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BOOSTING THE TECHNOLOGICAL DEVELOPMENT CAPABILITIES OF TRAINEE PHYSICISTS IN COLLEGES OF EDUCATION IN NIGERIA THROUGH STUDENTS' INDUSTRIAL WORK SCHEME (SIWES)

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Abstract

Students' Industrial Work Experience Scheme (SIWES) is a skill acquisition program meant for Nigerian Students studying occupationally-related courses in Nigerian higher institutions to give them the experience that would supplement their theoretical learning. It is also designed to cater to the difficulties faced by Nigerian graduates after graduation, making the transition phase from school to the world of working experience easier. Trainee Physicists in Colleges of Education are excluded from this vital skill developmental and acquisition program even though Physics is a physical science that involves theory, laboratory practice, excursion, and industrial application/practice for meaningful learning on the part of the learner to take place. This paper, therefore, focuses on SIWES, the philosophy and objectives of Physics education in Nigerian Colleges of Education, and the need for the inclusion of trainee Physicists in the scheme to make them more productive, maximize their potential, and expedite the aspiration of Nigeria towards the much desire Technological advancement like all developed nations. This will, no doubt be a step forward in the right direction in improving the quality of physics graduates from Colleges of Education, on one hand, and moving our nation into committees of Developed nations, on the other hand.

Keywords: SIWES, Physics, Trainee Physicists, Colleges of Education

Introduction

SIWES is an acronym for Students' Industrial Work Experience Scheme. SIWES was designed by Industrial Training Fund (ITF) which was established by Federal Government of Nigeria (FGN) in 1973. It is designed for Nigerian students studying occupationally-related courses in higher institutions (to give them the experience that would supplement their theoretical learning). Prior to its establishment, there was a general feeling, by Industrialists and other employers of labor, that:

- Graduates of Nigerian tertiary institutions were deficit in practical background studies preparatory for employment in industries and other organizations; and also that,

- The theoretical education being received in our higher institutions was not responsive to the needs of employers of labor.

This led to the establishment of ITF and, hence, the directive by FGN that ITF should come up with a solution to bridge the gap identified by the Industrialists and employers of labor. Some of the objectives of SIWES, according to Aderonke (2012), include:

I. To provide an avenue for students in the Nigerian tertiary institutions to acquire industrial skills and experience during their course of study;

II. To prepare students for the work situation they are likely to meet after graduation;

III. To expose the students to work methods and techniques in handling equipment and machinery that may not be available in their respective institutions;

IV. To allow the transition phase from school to the world of working experience easier and facilitate students' contact for later job placements;

V. To provide students with an opportunity to apply their theoretical knowledge in real work situation thereby bridging the gap between theory and practice.

According to the Industrial Training Fund, SIWES is "a skill training program designed to expose and prepare students of universities, polytechnics, and colleges of education for the industrial work situation they are likely to meet after graduation" (ITF, 2019).

Each of these Organizations and agencies has specific roles to play in the management of SIWES. The Courses in Universities, Polytechnics, Colleges of Technology and Agriculture, and Colleges of Education in which Industrial Attachment is compulsory and centrally funded are restricted to Engineering and Technology, including Environmental Studies and other courses that may be approved. In Colleges of Education as at the moment, all NCE II students in School of Secondary Education (Technical), all NCE II students in School of Secondary Education (Business), all NCE II students in School of Secondary Education (Vocation) and only NCE II Computer Science students in School of Secondary Education (Science) are allowed to go for SIWES while students in Physics department are left out of the Scheme.

Physics Education in Nigerian Colleges of Education

Physics education is an important sub-field within science education, with foci on the teaching and learning of physics both at school, colleges and university level, as well as physics teacher preparation and development and public understanding of physics (Taber, 2012).

