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Bracing up synergy in physics education to end poverty in all its form: A systematic review

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Abstract
Poverty is a man-made scenario which effects are devastating on humans and national development. With the multi-dimensionality of the concept of poverty and its implications, the governments around the world came out with the vision of eradicating poverty in all its forms through Sustainable Development Goals (SDGs) by 2030. This paper systematically review literature and synthesizes on Physics education's role in poverty alleviation. The paper underlines the importance of education particularly influence of Physics knowledge to envision and prepare individuals to come out from the clog of poverty. The paper reviewed the contributory nature of Physics knowledge in stirring up humans' mind towards problem solving, creativity, practical knowledge for entrepreneurial skills that could be useful to repair devices such as calculator, radio, television and electrical installation of gadgets and wiring of houses, production of laboratory equipment, manufacture of knife edges for sale to schools. Besides, the usefulness of Physics knowledge across all disciplines can enhance technical and technology development which could boost economic development. The study concluded that Physics knowledge should not be confined to Physics students alone but some of the applied concepts to daily life should be taught to all learners at the foundational levels of education. However, with the usefulness of Physics knowledge to reduce poverty levels, the paper reviewed some of the constraints in achieving this which includes lack of adequate infrastructure, shortage of well-equipped Physics laboratories, lack of up-to-date textbooks, curriculum implementation deficiency and insufficient access to modern technology among others.

INTRODUCTION

Poverty is one of worst crises that has great and ripples effect on humans across all ages. It affects individuals and nations alike. It is now obvious that every country of the world is taking a decisive measure to tackle poverty at all costs through different policies. Poverty has been revolving all this while in most developing countries affecting the lifestyles and healthy living of citizens. Living in poverty is a life of struggling, deprivation and economic valueless to the society. Statistics has it that more than 20% of the world's population is living under the extreme poverty and it is a serious

concern for the whole world, since a large number of people die every year because of this big issue (Wijekoon, Sabri, & Paim, 2021). All hands must be on deck by countries of the world to reasonably check the growing rate of poverty because of its aftermath effect on moral, psychological and welfare of individuals as well on nations' economic growth.

Due to the trend at which poverty was pervading, the world leaders at the beginning of the new millennium came up with a vision to fight poverty through different dimensions. This vision has been on course with a deadline in 2015. This project is known as Millennium Development Goals (MDGs) capturing eight goals' policy. The topmost goal on the agenda was to eradicate extreme poverty and hunger. So, every country has been making all efforts to reduce the poverty rate, however, there are huge disparities in successes across and within countries. The account of poverty is predominantly in rural with 70 percent of the extreme poor live in rural areas (United Nations Development Programme, UNDP, 2016). Typically, People who are illiterate, linguistic minorities and indigenous people are all disproportionally represented in poor populations in Africa. The good news is that there has been significant breakthrough by an estimated of 130 million people with an average overall income increased tremendously (Millennium Development Goals, 2025). The Millennium Development Goals metamorphosed to Sustainable Development Goals (SDGs) or Global Goals with now 17 goals' policy, the first policy is to end poverty in all its form. This goal seeks to implement social protection for all and sundry in the society. According to Maryanti, Rahayu, Muktiarni, Al Husaeni, Hufad, Sunardi, and Nandiyanto (2022), this implies that poor and vulnerable aspects have the same rights to accessing economic resources and obtaining access to science and technology which by extension create policy frameworks at the national, regional, and international levels for development, especially which is pro-poor and gender-sensitive, and making faster investment in poverty alleviation actions.

From survey carried out by Nigeria's National Bureau of Statistics, 30.9 percent of Nigerians lived below the international extreme poverty line of $2.15 per person per day in 2018 and 2019 before the COVID-19, the poverty rate in northern geopolitical zones was high as 46.5 per cent in 2018 and 2019, compared with 13.5 per cent in southern zones (World Bank Group, 2024). The Northern zone is notable for activities of Boko Haram group, this group defies education and never value in science engagements.

