SUSTAINABLE HEALTHCARE DELIVERY AND INDISPENSABLE ROLE OF PHYSICS EDUCATION

BY

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Abstract

If the developed nations of the world have been able to effect economic growth, improve on life expectancy, reduced infant mortality and even surpass the Sustainable Development Goals (SDGs) through physics, it therefore, become very necessary for the countries in the sub-Sahara Africa like Nigeria to invest heavily on physics education towards promoting a healthy society and sustainable development. It has been observed overtime that the role of physics education in building a healthy society is often undermined and underrated. Not much attention is given to this body of knowledge at the secondary school level beyond its relevance in fulfilling the requirement to seek admission into the university to pursue science or medical related courses especially in developing countries like Nigeria. This paper, has presented a theoretical approach in discussing the concepts of physics and sustainable healthcare delivery. Among the useful recommendations proffered, it was suggested that more of Nigeria physics graduates should be encouraged to further their study in Medical Physics immediately after the completion of their first degree in physics to enable the nation deliver on their commitment towards the Sustainable Development Goals.

Keywords: Physics, Sustainable healthcare delivery

Introduction

Virtually all sciences and physics in particular, contribute to the maintenance of human health and the practice of medicine; each makes its specific contributions. This accounts for global transformation in human health that has led to people living longer, healthier and more productive lives (Amusa, 2015). In the course of medical history, physics has been one of the fundamental contributors to the development medical sciences. First, it was applied to understand the functions of the human body. There is a long and rich history of applying physics principles and the development of many types of technology for both the diagnosis of disease and injury and for a variety of therapeutic purposes (AAPM, 2012).

Physics and health experienced a major revolution following the discovery of a new kind of radiation by a physicist, Professor Wilhelm Roentgen, in 1895. This was soon followed by the discovery of radioactivity. Roentgen radiation (x-rays) and radiation from radioactive materials soon became the physical agents for major medical diagnostic and therapeutic procedures. For over a century physicists and engineers have developed and supported the clinical application of radiation. This has been complemented by the continuing developments in technology that utilize other forms of physical energy such as sound, light, heat, nuclear radiation and magnetic fields to expand the capabilities of the medical specialties of Radiology or Medical Imaging and Radiation Oncology. Associated with this is the extensive growth of Medical Physics and Biomedical Engineering as two of the major healthcare professions.

It is against this background that the role of physics as a foundational subject towards achieving the MDGs is needed to be re-examined for renewed commitment. This paper therefore, attempted to re-emphasize the role of physics as a relevant subject beginning from the secondary school level in maintaining healthy society for sustainable

development. Physics is a cross-cutting discipline that has application in many sectors of economic development, including health, agriculture, water, energy and information technology. The importance of physics for the economic development of all countries is clear. Validiya (2003) agreed to the dominant roles played by physics in spearheading technological advancement, promoting national wealth, improving health and accelerating industrialization.

Among the sciences, physics is considered a fundamental subject of all-natural sciences. (Murenzi, 2005). Physics, according to Amusa (2015), is the science that attempts to describe how nature works using the language of Mathematics. It is a sub branch of science which fundamentally applies to all forms of physical sciences. Physics act as root to myriad studies in the scientific community as it provides the knowledge of how matter and energy work which are essential to the fundamental principles of biology and chemistry. Of all the branches of physics, Medical Physics or Biophysics is known for its tremendous contributions to the development of human health and well-being. Other branches of physics such optical physics, nuclear physics, atomic physics and acoustics are very relevant in the development of health industry. People look at the same image yet come up with different perspectives, expressions, interpretations, interest and so on. Such is the case with education which means different things to different people. Education has been defined as the systematic process of learning and training, which culminates in changing the perception of an individual for the better (Ivowi, 2012). It is a process that continues throughout life (Long life Education). It leads to change of behaviour, beliefs, attitude, values, etc. Education is the most singular powerful instrument of life, charged with the responsibility of shaping and refining all the other challenges of life (Adegun, 2003). Plato holds that a good education consists of giving the body and soul all the beauty and all the perfection of which they are capable. Examining this closely reveal that education can be used as an instrument per excellence to promote a healthy and safe society towards meeting the eight goals of the Millennium Development Goals (MDGs) by the year 2015.