Physics education provides a person with the knowledge and understanding about how physical world works (NAP, 2013). Through training in physics one develops within himself/herself the analytical skills required for problem solving and problem management. Physics is crucial to understanding the world around us, the world within us

and the world beyond us (Olabimtan et.al., 2019). Physics education must meet the needs of several diverse groups. The general public must have the background they need to understand and foster the progress of science. Industry requires a workforce trained in a wide variety of engineering and science disciplines, all of which are founded on physics principles. According to Udoh (2012), the National Policy on Education (NPE) of the Federal Republic of Nigeria (1981 and 2004) stipulated the following major national educational goals:

- The training of mind in the understanding of the world around us;
- The acquisition of appropriate skills and the development of mental, physical and social abilities and competences as equipment for the individual to live in and continue in the development of the society; and,
- The inculcation of the right type of values and attitudes for the survival of individual and the Nigerian society.

To achieve all these stated national goals it is expressly stipulated in the NPE of FRN that "Government shall establish efficient inspectorate services at federal, state and local government levels for monitoring and maintaining minimum standards at all levels of education (FRN, 1981 and 2004).

Philosophy of Nigerian Certificate Education (NCE) in Physics

The philosophy of the N.C.E Physics is inspired by the desire to help students become intellectually informed in physics, the need to produce competent and effective teachers with good mastery of content and method; and knowledge of the development of the learners, on one part, and the society, on the other part, (NCCE Minimum Standard, 2012).

The philosophy of the N.C.E Physics program, as outlined by the NCCE Minimum Standard (2012), reflects a holistic approach to education that combines intellectual rigor with practical teaching skills and societal awareness. By focusing on these three core areas, the program aims to develop well-rounded physics educators who are capable of making significant contributions to both the academic and societal spheres. This comprehensive educational strategy ensures that graduates are not only effective teachers but also informed citizens who can contribute to the development and well-being of their communities and the nation at large.

Objectives of Physics Education in Colleges of Education

The objectives of Physics Education, as stated in the Minimum Standard for Colleges of Education (2012), in Nigeria include the following:

I. To have basic knowledge of the organizational concepts and techniques in practical and laboratory management;

II. To have sound and basic knowledge of physics concepts and principles to equip them for further studies in physics and physics related courses;

III. To demonstrate the understanding of concepts of physics, reflect upon them and revise them when necessary;

IV. To explain the nature of science;

V. To use science resources effectively;

VI. To be aware of the fact that fundamental ideas of physics evolved from a process of inquiry, which will enable them to develop scientific attitudes which are transferrable to other life situations;

VII. To plan and effectively execute physics-based lessons Basic 1 to Basic 9 classes in accordance with the Universal Basic Education (UBE) Policy;

VIII. To use Information Technology (IT) effectively to support pupils/students learning physics;

IX. To organize physics lessons for the whole class, groups, and individuals effectively;

X. To organize the difficulties students face with their physical learning;

XI. To remedy students misconception in physics;

XII. To develop pupil's use of physics language; and

XIII. To carry out formative, diagnosis and summative assessment of student's work (both theory and practical) in physics very successfully.

Olabimtan (2012) opined that the objectives of physics education listed above are drawn from three basic expectations:

I. The applicability of the knowledge of physics to the immediate and global environment by both teacher and the students;

II. A good mastery of laws, principles and concepts of physics and/or curriculum content of the subject; and

III. The effective dissemination or transfer of this knowledge to learners by the use of appropriate method(s), skills, instructional materials and incentives/reinforcements.

The objectives of Physics Education outlined above encapsulate a well-rounded and forward-thinking framework essential for the intellectual and practical development of students in the field. The objectives emphasize not only the acquisition of fundamental knowledge in physics but also the application of this knowledge to real-world situations, fostering critical thinking, problem-solving skills, and innovation. Here are several reasons why these objectives are commendable and vital:

I. The primary goal of physics education, as outlined, is to provide students with a comprehensive understanding of the principles and concepts of physics. This foundation is crucial because it prepares students to grasp more advanced topics and theories as they progress in their studies. A strong grounding in the basics of physics also enhances students' ability to integrate knowledge from other scientific disciplines, promoting a more interconnected and interdisciplinary approach to science education.

