

PURE AND APPLIED MATHEMATICS AND SCIENCE EDUCATION RESEARCH AND STRATEGIES FOR SUSTAINABLE DEVELOPMENT IN 21ST CENTURY

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ABSTRACT

Pure and applied mathematics is a veritable tool in driving and shaping societies; technologically and otherwise. This paper looks at the importance of pure and applied mathematics as well as science education in achieving the sustainable development goals in this 21st century. The introduction highlights the importance of mathematics in general and provides a context for understanding its significance as it relates to sustainable development goals. The subsequent sections delve into the specific impacts of pure and applied mathematics, focusing on their contributions to sustainable development goals. The section on pure mathematics discusses its role in fostering critical thinking, logical reasoning, and problem-solving skills, while also showcasing the accomplishments in sustainable development goals. The section on applied mathematics explores its applications in sectors such as finance, telecommunications, and engineering, and its contribution to addressing societal challenges and building a strong economic. The section on science education explains how a better education can take care of the sustainable development goals; good health and wellbeing, quality education, gender equality, clear water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure. Finally, the paper addresses the strategies for sustainable development such as: building mathematics research workshops, integration of mathematics in industry, promotion of women's participation in mathematics, fostering interdisciplinary collaboration, promoting public awareness and engagement, etc.

KEYWORDS: *Pure and Applied Mathematics, Science Education, Sustainable development Strategies.*

INTRODUCTION

Mathematics as a field of study and by application is an indispensable tool for sustainable development and is also a key factor in achieving the Sustainable development in this 21st century. Adebayo and Oyediran, (2018) described Mathematics, both in its pure and applied forms, as holding a pivotal position in human civilization. Its profound influence stretches across a wide array of domains, from science and technology to economics and social sciences. According to Adebisi and Olusola (2019), Pure mathematics, characterized by its pursuit of abstract principles and logical reasoning, intertwines with applied mathematics, which focuses on the practical utilization of mathematical concepts to solve real-world problems. Together, these branches have contributed significantly to society, fostering innovation, enabling technological advancements, and shaping our understanding of the world. Mathematics gives a quantifiable description, measures and direction to almost all the activities of man. Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. Human, social, economic and environmental are known as the four pillars of sustainability, Anjali and Arihant (2024). There are about 17 Sustainable Development Goals (SDGs), namely: (1) no poverty; (2) zero hunger; (3) good health and wellbeing; (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, UNESCO (2017).

Total eradication of poverty which is the first of the 17 sustainable development goals UN has observed that more than 13% of the world still lives in high level of poverty. Poverty might be probably through unemployment, underemployment, famine or disaster. A culture that embraces functional education with attention on Mathematics as core in its curriculum produce creative learned people who has the potentials for job creation. In the same vein, hunger will be limited when the citizenry are gainfully employed, and when they embark on functional education, This aimed at putting an end to hunger and ensuring access to safe, nutritious and sufficient foodstuff for all citizens all around the year, and an end to all forms of malnutrition, ensuring the sustainability of food production system. It must be noted that extreme hunger and malnutrition are serious issues to sustainable development that needs ultimate attention through the knowledge of mathematics, (Afolabi, 2021; Anjali and Arihant, 2024).

Science Education for Sustainable Development:

A quality education in science means better things for the society by helping students develop into more responsible citizens who help to build a strong economy, contribute to a healthier environment, and bring about a brighter future for everyone. The more science-literate individuals are, the stronger their society can be. Specifically, the lessons and skills science gives us can have effects that help make for more responsible citizens, a strong economy, a healthier environment, and a brighter future for everyone. A better education can take care of the sustainable development goals 3-9, respectively, that is; good health and wellbeing, quality education, gender equality, clear water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure.

Mathematics and science for critical thinking

Responsible Citizens Students who have learned to think critically and have a healthy dose of skepticism can better make their own, informed decisions, which can make them more enlightened, informed voters and stronger consumers. Also, the sense of responsibility and caution that mathematics and science provide - along with the understanding of how things work (be they chemical reactions, human development, or nutritional needs) - can help future parents to provide safe, healthy environments for their own children, and be more responsible pet owners and neighbors; Okoli, S. O., Obiajulu, A. N. & Ella, F. A. (2013). This is in line with SDGs 8 and 12.