Physics education is the theory and method of teaching physics in the curriculum. It is a combination of physics content and the relevant pedagogical strategies in instruction delivery. The theories and methods developed in this field of study will enhance teachers' effectiveness and versatility in the process of teaching physics in the classroom. All the intellectual efforts dissipated by physics educators are towards improving the learning of physics at all levels of institutions especially secondary schools where the foundation is built in preparation for societal peace and development. Physics educators have expressed continuous worry over the poor performance of students in physics at the foundational stages, secondary schools and advanced colleges (Amadalo, Ocholla, & Memba, 2012). Elementary physics has been integrated into a subject called Basic Science at the Junior Secondary School level where students are introduced to foundational concepts of physics. At the senior secondary however, science students are exposed to proper physics curriculum with higher emphasis on practical activities. This progression into higher level is the primary concern of physics education.

Various obstacles and challenges that militate against the teaching and learning of physics are often cross-examined through constant and continuous research studies towards finding solution. Teaching methodologies, instructional strategies, curriculum issues, policy formulation, interpretation and implementation in connection to physics are some of the focus of physics education. The primary intent of physics education therefore, is to prepare all the prospective health professionals – medical doctors, dentists, ophthalmologists, nurses, pharmacists, medical physicist, laboratory technologists- towards having a very sound understanding of physics at the secondary school level which will in turn be beneficial for them securing admission into tertiary institutions for further studies and also prepare them to apply fundamental principles of physics as it applies to their course of study and their life in general.

Application of physics in the Medical field

Medical physics is a branch of applied physics, pursued by medical physicists, who used established physics principles, methods and techniques in practice, in the clinical environment and in research, for the prevention, diagnosis and treatment of human diseases with the specific goal of improving human health and well-being. Medical physics encompasses a wide range of applications in multiple areas and has been classified internationally as a profession (Smith et. al., 2013). Many of the greatest inventions in modern medicine were developed by physicists who imported technologies such as x- rays, nuclear medicine, magnetic resonance, radiation therapy, ultrasound, particle accelerators and radioisotope tagging and detection techniques into the medical domain. They employed magnetic resonance imaging (MRI), computerized tomography (CT) scanning, nuclear medicine, positron emission tomography (PET) scanning, and various radiotherapy treatment methods. These contributions have revolutionized medical techniques for imaging the human body and treating disease (Freeman, 2012).

There are two main specialties within medical physics, therapy and imaging. Therapy is the delivery of ionizing radiation with palliative or curative intent and imaging uses ionizing and non-ionizing radiation for diagnostic purposes. Many medical physicists practice all aspects of medical physics, but specialization as a therapeutic radiological physicist, diagnostic radiological physicist, medical nuclear physicist or medical health physicist is becoming more common. Physicists were also pivotal in using radiation as a treatment for cancer. The President of the American Association of Physicists in Medicine (AAPM), the premier scientific and professional association of medical physicists, asserted that Medical Physicists have developed cutting-edge technologies in physics laboratory while others who are board-certified health professional apply these technologies in the clinic and help diagnose illness and alleviate suffering for millions of people (Gerald, 2008). In developed nations like United State of America (USA), virtually all hospitals have medical physicists as staff to help administer radiation therapy treatment and to ensure quality treatment and imaging techniques.

According to the definition of the International Basic Safety Standards (BSS), a medical physicist working in a clinical environment is a health professional, with specialist education and training in the concepts and techniques of applying physics in medicine, and competent to practice independently in one or more of the subfields (specialties) of medical physics (IAEA, 2011). The term practice independently according to European Commission (2011), means that a medical physicist works without the direct supervision of a more experienced medical physicist and is capable of ensuring the safe and effective delivery of radiation to achieve a diagnostic or therapeutic result as prescribed in patient.

The specialties involving the use of ionizing radiation in medical exposure comprise medical imaging physics, which include diagnostic and interventional radiology (DIR) procedures (radiology physics) and radionuclide procedure (nuclear medicine physics), radiation therapy physics and medical health physics (radiation protection in medicine). These medical physics specialties are an essential component of radiation medicine. On the whole, a medical physicist is a member of the multidisciplinary team involved in diagnosing and treating patients with ionizing and non-ionizing radiation, and contributes to ensuring a high standard of quality of service in hospitals and clinics (AAPM, 1993).