It is obvious that sciences, particularly Physics contribute to sustainable development. Physics is a cross-cutting subject that has its applications registered in all disciplines. Physics knowledge educates individuals to be empowered for economic growth through the process of innovation and critical thinking. Physics education instils process skills during experimentation, problem- solving, and project based and inquiry exercises that foster creativity in learners. Creativity is regarded as a trend that associates with innovations, statistical awareness and uniqueness of solutions aimed towards a particular event (Guliford as cited in Mazeh, 2020). Creativity is an important skill that enables individuals to find new opportunities while adapting to a dynamic environment (Cropley, 2011). From this perspectives, Oppert, O'Keefe, Bensnes, Grecu & Cropley (2023) asserted that the world is constantly rampaged by food scarcity, pandemics, climate change, economic doldrums and inequities orchestrated by poverty and individuals must be creative to solve these global challenges.

This elucidates the fact that education has evidently proven to be a tool for eradicating poverty (Spada, Fiore, & Galati, 2023), a giant step towards national development. National Policy on Education states that education is an instrument par excellence for furnishing national development (The Federal Republic of Nigeria, 2008). National Policy on Education (NPE) captures self-reliance and productivity as a path of eradicating poverty and enhancing economic buoyancy. Therefore, humans

are expected to explore nature for their productivity. The most interesting phenomenon is that science gives meaning to nature and Physics knowledge equally does the same.

Physics education is a central discipline in science education which plays a pivotal role in enhancing entrepreneurial skills and professional development as well as in the advancement of nations. The applications of laws and principles in Physics have their usefulness to sustain individuals' decision on job creation. A skilled and educated workforce with physics knowledge can make scientific contributions and innovation that can possibly add value to economic growth. Engaging learners in Physics education phenomena at the secondary schools can helps individuals' livelihoods and can as well helps in providing entrepreneurial opportunity in electrical wiring, painting, telecommunication, programming and Web designing thereby increasing the well-being (quality of life) and the livelihoods of people globally (Billé, Lapeyre & Pirard, 2012).

Adequate knowledge of Physics can be used in preservation of biodiversity through the Law of conservation of energy. In addition, Physics provides necessary tools and methodologies that can help to fully understand dynamics that occurs in ecosystem. Justifying the emerging consensus on biodiversity and poverty with static evidence, life on earth (biodiversity) and ecosystem services enhance the quality of life through protection from natural hazards; provision of food and food security with quality water; provision of medicines, timbre, and fuel; regulation of infectious diseases (Ash & Jenkins, 2007) as cited in (Billé et al., 2012). Therefore, prioritizing nature-based solutions remains a key enabler of SDGs to alleviate poverty . Although poor scientific knowledge of nature or wrong intentioned polices may be a bane for humanity thereby leading to global impoverishment. Several debates have ensued like those of climate change. In this line with critical questions asked, on whether biodiversity conservation is a route to poverty alleviation and if poverty alleviation is a route to better biodiversity management (Billé et al., 2012), The crux of this matter is to understand how nature functions and how biodiversity can be worked with effectively, efficiently, and safely. Channeling our education through science education toward understanding nature cannot be a misplaced priority. The place of educating the people about science becomes paramount. Science is the study of nature. Science, especially Physics encompasses not only the essential activities experienced in our community and daily life, but give attention to development of technology; increasing the efficiency and effectiveness in the use of natural resources, enhancing socio-cultural change, and discovering the keys to a longer and quality life. The present world and the various societies in it have been powerfully shaped with the help of science (Reis, 2014).

DIMENSIONALITY OF POVERTY

Poverty has for long been associated with humans and it is loosely used to mean having no valuable possession such as money, materials when compared to predetermined status in the society. The issue of poverty continue to gather momentum as the population of the world increases with humans exceeding the carrying capacity of the earth. Poverty according to Davis and Sanchez-Martinez (2014) is a situation where the personal or group of people resources are inadequate to meet their minimum needs. The World Bank (2004) and cited by Davis and Sanchez-Martinez (2014) extended the definition further by indicating that poverty is defined as a pronounced deprivation in well-being, comprising of many dimensions. Largely, poverty could be assessed in four different ways: lack of access to basic needs or goods; impaired access to productive resources; outcome of inefficient use of common resources; and result of exclusive mechanisms (Olowa, 2012).