Building a Strong Economy

The communication, research, reporting, and collaboration skills that science provides can produce a generation of individuals who are better prepared for any career and can make greater contributions to society. Also, students who have a solid knowledge base in science will later be more open to emerging technologies and ideas that can boost businesses and stimulate the economy. It has been noted that the difference between developed and developing countries is based on the quantity and quality of science and technology they possess, Okoli, Obiajulu and Ella (2013). Adikwu (2008) maintained that, if Nigeria must survive as a nation we need mathematics, science and technology used and managed by Nigerians.

Mathematics and Science Teachers in the Sustainable Development

Mathematics and Science teachers create various opportunities for students to engage in doing activities that will enable them make sense of the world around them, make new discoveries, solve interesting problems and develop skills that are sustainability driven. Omoifo (2012) emphasized that science teachers therefore, need to recognize the nature of scientific endeavours and how it relates to science teaching if they are to help their students completely understand the content and underlying principles of science. Okoli, S. O., Obiajulu, A. N. & Ella, F. A. (2013) opined that effective and consistent implementation of the science and technology curriculum will lead to poverty alleviation, increase in productivity and rapid economic growth. This will surely reduce the capital flight incurred on importation of goods. Science teachers are increasingly

realizing the necessity to become agent of change in order to better meet the needs of students, families and communities they serve and thus fulfill society's expectations about science educators' civil responsibility. Science teachers play crucial role in shaping the students' mind towards sustainability as they impart the knowledge of science. Science teachers help to develop sustainability skills for students such as

- Mastery of subject matter in science'
- Motivating students to learn science
- Psychomotor skills
- Facilitating team work
- Becoming skilled personnel

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

1. The mathematics research workshop

The mathematics research workshop for students replicates research activities carried out by professional researchers. The workshop capitalises on the students' inventiveness and creativity, inviting them to discover mathematics, sciences (including computer sciences) and to carry out research work in this field. Throughout an academic year, working in small groups, the students look for mathematical solutions and do computer modelling for a problem/ research topic formulated by researchers in the field of 'hard' sciences. The students' activity is facilitated by a teacher and supported by a professional researcher. After the research activities proper are over, the students seek opportunities to share the results they have obtained – for instance, in scientific conferences, students' congresses, etc. In addition, the students write research report articles in which they share the research topic, how they approached the solution to the problem and the results they found, Vacaretu and Proal (2016) and <https://www.mathenjeans.fr/publication2024>.

- organization of learning activities to students and stake holders
- attended lectures on research methodology provided by mathematics and environmental science researchers,
- participated in study visits to learn about environmental issues (e.g. – protected areas),
- discussed with representatives of environmental organizations, and
- worked in groups with their peers from the partner schools and organization

Combining sustainable development and mathematics can have several significant benefits for both students and society as a whole. Here are some reasons why integrating sustainable development into mathematics learning experiences is valuable:

- i. **Real-world Relevance:** Incorporating sustainable development topics into mathematics lessons/ workshops allows students to see the real-world applications of mathematical concepts.
- ii. **Interdisciplinary Learning:** Sustainable development issues are multifaceted and require a holistic approach.
- iii. **Critical Thinking and Problem-Solving:** Sustainable development problems often involve complex data analysis and decision-making.
- iv. **Ethical and Global Awareness:** Sustainability education encourages students to consider the ethical implications of their decisions and actions.
- v. **Environmental Stewardship:** Mathematics can be used to understand and address environmental problems, such as calculating carbon footprints, analysing energy consumption, or assessing the impact of waste generation.
- vi. **Empowerment and Hope:** Teaching mathematics within the context of sustainable development can inspire hope and a sense of empowerment in students and the society.

2. Integration of Mathematics in Industry

The integration of mathematics into various industries is crucial for maximizing its impact on Nigerian society. However, there is a need for stronger collaboration between academia and industry to facilitate the transfer of mathematical knowledge and expertise.

Establishing research partnerships, internships, and consultancy programs that bridge the gap between mathematical research and practical applications can foster the utilization of mathematical techniques in industries ranging from finance and telecommunications to health care and engineering, Imran (2023).