A clinically qualified medical physicist (CQMP) is able to identify problems and formulate strategies for their solution, interpret new or non-standard information, evaluate unusual situation in a scientific way, communicate scientific opinion clearly and accurately, recognize erroneous situations and take appropriate corrective actions and recognize their own limitations in knowledge and skills. The primary role of the CQMP in clinical practice is to optimize or advise other healthcare professionals to optimize the use of radiation to ensure the safety and quality of

diagnostic or therapeutic procedures, establish policies, guidelines and measurement techniques for the determination of patient dose and to collect and analyze clinical physics data for diagnosis or treatment of diseases.

Medical physics requires a solid undergraduate preparation in physics or another technical discipline (for example, nuclear engineering) and graduate study. While many current medical physicists studied pure physics or related engineering subjects at the graduate level, increasingly graduate study in medical physics is the preferred route of entry into the profession. Graduate programs in medical physics and residency programs in medical physics may be certified by the Commission on Accreditation of Medicals.

It is important to state that modern medicine cannot thrive only on medical physics without the contribution of other branches of physics such as nuclear physics, optical physics, electromagnetism and electronics. All these branches are inter-connected to build useful medical devices. The background principles and theories of elementary physics will clearly explain some of the activities going on in the medical world.

The Role of Medical Physics in building a Healthy Society

Health as defined by World Health Organization is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1997). Good health is basic to human welfare and a fundamental objective of social and economic development. Ill-health, due to infectious and chronic diseases, leads to suffering, disability and premature death, affecting social and economic development of a nation. The productivity of an individual depends greatly on his or her health status. Therefore improving the health status of a nation's population will contribute greatly towards achieving sustainable development. Individuals, households and communities are key actors in health and development of any nation. A healthy society therefore is a society, community, or nation where the individual members residing there are in good state of mental, physical and social fitness.

Understanding what engenders a healthy society requires in-depth knowledge of the interactions between health and social policies, health system characteristics, health expenditures, and socioeconomic determinants of health, among other factors. In the technical report for the post-2015 development agenda on the theme: Health in the Framework of Sustainable Development, powered by the Global Initiative for United Nation, it was posited that health is crucial for sustainable human development, both as inalienable human right and an essential contributor to the economic growth for society. Health is also a good summative measure of the progress of nations in achieving sustainable development.

The report further emphasized that Good health contributes to national development through productive employment, reduced expenditure on illness care and greater social cohesion. By promoting good health at all ages, the benefit of development extends across generations. Investment in primary healthcare can promote health across all social groups and reduce health inequities within and between countries. Improving performance of health systems by enhancing financial and human resources, appropriate use of technology, community empowerment and good governance will advance this agenda.

In building a functional health system, availability of qualified personnel and relevant infrastructure are key components. According to WHO (World Health Organization), health systems comprise all the organizations, institutions and the resources that are devoted to producing health actions for improving the health of the community. Medical physics plays a very significant role in the production and utilization of all modern medical equipment. Complex medical challenges that have claimed several souls in the past are now been diagnosed and

treated using high-tech medical equipment. In the past two decades, an advanced treatment technique called intensity-modulated radiation therapy (IMRT) has enhanced the ability of radiation to control tumors. IMRT uses computer programs to precisely shape the treatment field and control the accelerator beam in order to deliver a maximal dose of radiation to a tumor while minimizing the doses to surrounding healthy tissues. IMRT is already in use for treating prostate cancer, cancers of the brain, head and neck and other malignant diseases, in children and in adults.

Another rapidly growing technique used to detect diseases in people of all ages is positron emission tomography (PET). This technique uses short-lived radionuclides produced in cyclotrons. These nuclides are labeled to compounds such as glucose, testosterone and amino acids to monitor physiological factors including blood flow and glucose metabolism. These images can be crucial in detecting seizures, coronary heart disease and ischemia. In cancer care PET imaging is used to detect tumors and monitor the success of treatment courses as well as detecting early recurrent disease.