Poverty is said to be characterised with lack of income and productive resources to ensure sustainable livelihoods; hunger and malnutrition; ill health; limited or lack of access to education and

other basic services; increased morbidity and mortality from illness; homelessness and inadequate housing; unsafe environments and social discrimination and exclusion, lack of participation in decision-making in civil, social and cultural life, loss of livelihoods as a result of economic recession, sudden poverty as a result of disaster or conflict, the poverty of low-wage workers, and the utter destitution of people who fall outside family support systems, social institutions and safety propensity (UN, 1995). So, poverty is captured in underlying facts to being poor, hungry, and destitute of social amenities.

The depth of poverty is succinctly captures in absolute and relative terms. Absolute poverty is premised on lack of a minimum level of subsistence needed for the basic wellbeing while relative poverty determines income or consumption of other people. The two concepts involve both minimal-living and income distributions. Absolute poverty can be eradicated by providing basic things and the former bridge the gap among others with the two needed to achieve Sustainable Development Goal (SDG) Poor health, poor housing conditions, inadequate quality of life, and employment dislocations are the indicators of poverty, by extension poverty is regarded as monetary poverty, capability poverty and social exclusion (Banerjee & Duflo, 2011; Spada, Fiore & Galati, 2023; National Bureau of Statistics, NBS 2023).

With the rate of on-going national development and attention given to Sustainable Development Goal (SDG) from different countries. Poverty can be traced to illiteracy and insufficient application of knowledge based from science of nature to create economic buoyancy. This where quality education take effect. Education that is not accompanied by concurrent progress such as eliminating poverty will fall short of enabling all people to realize their full potential in life(High-Level Political Forum, 2019).

Education is a central tool that unlocks the close mind and prepares individuals to positively contribute to economic growth as well making the society better. According to world Bank (2009), education is a tool both for poverty alleviation and for the promotion of social development as education is said to equip man with right skills engendering the right attitudes and produce the needed knowledge for facing major life challenges. So productive education must follow the SDG 4 Objectives which focuses on quality education. Quality Education is a type that builds knowledge to tackle critical challenges in environment, prepare youth for employment, and a sure foundation to equip peaceful coexistence (High level political forum on SD,2019).

In the light of Physics knowledge, one could apply what is taught from Physics curriculum to bring about self-confidence, enhancement of well-being and economic sustainability of individuals in the society. The Nigerian Educational Research and Development Council (NERDC, 2009) stated in the new Nigeria senior secondary school Physics curriculum, the objectives of Physics in secondary school curriculum are to;

a) Provide basic literacy in Physics for functional living in the society;
b) acquire basic concepts and principles of Physics as preparatory for further studies;
c) acquire essential scientific skills and attitudes as a preparatory for technological application of Physics; and
d) stimulate and enhance creativity and provide a course, which is complete for students not proceeding to higher education, while it is at the same time a reasonable adequate foundation for a post-secondary Physics course.

All these objectives are directly articulated to solve intellectual poverty which is basic to solving other ethical poverty in the society.This is achievable through practical laden teaching of physics concept inscribe in Science, Technology, Engineering and Mathematics (STEM) before the students

leave the school. Physics like other science subjects inspires learners through activities for careers in science and other occupations and professions to meet up with modern intensive societies .Physics teaching uses different approaches, methods, and strategies capable of instilling scientific processes and abilities into its recipient (Darling-Hammond, Flook, Cook-Harvey, Barron & Osher, 2020). Effective use of pedagogy in Physics education inculcates and develops creativity in learners. Creativity is associated with innovations, statistical awareness and uniqueness of solutions tailored to a particular event (Guliford as cited in Mazeh, 2020). Creativity is an important skill that must be possessed to helps humanity to find new opportunities while adapting to a dynamic environment (Cropley, 2011). In a world rampaged by food scarcity, pandemics, climate change, economic doldrums and inequities orchestrated by poverty, human endeavours must be creative to solve these global challenges (Oppert, O'Keefe, Bensnes, Grecu & Cropley, 2023).

