Goals (SDGs). Mathematics Education can be a driving force to achieving these goals. The Sustainable Development Goals (SDGs), according to UNESCO, 2017 are: (1) no poverty; (2) zero hunger; (3) good health and well-being; (4) quality education; (5) gender equality; (6) clear water and sanitation; (7) affordable and clean energy; (8) decent work and economic growth; (9) industry, innovation and infrastructure; (10) reduced inequalities; (11) sustainable cities and communities; (12) responsible consumption and production; (13) climate action; (14) life below water, (15) life on land; (16) peace, justice and strong institutions; and (17) partnership for the goals. The United Nation (UN) proclaimed 2005-2015 the 'Decade of Education for Sustainable Development', signaling the importance of ESD across fields and communities worldwide, Jackson, 2016. In the last four decades, a wide range of term have been used alongside ESD which emphasize different priorities and approaches, such as eco-pedagogy, education for sustainability, sustainability education, and pedagogy of place. Most approaches ask students to consider how human economic and social and cultural concern interacts with the importance of conservation of natural resources, Jackson, 2016. Bonnett (2002), Education can be a vehicle for actively promoting positive attitudes and patterns of behaviour that reflect the requirements of Sustainable Development. Education for Sustainable Development is all aspect of public awareness, education and training provided to create or enhance an understanding of the linkages among the issues for Sustainable Development and to develop to knowledge, skills, perspective, and values that will empower people of all ages to assume responsibility for creating sustainable futures, Jaspar, 2008. The World Summit on Sustainable Development Report (2002) posits that sustainable development operates at three domains. They are economic domain, aims at reducing and seeking to eradicate poverty, achieving higher levels of prosperity and enabling continued gains in economic welfare; social domainaims at reducing and seeking to eradicate other dimensions of poverty, improving the quality of education, health, housing, and other aspects of welfare of individuals and communities, and enhancing the quality of social interaction, engagement and empowerment; environmental domain-aims at reducing pollution and other negative impact on environment, mitigating the effects of industrialization and human activity, and seeking to achieve sustainable use of resources in the interest of future generations as observed by Azuka, 2015.

Concept of Mathematical Competences is Based on the Danish KOM.

Niss and Hojgaard (2011)

- Thinking mathematically: knowledge of the kind of the question that are dealt with in mathematics and the types of answer mathematics cannot provide, and the ability to pose such questions: recognition of mathematics concepts and understanding of their scope and limitations, extending the scope by abstraction and generalization of results; understanding of the certainty of mathematical considerations
- Reasoning mathematically: ability to understand and assess an already existing mathematics argumentation and the notion of proof, and to recognize the central ideas in proofs; knowledge/ability to distinguish between different kinds of mathematics statements; construction of chains of logical arguments and hence of transforming heuristic reasoning into own proofs (reasoning logically)
- Posing and solving mathematical problem: ability to identify and specify mathematical problems; ability to solve mathematical problems (including knowledge of the adequate algorithms); personal capabilities to decide a question considered as a problem
- Modelling mathematically: ability to analyze and work in existing models; ability to perform active modelling
- Representing mathematical entities: ability to understand and use mathematical representations and know their relations, advantages and limitations; ability to choose and switch between representations
- Handling mathematical symbols and formalism; ability to understand symbolic and formal mathematics language and its relation to natural language as well as the translation between both;

rules of formal mathematics system and the ability to use and manipulate symbolic statements and expressions according to the rules
• Communicating in, with, and about mathematics: ability to understand mathematical statements (oral, written, or other) made by others; ability to express oneself mathematically in different ways
• Making use of aids and tools: knowledge about the aids and tools are available: ability to use the aids and tools thoughtfully and efficiently. There are several important competencies related to Sustainable Development by several experts, such as Vintere and Briede in (Vintere and Briede, 2016).
• Problem solving, critical thinking, action competence and system thinking, (Jones, Selby and Sterling 2010).
• Imagination, critical thinking and reflection, system of thinking, partnership, learning to work together, participation in decision-making, (Bonnett, 2002 and Stibbe, 2009).
• Systems thinking-the ability to see the interconnections between different dimensions and the complexity of systems and situations as in (Renert 2011, Tilbury and Wortman 2004, Cebrian and Junyent 2015) in developed a theoretical framework of the professional competencies in ESD) and elaborated eight key components.
• Future/alternative scenarios visioning: understanding the different scenarios, possible futures, promoting work with different visions and scenarios for alternative and future changes.
• Contextualizing: taking into account the different dimensions of a problem or action, the spatial dimension (local-global) and the temporal dimension (past, present and future).
• Work and live with complexity: the ability to identify and connect the ecological, economic and social dimensions of problems. Generate the conditions for systems thinking in the school environment.
• Think critically: creating the conditions for critical thinking to question assumptions and to recognize and respect different trends and views in different situations.
• Decision-making, participation and acting for change: moving from awareness to action; sharing responsibilities and engaging in joint action.
• Clarify values: values clarification and strengthening behavior towards sustainability thinking, mutual respect and understanding of other values.
• Establish a dialogue between disciplines: developing teaching and learning approaches based on innovation and inter-disciplinary.
• Manage emotions and concerns: promoting reflection on one's own emotions and as a means to reach a deeper understanding of problems and situations.