Pathways from Healthy Society to Sustainable Development

It is often stated that economic development can contribute to better health – wealth brings better nutrition, and wealthier countries have greater capability to invest in medical care and public health measures. However, there are reasons to believe that the relationship also runs in the reverse direction. That is, health improvements and healthy society can contribute to economic growth and sustainable development. Better health can make worker active and improve their productivity either through fewer days off or through increased output while working. Similar impact will be experienced when family members are healthy thereby reducing time lost to caring for dependents. Family according to the sociologist is the unit of a society. Consequently, it is right to say that the whole society will be healthy if the individual family unit is healthy. The health professionals posited that improved nutrition and reduced diseases, particularly in early childhood, leads to improved cognitive development, thereby enhancing the ability to learn. Healthy children will gain more from school having fewer days absent due to ill health. Enhanced learning through either of these mechanisms will add to human capital – and important determinant of economic growth and sustainable development. Healthy individual and society at large will have the ability and incentive to save more, and as noted above, this accumulation of capital may help fuel growth and investment. Companies may likely invest more when workforces are healthier and better educated. Initiatives that prevent certain illness or provide for their early treatment can help avoid major downstream costs associated with illness and subsequent complications. Such initiatives can reduce health care burdens on families and government, freeing capital for investment in productive activities and infrastructure. It is therefore logical to assert that healthy society is a predictor of sustainable development.

The Case for Physics Education in Sustaining a Healthy Society.

Structures cannot be built on emptiness or in a vacuum. This philosophy depicts that a healthy society cannot exist without framework of components. One of such components is physics education. All health professionals and practitioners require strong foundation in physics education before they could embark on medical or health mission. Going by the basic admission requirement of University and Tertiary Institution Matriculation Examination (UTME), the subject physics is compulsory at the Ordinary Level Examination. Prospective students will not be offered admission to study any Medical, Paramedical or health related courses in any university across the world unless such candidate possesses a minimum of credit at the Ordinary Level physics. The Implication of this therefore, is that, if students' performance in physics is very low as indicated in some studies, only few students will be eligible to enroll for medical oriented courses. The supply of medical personnel required to maintain a healthy society will

consequently be in short supply. This will probably explain the reason why the medical practitioners in the country are overworked while the few lucky ones opted for greener pasture in the developed countries.

The spiral effect of poor performance of students in physics has equally affected the enrolment of students into the field of medical physics. At present, the country is yet to tap from the tremendous opportunities of physics as experienced in the European economy. All the benefits of modern medicine powered by medical physics may not be useful to the nation if physics education is left in the doldrums. Prominent among the challenges facing physics education is the unavailability of competent and qualified physics teachers (Adedayo, 2010). The Institute of Physics (IOP) also noted that there is still a long way to go before physics can boast a healthy teaching workforce. The problem has been compounded in recent years by 15% of potential teachers not making it to the end of their training course. From those who completed however, half of them left the teaching profession within four-and-a-half years.

In maintaining healthy citizenry, relevant and basic knowledge of physics, especially on nuclear and medical physics, is needed to avert any form of possible hazards in relating with the creations or product of physics. This position is against the background of indiscriminate burning of unused or damaged electrical products which may release various forms of dangerous radiations into the atmosphere with its consequent effects on the cells and tissues of the body. In addition, modern students need to know the elementary aspects of electromagnetic radiations and their primary sources. The 21st century society is high-tech based where radiations of different power of penetration are been discharged from various gadgets at our disposal. The position of this paper therefore is that physics education is highly significant in building a very strong and healthy society. It requires the commitment of the government in funding useful educational projects on physics education towards revamping the interest of younger ones in physics.

Conclusion and Recommendation:

It is an undeniable fact that all medical and paramedical practitioners documented in this paper may not be able to record significant and landmark achievement in modern medicine which is the bane of modern-healthy society without reliance the use of technologies produced as a result of the principle of physics and knowledge of physics education as the driving force. Any health practitioner must have established a very strong and compulsory relationship with physics, at least, at Credit level, at one time or the other in their secondary school days or their early years in the university. If this is the true situation and position of physics and specifically in maintaining a healthy society towards a sustainable development, it therefore becomes imperative on Federal Government of Nigeria to re-invest heavily on the sciences in which physics is a part. To attain a sustainable development therefore, healthy population will in turn produce a healthy workforce which will automatically ignite the expected development.