3. Promoting Women's Participation in Mathematics

Encouraging and empowering women to pursue careers in mathematics is an important objective for Nigeria and many other countries. Steps can be taken to provide equal opportunities and support for women in mathematics, such as scholarships, mentorship programs, and initiatives that promote gender diversity in mathematical research and education. By increasing women's participation in mathematics, Nigeria can tap into a broader pool of talent and expertise, leading to a more vibrant and inclusive mathematical community, Oluwalana (2018).

4. Fostering Interdisciplinary Collaboration

Encouraging interdisciplinary collaboration between mathematicians and researchers in other scientific fields can unlock new frontiers for mathematical applications. Creating platforms for collaboration, such as interdisciplinary research centers and joint research projects, can facilitate the exchange of ideas, methodologies, and insights, leading to novel approaches for tackling complex societal challenges, (Oluwalana, 2018).

5. Promoting Public Awareness and Engagement

Increasing public awareness of the value and applications of mathematics is vital for its acceptance and utilization in society. Public lectures, outreach programs, and media campaigns can highlight the impact of mathematics on everyday life, dispel misconceptions about the subject, and inspire young minds to embrace mathematical study and careers. Engaging policymakers, industry leaders, and the general Public in discussions on the importance of mathematics can also create a conducive environment for its integration and utilization. Addressing the challenges and charting future directions for pure and applied mathematics in Nigeria requires a multifaceted approach involving investment in research infrastructure, nurturing mathematical talent, fostering collaboration between academia and industry, promoting gender diversity, and strengthening mathematics education. By pursuing these directions, Nigeria can unlock the full potential of mathematics as a catalyst for scientific advancements, technological innovation, and societal development, Imran (2023).

6. Strengthening Mathematical Research Institutions

Investing in research institutions dedicated to pure and applied mathematics can provide a platform for collaboration, knowledge exchange, and cutting-edge research. Supporting the establishment and development of research centers, institutes, and networks that focus on specific mathematical disciplines can foster a vibrant and internationally recognized research community in Nigeria (Ogunleye and Oyenuga 2016).

7. Strengthening Mathematics Education

Enhancing mathematics education at all levels is crucial for nurturing a strong mathematical workforce. This can be achieved through the adoption of modern teaching methods, curriculum reforms that emphasize problem-solving and critical thinking, and the professional development of mathematics teachers. Emphasizing the practical applications of mathematics and promoting mathematical competitions can also inspire students to pursue careers in mathematics and related fields, (Oluwalana, 2018).

CONCLUSION

The indispensability of pure and applied mathematics and science education on Nigerian society is undeniable. Pure mathematics provides the foundation for critical thinking skills, logical reasoning abilities, and problem-solving techniques that are essential in various fields, from engineering and computer science to economics and finance which is geared towards solving problems of

sustainable development. Nigerian mathematicians have made significant contributions to the global mathematical community through their research findings, showcasing Nigeria's mathematical prowess and advancing mathematical knowledge worldwide. On the other hand, Applied mathematics, has played a vital role in driving technological advancements, addressing societal challenges, and promoting economic development in Nigeria. It has facilitated the development of algorithms, optimization models, and data analysis techniques that have improved efficiency, enhanced decision-making processes, and fostered innovation in sectors such as finance, telecommunications, and e-commerce. Applied mathematics has also contributed to sustainable development solutions, enabling the analysis of energy systems, resource allocation, and environmental management. However, the development of any nation also depends directly on its level of scientific literacy. Science education if fully implemented will accelerate the sustainable development of Nigeria by providing the bedrock upon which technological advancement of the nation is built. It is the hope of the writers that when the strategies fully addressed and implemented, sustainable development will be achieved in the nation.

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, Udonsa, (2022) stated the necessary steps to include:

- Stronger teaching of mathematics to 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.

Government and private sectors should in addition:

- i. put in more effort and resources towards the development of science education
- ii. provide necessary science research equipment in the research institutes so that Nigerian scientists can carry out research work without tears especially as regards to the economy of the country.
- iii. More mathematics and science laboratories should be established and the few existing ones equipped and staffed so that students can have enough facilities to research on.
- iv. qualitative and affordable science education should be made available for all.
- v. more modern learning aids such as computers, internet, web sites facilities, overhead projectors, firms etc. should be provided in schools.
- vi. science teachers should be well paid so that they can put in their best in teaching the students.

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