ACHIEVING SUSTAINABLE DEVELOPMENT GOAL (SDG) THROUGH EDUCATION

Sustainable Development (SD) plan has received attentions by all countries because it is a social call for dynamisms into the path of development. Sustainable Development has a plethora of definitions. According to Evers (2018) Sustainable Development refers to the organizing principle for meeting human development goals while at the same time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society is anchored. Sustainable Development (SD) policy becomes imperative as a result of geometric growth in population which if not sustained can resort to distortion to nature and impede human development. The imbalance in the trends of development in developing countries has led to high level of corruption, violence, criminality in most countries which further jeopardise lasting development. Brundtland Report (1987) succinctly addressed Sustainable Development under two key concepts:

1. the concept of 'needs', particularly the essential needs of the world's poor, to which overriding priority should be focussed and given; and
2. the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

For successful achievement of Sustainable Development plan, human development should not be neglected. It is therefore imperative that human development is sustained through continuous education for individuals. This required that education should be pragmatic. According to United Nation, for successive Sustainable Development education is required to prompt generation and application of creative ideas and innovative design and techniques. Sustainable Development becomes achievable through individuals action and commitment. The process of SD must be participatory by all to make it successful and sustainable (Guo, 2017). People, planet, prosperity, peace and partnerships are five Ps that fortifies sustainable development goals (Hylton, 2019; Guo, 2017; Zhai & Chang, 2019). Among these 5 Ps, it is the people that can be taught, organised and informed to harmonise the other 4Ps for sustainability and this can be through education. This makes Education to move towards cognitive, interpersonal, and intrapersonal domains (Bao & Koenig, (2019), According to National Research Council, (2012) and National Science and Technology Council, (2018), deep learning, non-routine problem solving, systems thinking, critical thinking, computational and information literacy, reasoning and argumentation, and innovation constitute the cognitive domain; Interpersonal skills are within the confinement of creativity and collaboration while Intrapersonal focus on metacognitive thinking, adaptability, and self-management (Bao & Koenig, 2019). Equipping people becomes

imperative to achieve economic and environment sustainability through the knowledge and incorporation of science education.

Science education equips teachers, learners and the society with knowledge, skills, equipment and freedom to perform noble tasks useful for improving socio-economic standard, thus, the goal of science education is to produce a sufficient number and diversity of skilled and motivated future scientists, engineers and other science-based professionals (Danjuma, & Adakole, 2019). Science here does not imply memorizing of laws and rigid experimentation. Science education includes scientific phenomena that occur in everyday life (Maryanti, Hufad, Tukimin, Nandiyanto, &Manullang, (2020); Hidayat, Rahmat, Fattah, Rochyadi, Nandiyanto, & Maryanti, 2020); Maryanti, Hufad, Sunardi, & Nandiyanto, 2022). This ought to be learnt by all students in schools at every level. Among all, the contribution of Physics to science discipline, general world of nature and technology is inestimable. The study of Physics fosters analytical reasoning, logical reasoning, and systematic problem solving skills that are useful in a variety of domain, such as in engineering, data science, finance, and economics. Physics knowledge enables an individual to repair devices such as calculators and electrical wiring of houses (Delphonso, Osunloye, Ajose, &Sunday, (2024), production of laboratory equipment such as standard resistors, potentiometer, meter bridge and knife edges for sale to schools. For total transformation the knowledge of Physics should cut across schools in cities and in rural areas.

The current trends in Nigeria is that the level of illiteracy is high in the among rural dwellers experiencing unhealthy and marginalised life although they possessed vast land for agriculture yet there production rate would have been more if they are equip with educational knowledge. The Federal Government of Nigeria in response to this approved 66 vocational schools in Nigeria to acquire demonstrable practical skills to generate self- employment.

SYNERGY IN PHYSICS EDUCATION TO END POVERTY

The knowledge of Physics is crucial in enhancing developments. Adebisi, Seweje, & Ajayi, (2015) asserted that Physics knowledge revolves around intelligence, social and practical activities which aids uncommon development. This makes the knowledge of the subject a reasonable factor to eradicate poverty.