This study therefore recommends among others that:

1. More of Nigeria physics graduates should be encouraged to further their study in Medical Physics immediately after the completion of their first degree in physics to enable the nation deliver on their commitment towards the Sustainable Development Goals
2. The physics components in the basic science curriculum at the Basic level of our educational system be revised to reflect those concept that, when taught can help in building a healthy society.
3. Physics educators should be encouraged through adequate funding in the area of academic research towards improving the teaching and learning of physics at the secondary school level (Post Basic)
4. All recommendations in previous studies on improving and motivating students' interest towards learning physics in secondary schools should be implemented. Such recommendations include adequate provision of

laboratory materials, employment of qualified and competent physics instructors, standard teacher-students ratio, review of the physics curriculum.

Reference

Adedayo J. O. (2010). Effect of teacher's qualification on the performance of senior secondary school students in Physics: Implication on technology. A paper presented at the 6th annual conference of the Nigerian Educational Research Association University of Nigeria, Nsukka; 5th—7th November.

Adegun O A (2003). Sociology of education, Ado-Ekiti: Petoa Educational Publishers. 7.African Development Bank Group (1991). Education sector policy paper. Available online at http://www.africandevelopmentbank.org.

Amadalo, M. M., Ocholla,A.A,Memba, E.B., (2012), Effect of practical work in physics on girls' performance, attitude and skills acquisition in the two-form three Secondary Schools' transition in Kenya, *International Journal of Humanities and Social Science*, 2(23)

Amusa, J.O. (2015), Physics Education – A Bedrock of Healthy Society and Sustainable Development. *International Journal of Research in Science, Technology and Mathematics Education*, *3*(1), 173 – 184.

Bhargava, A., Dean T. J., Lawrence J. L, & Christopher, J. L.,.Murray, 2001, "Modeling the Effects of Health on EconomicGrowth," Journal of Health Economics, Vol. 20 (18), pp. 423–450.

European Commission, Draft Proposal for a Council Directive Laying Down Basic Safety Standards for Protection Against the Dangers Arising from Exposure to Ionizing Radiation(COM/2011/0593 final 2011/0254 (NLE)) (2011).

Freeman T., (2012), *The Lancet highlights role of physics in medicine, medicalphysicsweb*, April 20, http://www.iop.org/mt4/mt-tb.cgi/4415

Garwin, M.R. &Ramsier.R.D. (2003). *Experiential learning at the university level: a US case study*,*Education and Training*. *45(5)*, 280-285

Hirschfeld D, (2012). Interest in science careers wanes in Latin America, *Science and Development Network*, 4 January 2012

International Atomic Energy Agency, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards — Interim Edition, IAEA Safety Standards Series No.GSR Part 3 (Interim), IAEA, Vienna (2011).

Ivowi, U.M.O. (2007). Science Education: The Bedrock for National Development, a paper presented at kings College, Lagos, Science Week Programme on Thursday, 18 October

Murenzi (2005), A Paper Presented at a World Conference on Physics for Sustainable Development, by Professor Romain Murenzi, the Former Chair of the Department of Physics at Clark Atlanta University, United State of America and also then Rwanda's Minister of Education, Science, Technology and Scientific Research Durban 2005.

Semela T, (2010). Who is joining physics and why? Factors influencing the choice of physics among Ethiopian university students, *International Journal of Environment & Science Education*, 5(3), 319-340

Smith, P.H.S., Nusslin, F., (2013) Benefits to medical physics from the recent inclusion of medical physicists in the international classification of standard occupations (ICSO-08), *Med. Phys. Int.J. **1** 10–14.*

Tesfaye C.L. & White S., 2012, Challenges High School Teachers Face, American Institute of Physics: Statistical Research Center, April pp 1-8

Validya, N. (2003). Science Teaching for 21st century New Delhi: Deep & Deep Publication PVT. Ltd

UNESCO, (2010). World Data on Education: Kenya, 7th Edition. http://www.ibe.unesco.org/