Intellectual Precedents of Reform Trends. (https://about.jstor.org/terms**)**
Precursors of many of the current ideas in science-education reform are found in the writings of several educators. Philosophers Alfred North Whitehead and John Dewey promoted education that guides the self-development of students through experiential learning, (Alfred, 1997). Social psychologist Kurt Lewin believed that learning was best facilitated in a collaborative environment where active dialogue by members of a group is used to resolve tensions between immediate, concrete experiences and previously held conceptions. Cognitive psychologist Jean Piaget focused on identifying stages of intellectual development in children and the role of experience in promoting intellectual growth, Jean Piaget, 1970.
Since 1960, a number of cognitive psychologists have extended earlier work on the abstract reasoning abilities of children to college-age adults and beyond as in Chickering and Gamson, 1991. These extensions have been pivotal in helping educators identify common learning difficulties of undergraduate students in mathematics and science, and have contributed to the articulation of reform principles.
Arnold Arons has had a profound influence on trends in science and mathematics education. He taught physics at Amherst College from 1952 to 1968 as part of a required interdisciplinary studies program that he helped to develop. He had a deep understanding of the history of science and was a keen observer of the intellectual development of several generations of Amherst physics students.

He wrote about the learning difficulties shared by a large percentage of introductory physics students in light of new research in cognitive development, and has been a relentless advocate of helping students achieve scientific literacy. Arons's notion of scientific literacy has much more to do with students understanding the basis of knowledge than with knowing facts. He spoke of the importance of allowing students to grapple with important concepts over and over again in new guises rather than being forced to study too many topics. His textbooks, expository books for physics teachers, and journal essays have served as the foundation for educational reform in science and mathematics.(Arons, 1985).

SCIENCE AND MATHEMATICS EDUCATION RESEARCH

Some of the most effective new curricula, especially in physics and mathematics, are based on a new style of discipline-specific educational research. It is helpful to understand the origin of this type of research and how it is used as a basis for effective curriculum development. In 1968, Arnold Arons, whose work contributed to many of the principles of science-education reform, moved to the University of Washington to develop a course in the physics department for prospective elementary school teachers, (Arnold, 1977). Lillian C. McDermott collaborated with Arons on this project, extending it to the development of a course for prospective middle and high-school teachers opined (Lillian, 1974). This collaboration led to the formation of the Physics Education Group at the University of Washington. As part of McDermott's early work on teacher preparation courses, she began to investigate student thinking about certain physical phenomena in order to identify conceptual difficulties that interfere with learning. For example, most physics students believe that a ball tossed in the air hovers at the top of its path before descending, so that its velocity, acceleration, and net force are all zero. Mature physicists understand that the ball's position is changing continuously under the influence of a constant downward gravitational force exerted by the Earth. It never hovers; its net force and acceleration are never zero. Students who believe that the ball hovers have a difficult time understanding Newton's second law of motion and using it to explain common, everyday motions. To identify student conceptual difficulties like that of the "ball toss," McDermott and other physicists often begin with individual student interviews. The results from these interviews are used to guide the design of written questions that are administered to large numbers of students. The information obtained from the interviews and written questions can then be used to develop curricular materials that enhance student understanding of various topics. The effectiveness of these instructional materials is assessed by comparing student performance on conceptual questions before and after the use of the curriculum. McDermott's systematic research on learning difficulties was the genesis of a new field of scholarly inquiry for physicists: Physics Education Research. In 1973, McDermott began a new program in which graduate students could earn doctorates in physics for research on the learning and teaching of physics.

CONCLUSION

Africa, with abundance human and material resource it takes collaborative environment where active dialogue by members of a group is used to resolve tensions. Poverty can be alleviated and other goals for sustainable development achieved if Africa is shifted from consumers 'economy to producers 'economy taking advantage of the land mass and available human resource.

RECOMMENDATION

The following recommendations necessary for the goals of sustainable development to be achieved

i. All hands must be on deck with critical thinking minds for a radical change
ii. Mathematicians and Economists must work in collaboration for this shift to take effect.
iii. Government must be responsible enough and shun corrupt practices for a better Africa
iv. The education system should gear towards a producing economy and not that of consuming.

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