II. One of the key objectives is to cultivate students' ability to think critically and solve complex problems. Physics, by its very nature, challenges students to analyze situations, formulate hypotheses, and test these hypotheses through experiments and calculations. This rigorous approach to learning hones analytical skills that are not only applicable in scientific careers but are also invaluable in everyday decision-making processes and in various professional fields.

III. The emphasis on applying physics knowledge to solve practical problems is a particularly commendable objective. It bridges the gap between theoretical learning and practical application, ensuring that students can see the relevance of their studies in everyday life. This application-driven approach can inspire students to pursue careers in engineering, technology, and other fields where physics plays a critical role. Furthermore, it helps in nurturing a generation of problem-solvers who can tackle global challenges, such as energy sustainability, environmental conservation, and technological innovation.

IV. The objectives also aim to prepare students for further education and careers in science and technology. By instilling a deep understanding of physics and its applications, students are well-equipped to excel in higher education and contribute to advancements in various scientific and technological fields. This preparation is crucial for maintaining a competitive edge in a rapidly evolving global economy that increasingly relies on scientific and technological innovation.

V. Encouraging a lifelong interest in learning and curiosity about the natural world is another admirable objective. Physics education, with its vast array of phenomena and principles, naturally stimulates curiosity and a desire to explore. By fostering this mindset, students are likely to remain engaged with science throughout their lives, continually seeking knowledge and contributing to the scientific community.

VI. The objectives of Physics Education are comprehensive and forward-thinking. They not only aim to provide students with a robust foundation in physics but also prepare them for real-world applications and future scientific endeavors. By supporting these objectives, we invest in the development of knowledgeable, skilled, and innovative individuals who can drive scientific progress and address the challenges of the future.

Workshop Practice and Industrial Work Experience: As Vital Components of Physics Education

Physics, being a physical science, requires more than classroom interactions between the teacher and the taught for meaningful learning to take place in learners. Without laboratory practice and practical experience, students assimilate less than 20% of physics concepts taught in class (Ojediran et.al; 2014). This indicates a significant gap in understanding theoretical knowledge without practical application. Without practice through practical experience, students learn by rote, memorization of facts and recipes for problem-solving. They are not having a true and deeper understanding of the concepts taught and this has become a major clog on the technological development and advancement of our nation. This is due to the fact that the relevance of Physics in the society cannot be visualized by learners through classroom experience alone. For purposeful and meaningful knowledge transmission and transfer in physics, classroom

experience must be complemented with school laboratory practical, excursion and workshop practice both within and outside the walls of a school.

Workshop Practice and Industrial Work Experience by Physics Pre-Service Teachers in Colleges of Education in Nigeria

A workshop is usually a brief intensive educational program for a relatively small group of people that focuses especially on techniques and skills in a particular field (Merriam-Webster, 2024). A workshop can also be seen as an arrangement whereby a group of people learn, acquire new knowledge, perform creative problem-solving, or innovate in relation to a domain-specific issue (Ørngreen et.al;2017). The synergy between these two definitions illustrates the multifaceted value of workshops. They are not only avenues for intensive skill-building but also for collaborative innovation. In today's rapidly evolving world, where the ability to adapt and innovate is crucial, workshops serve as vital platforms for continuous learning and development. They provide a structured yet flexible environment where participants can update their skills, stay abreast of the latest developments in their field, and collaboratively tackle emerging challenges.

A Workshop practice involves putting into practice theoretical activity(ies) learnt in an informal and/or a formal environment with the aim of inculcating into the learner(apprentice) maintenance, manufacturing and problem-solving skills so as to reinforce his/her theoretical knowledge, earn a living and appreciate the applicability and relevance of acquired knowledge in the resolution of societal contemporary problems (Olabimtan, 2015). This is to say that a Workshop practice helps the learner to see the relevance and applications of what he has been taught, in an informal or a formal environment, to his immediate and global society in which he/she found him/herself. Workshop practice and practical laboratory activities emphasize "I do, I understand" of the popular Chinese statement "I hear, I forget; I see, I remember and I do, I understand" (Biggs et.al; 2011).