Over the time, Physics has significantly imparted and shaping individuals' thought and ideas. At present, the teaching of Physics involves more than just memorizing theory; it also involves developing transferable problem-solving skills, creativity, and critical thinking abilities. The complexities imbedded in the teaching of Physics cover a broad range of areas, from quantum theory to classical mechanics, all of which advance students' comprehension of the cosmos. At the secondary schools, one of the objectives of Physics National curriculum is the provision of basic literacy for functional living in the society. This has informed new methods of teaching places emphasis on experiential learning, real-world applications, and interdisciplinary links. These have beneficiary effect to check poverty level. According to Adebisi (2016) Physics is noted for its ability to interpret natural phenomenon through principles, laws and mathematical concepts to create comfort for man. Adebisi further stated that Physics knowledge helps to attain socio-economic, scientific and technology developments through modeling of individuals to be resourceful, developing process skills and instill correct attitude toward poverty eradication. Efforts are being garnered by Physics educators through researches and literature on getting students interested in Physics by using hands-on experiments, interactive simulations, and group projects that demystify difficult ideas and make the subject matter more approachable for a wider audience. The advantages of these contemporary methods of teaching Physics go well beyond scholastic success. Students are better prepared to contribute to problem solving and innovations for

them to cope with challenges of life. This transition in Physics education promotes informed citizenry, where people can discuss societal concerns like climatic change, renewable energy, and technology breakthroughs, in addition to producing a new generation of scientists and engineers. The underlying abilities of critical thinking, scientific attitude and values are attained through Physics Education. Basic knowledge in Physics can equip students with tie and dying skills, photography skills, electrical and electronic innovation, all these can check the trends of unemployment among the unemployed. This shows that development of any nation and its sustenance are actualised in the classroom. For studying of Physics to articulate socioeconomics of a nation Adebisi (2016) pointed out that students should be given the opportunity to discover, invent and part of rapid expansion of knowledge through practical activities. For example, Physics has interrelated concept which hinge on laws and principles therefore it needs special teaching methods, to solve socioeconomic problems the process of delivering the contents in the curriculum should be structured to take care of societal issues. The teaching should be pragramatic to provide the real life experiences relevant to constructivism and socio-cognitive theory,

However, many schools in Nigeria are confronted with numerous difficulties that impede the effective delivery of Physics knowledge that can sustain the objectives of Sustainable Development Goals. These challenges are lack of adequate infrastructure, shortage of well-equipped Physics laboratories hindering students' opportunities for hands-on experimentation and practical demonstrations, insufficient access to modern technology, such as computers and educational software, further limits students' exposure to interactive learning experiences, lack of reliable electricity supply compounds these challenges, as it restricts the utilization of technological resources and limits the effectiveness of instructional methods, and also scarcity of teaching resources (Kwari, Naabu, Salah, Shehu, &Yabo, 2023). Public secondary schools often struggle to provide up-to-date textbooks, laboratory manuals, and supplementary materials, primarily due to the high cost of these resources and limited availability (Smith, Brown, & Johnson, 2018). Further finding revealed that the existing physics curriculum in Nigeria may not adequately cater for the needs of students or align with modern scientific advancements (Kumar & Sharma, 2018). Addressing these difficulties in teaching Physics will provide a through fare for nurturing scientific literacy, developing critical thinking skills, and preparing students to be resourceful and productive in the society.

THE NATURE OF PHYSICS EDUCATION

Physics Education extends the frontier of knowledge to other disciplines at advance level in earth, agricultural, chemical, biological and environmental sciences, as well in astrophysics and cosmology. But over time, Physics education has changed dramatically, moving from passive learning and rote memorization to more dynamic, interactive, and inquiry-based methods to sustain man in the society (Knight, 2017). Physics education aims at the following:

Problem-Solving Procedure

The fundamental goals of Physics education are the development of conceptual knowledge and analytical abilities. Physics demands that students have a thorough understanding of abstract ideas and use those ideas to solve problems in a variety of situations. Physics differs from many other subjects in that it emphasises the development of critical thinking skills while maintaining a balance between theory and practice (Redish, 2014). Problem solving ability is essential to stir up human minds for innovation and enquiry about the environment. According to Elif (2018) at every stage of our life problem solving ability is needed because every human being encounter various problems or issues to

strive over. To cope with life challenges, Adegoke (2017) stated that students of all ages need to acquire problem solving ability.