According to Olabimtan (2015), putting theoretical knowledge into practice in a workshop setting, either in tertiary institutions or in various relevant industries, exposes or makes a learner to gain the following skills:

a) Operation, usage, and maintenance (and in some cases, knowledge of basic repairs) of different machines and/or equipment;

b) Usage and maintenance of various kind of tools;

c) Repairs of different damaged and malfunctioning parts/components of different industrial machines and equipment;

d) Redesigning or reconstruction of existing parts for better performance and improved efficiency;

e) Manufacturing of entirely new parts or components and/or equipment/machine for better output;

f) Problem identification and problem-solving skills; and,

g) Safety precaution measures skills.

Physics is one of the most relevant subjects in our present world because of its direct influence and applicability to everyday concerns and activities in our society. Physics has been very successful in revealing many of nature's profound secrets and has play key roles in the development of many disciplines such as Chemistry, Biology, Medicine and Engineering (Hussain, 2008). However, students and society, at large have contrary views. People see Physics as being abstract and having no relevance or linkage to both the immediate and global society they live because there is no physical 'Physics Industry' like as in the case of 'Biotechnology Industry' and other discipline. Through practice in a workshop and relevant industries in the society, this erroneous view and misconception of physics can be remedied for good.

Applications and Relevance of Physics to the Society

Physics-the study of matter, energy and their interactions-is an international enterprise, plays a key role in the future progress of humankind. Physics plays a crucial role in the advancement of society by contributing to various fields and improving our understanding of the natural world. The importance of physics to society according to Khan (2020) can be highlighted through its applications in technology, healthcare, energy, environment, and education.

1. Technological Advancements

Physics is at the core of technological innovations. It provides the principles and concepts that drive the development of new technologies, which in turn fuel economic growth and improve quality of life.

- Transistors and Semiconductors: The development of transistors, which are the building blocks of modern electronics, including computers, smartphones, and other digital devices, is a direct result of research in quantum mechanics.
- Lasers and Fiber Optics: Physics research led to the invention of lasers and the development of fiber optics, which are critical for high-speed internet and telecommunications.
- Medical Imaging and Treatment: Technologies such as X-rays, MRI, PET scans, and radiation therapy are based on principles of physics and have revolutionized medical diagnostics and treatment.

2. Economic Development

Physics contributes significantly to the economy by driving innovation and creating new industries. The knowledge generated by physics research leads to the development of new products and processes that enhance productivity and economic competitiveness. For instance:

- Consumer Electronics: Advances in physics have made possible the development of electronic devices such as smartphones, televisions, and computers, which are integral to modern life and commerce.
- Energy Solutions: Physics research is crucial in the development of sustainable energy solutions, including solar panels, wind turbines, and nuclear energy, helping to address global energy needs and environmental challenges.

3. Improvement of Quality of Life

Physics improves everyday life through practical applications that enhance comfort, safety, and convenience. Examples include:

- Household Appliances: Many household devices, from microwaves to washing machines, are based on principles of physics, making daily tasks easier and more efficient.

- Health and Medicine: Advances in medical physics have led to better diagnostic tools and treatments, improving healthcare outcomes and increasing life expectancy.

4. Scientific Understanding and Education

Physics forms the foundation of other natural sciences such as chemistry, biology, and earth sciences. It helps us understand fundamental natural phenomena and the universe. Physics education fosters critical thinking, problem-solving skills, and a deeper appreciation of the natural world. This education is vital for training scientists, engineers, and technologists who drive further innovation and research.

5. Environmental Protection

Physics plays a critical role in environmental science by providing tools and methods to monitor and mitigate environmental issues. For example:

- Climate Change Research: Physics-based models and technologies are essential for understanding and addressing climate change. This includes the development of renewable energy sources and efficient energy storage systems.

- Pollution Control: Techniques derived from physics are used to detect and reduce pollution, such as the use of filters and catalytic converters to reduce emissions from industrial processes and vehicles.