Hands-On Learning and Experiential Education

Active participation is encouraged in modern Physics education through practical learning. Practical activities have become significant components of Physics curriculum , allowing students to directly observe and evaluate physical laws. According to Mazur (1997), the utilisation of experiential learning is not only to improve students' conceptual comprehension but also fosters the development of technical and experimental skills that are beneficial for jobs' creation in science and engineering. It is obvious that a good number of Physics concepts have given rise to different scientific knowledge for the benefits of job opportunities. The production, application and utilization of integrated circuits, production and use of machines and other contrivances are benefits from Physics knowledge. Physics knowledge also accounts for the discovery and production of hydroelectric power, gas turbine and thermonuclear power plant, telephones, refrigerators, heaters and gas and electric cookers (Awodun, 2015).

Interdisciplinary Connections

Physics is often regarded as the most fundamental of all sciences, since Physics is linked to many other disciplines of engineering, Biology, Chemistry, Mathematics and environmental science, it forms the basic knowledge of modern technology. Physics education has shifted more and more toward incorporating multidisciplinary approaches (Knight, 2017). For instance, biophysics uses the principles of Physics to comprehend biological processes, which has consequences for medical treatments and technology. Designing of machines, vehicles, and buildings that follow the laws of motion, thermodynamics from Physics are used in material science, civil engineering, mechanical engineering and technology (Knight, 2017). Physics knowledge is utilised in all spheres of life by encouraging students in different context (Henderson, Beach, & Finkelstein, 2011).

Role in Technology

The way Physics is taught has changed as a result of its impact on technology. Knowledge-based technology is needed for technical knowledge and management skills to create wealth and boost economic of individuals. According to Egbogah (2012), Technology is the total and complete application of man's knowledge, skills, tools and materials to develop and produce goods and services useful to man. The interplay between Physics and technology has transformed the world technologically. Many of the advancements in modern technology are fueled by Physics. Advanced materials, computer systems, medical imaging equipment, and renewable energy sources are examples of advancements made possible by the concepts of electromagnetism, quantum mechanics, and thermodynamics. Students who study Physics will acquire the abilities and know-how requirement to advance these technologies. The development of quantum computing is one of the most promising technological developments of our time also require Physics background. A solid foundation in Physics education is essential for laser applications used in commerce and industry, electromagnetism is used to establish the principle of mobile phone communication, satellite communication and X-ray crystallography, recently, nanotechnology and artificial intelligence industries for future developments have underlying principles of Physics.

Global Perspective and Societal Relevance

The current world has been greatly impacted by Physics education, which shapes not only scientific and technological advancement but also daily living and global issues. The emphasis placed on societal relevance in modern physics education is another important feature. Physics offers the

fundamental basis for tackling global issues, such as renewable energy and environmental issues. The acquisition of basic knowledge of Physics inculcates basic scientific attitude such as intellectual honesty, diligence, perseverance and open-mindedness which aid human development for society relevance. According to Adebisi (2016), skills and relevant attitude are developed in Physics classroom to help the learners meet up with socio-economic challenges of future expectation.

CONCLUSION

Science has played an inestimable role in improving the world's economy and has continued to do so in terms of supporting sustainable development goals. However, Physics education basically articulates all other disciplines to enrich man with developments. The knowledge of Physics improves the skills, intelligence, and creativity of individuals for entrepreneurship. The synergy created by Physics education to enhance problem solving, experiential knowledge and scientific values cum contributory role to technology and societal relevance give a sure track to achieve the sustainable goal in eradicating poverty. Therefore, the applicable concepts should be taught experimentally to all students across all disciplines to foster their entrepreneurial skills and advance their knowledge in technology.

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