6. Global Connectivity and Communication

The principles of physics underpin the technologies that enable global communication and connectivity, such as satellites, GPS, and the internet. These technologies have transformed how we communicate, conduct business, and access information, making the world more interconnected.

Physics is integral to the progress of society, driving technological advancements, economic development, and improving quality of life. It enhances our understanding of the universe and provides the tools necessary to address global challenges such as energy sustainability, environmental protection, and health. The continuous support and investment in physics education and research are essential for fostering innovation and ensuring a better future for all.

Probable Establishments for Industrial Work Experience Exercise for Trainee Physicists

Without the laws of physics, our world would be without spaceships, computers, advanced medical technology, and even large buildings. Scientific investigation and problem solving is at the heart of what a physicist does. Physics serves as a broad

foundation for careers in astronomy, medicine, engineering, computer science and education (Kelly, 2018). The followings are some of the possible establishment where trainee physicists in Colleges of Education in Nigeria can be posted for their Industrial Work Experience Scheme:

a) Medical and Science Laboratories;

b) Energy Generation Industries;

c) Manufacturing Industries;

d) Aerospace and Airports;

e) Defense Industries ;

f) Telecommunication Companies;

g) Research Centers;

h) Information and Computer Technology Industries; and,

i) Health Care and Medical Facility.

Reasons for Inclusion of Students in Physics Department in Colleges of Education in SIWES

From the aforementioned possible places where physics graduate can work it is obvious that:

I. Through active participation in SIWES, Physics trainees in Colleges of Education will have a deeper understanding of physics concepts and its applicability in their immediate environment;

II. Physics graduates will be in a better position to work effectively and efficiently in relevant industries and compete effective with graduates from other disciplines;

III. The misconception of Physics by students and society about non-relevance of Physics to their immediate environment will be remedied;

IV. The knowledge of career opportunities and possibilities enabled by education in physics will be broadened and this might boost the interest and consequently, enrolment of students in physics education;

V. This will also boost the chances of the country in the attainment of the much desired advancement in technology and hasten our transition from developing nation to developed nation; and,

VI. This will increase the chances of attainment of the objectives of establishment of Physics education program in Colleges of Education in Nigeria.

Conclusion

It is pertinent to note that inclusion of physics trainees from colleges of education into SIWES will make them more productive, maximize their potentials and expedite the

aspiration of Nigeria towards the much desire Technological advancement like all developed nations. This will, no doubt be a step forward in the right direction in improving the quality of physics graduates from Colleges of Education, on one hand, and moving our nation into committees of Developed nations on the other hand.

Recommendations

The following recommendations focused on practical steps that stakeholders can take to implement the inclusion of trainee physicists in SIWES.

I. Engagement with educational policymakers and relevant government bodies to revise the SIWES policy to include physics education students from Colleges of Education.

II. Partnership with professional organizations such as the Nigerian Institute of Physics (NIP) and other educational bodies to lobby for the inclusion of physics education students in SIWES.

III. Integration of practical industrial training modules into the existing physics curriculum to align with SIWES objectives.

IV. Colleges of Education should work with National Commission for Colleges of Education (NCCE) to update the minimum standards for physics education to include mandatory industrial work experience.

V. Create partnerships between educational institutions and relevant industries such as energy, telecommunications, healthcare, and research centers to provide placement opportunities for physics students.

VI. Government should invest in modernizing laboratory facilities and workshops to ensure they meet the standards for effective industrial training.

VII. Colleges should provide training and professional development for physics educators to equip them with the skills necessary to oversee industrial training components.

VIII. Physics educators should be encouraged to participate in short-term industry placements to keep them abreast of current industry practices and technologies.

IX. Career counseling services should be offered to help students understand the various career opportunities available to them through industrial training.

X. Mentorship programs should be developed where students can receive guidance from industry professionals during their training period.

XI. Feedback mechanisms should be established where students and industry partners can provide insights and suggestions for continuous improvement of the training program.

XII. Incentives for both trainee physicists and industry partners should be provided to encourage participation in the industrial training program, such as stipends for students and tax breaks for participating companies.

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