IMPROVING PRACTICAL PHYSICS COMPONENTS FOR TRAINEE TEACHERS IN COLLEGES OF EDUCATION IN NIGERIA

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Abstract
Innovation, a catalyst to development, is tightly coupled to change, and is a key policy and strategic issue. Practical activities and classroom teaching of Physics concepts play complementary roles in effective teaching and meaningful learning. The level of practical activities in physics as contained in the National Commission for Colleges of Education (NCCE) minimum standard for Colleges of Education in Nigeria is grossly inadequate. Less than 20 percent of concepts of physics are being practically demonstrated. This is an impediment towards effective teaching and meaningful learning, and hence quality of physics education in Nigeria. There is therefore a great need for Physics Curriculum to be strengthened by increasing the number of practical courses students of Physics in NCE are exposed to while in training, for greater and deeper understanding of laws, principles and concepts of physics and its applicability. This will, no doubt, be a step in the right direction towards improving the quality of teachers and Physics education in Colleges of Education in the nation. Towards this end, number of practical courses offered by NCE physics students should be increased and functional modern laboratories, adequately stocked with contemporary equipment/apparatus should be made available in all the Colleges of Education in Nigeria.

Introduction
Innovation, a catalyst to development, is of interest to practitioners and researchers across a range of business and management disciplines. It has been discussed variously in the literature on human resource management, operations management, entrepreneurship, research and development, information technology, engineering and product design, and marketing strategy (Baregheh, Rowley & Sambrook, 2009). Each of these different disciplines proposes definitions for innovation that align with dominant paradigm of the discipline. Innovation is studied in many disciplines and has been defined from different perspectives (Damanpour and Schneider, 2006).

Technically, "innovation" is defined merely as "introducing something new;" there are no qualifiers of how ground-breaking or world-shattering that something needs to be-only that it needs to be better than what had be in existence earlier. Something new is not enough for the definition of innovation. There are many instances where something new has no new value. A lot of fresh or new things have been created which are of no new use or no new value. A new thing must create new value for it to be innovation. The different definitions of innovation hit on two major cords: something fresh (new, original or improved) and something that creates better value.

According to Wikipedia, the free encyclopedia, innovation can be viewed as the application of better solutions that meet new requirements, in-articulated needs or existing market needs. Innovation is a new idea, more effective device or process. The importance of innovation transcends business organizations. New ideas, effective processes and devices are needed in all sectors of a society and/or nation for continuing growth and existence of the society and/or nation. Innovation is tightly coupled to change, and a key policy and strategic issue. Innovation is a process that follows invention, being separated from invention in time. Invention is a creative act, while innovation is the first or early employment of an idea by one organization or a set of organizations with similar goals (Becker and Whisler, 1967).

Yunus (1998) defined innovation as a purposeful change from an established order that is progressive and beneficial in the areas of policy, objectives, content, materials and equipment, methods or evaluation strategies. Onwuka (1996) reviewed innovation from the point of curriculum revision as a series of planned and/or unplanned learning activities through the idea of adding or removing items in the

curriculum, implying revision or renewal (i.e modifying an existing learning process) with the hope of providing better programme. Innovation in Physics education is aimed at the purpose of training in non-traditional way, transforming the passive learning into active, creative process. This allows rapid identification and compensation of gaps in the knowledge, which in turn leads to a rationalization and a more complete and lasting control of educational content (Stinner, 2003). It worth noting that three of the objectives of Teacher Education in Nigeria, as stated in the in the NPE (2004), emphasize on effectiveness, efficiency and creativity/innovation. This is a pointer to the fact that the planner of teacher education in Nigeria embraces and gives room for innovation. Innovation therefore is the basis of teacher education in Nigeria.

Types of Innovations

Innovation varies in scope, time for completion organizational and societal impact. Classification of any kind usually involves areas of duplication, where the lines between one category and another overlap (Baker, 2002). When object of innovation is considered as basis for categorization, Oslo Manual (2005) concentrates on four innovation types which include:

a. **Product Innovation:** a product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics (Oslo Manual, 2005).
b. **Process Innovation:** a process innovation, according to Oslo Manual (2005), is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, Technology, equipment and/or software.
c. **Market Innovation:** a market innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing (Oslo Manual, 2005). Marketing innovation is aimed at better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market, with the objective of increasing the firm's sales.
d. **Organizational Innovation:** is the implementation of a new organizational method in the firm's business practice, workplace, organization or external relations. Organizational innovation can be intended to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies (Oslo Manual, 2005).

Other simplified classifications of innovation exist: using novelty of results as basis of classification we have the following types: incremental, radical and breakthrough innovations; when source of innovation is used as basis of categorization, we have Research and Development, and Non-Research and Development innovations; when firm's innovation strategy is considered, we have: open and closed innovations; and when innovation approach is used as basis of classifications we have: top-down and bottom-up innovations.

Features of Innovation

As identified by Yunus (1998), for a change to be classified as an innovation, it should posses the following or most of these features:

a. **Realistic/Achievable Objectives:** objectives that are realistic and achievable, that are not mere dreams/imaginations or copying from another already existing setting, which are fantasy, should be the forms of the innovation processes. The innovation procedures must take the social, political and economic atmosphere and available resources (indigenous technology) into consideration.
b. **Presence of New Elements:** the essence of innovation/change is to introduce something new which should have an improvement over the existing situation and which is capable of bringing some form of progress.

c. **Flexibility:** innovation must be flexible to allow for adjustments to the changing needs and conditions of society where it is operational.
d. **Must have been tested:** an innovation should first be experimented over a smaller group so that its worthiness and workability can be determined on a larger society.
e. **Acceptability:** innovations should reflect the needs of the society such that they become acceptable. Every purposeful change should reflect the aspirations, problems and societal values so that it can be seen and embraced by the society.
f. **Official Support:** the support of leaders/administrators of every section of the society upon which the innovation(s) would be implemented is very vital. It is the leaders/administrators that determine policies and how they are implemented
g. **Involvement of all Participants:** it is more than necessary to involve every group of people that would participate in new innovation/invention, say for example parents, teachers, organization, employers, sponsors e. t. c. so as to ensure that innovations exert the required impact.

Physics Education in Colleges of Education on Nigeria

The importance of Physics and its contributions to life and other disciplines cannot be over emphasized. Physics is in every life we can think of and everywhere matter exists. Physics is crucial to understanding the world around us, the world inside of us, and the world beyond us. It is the most basic and fundamental science. Physics challenges our imaginations with concepts like Relativity and String theory, and it leads to great discoveries, like computers and lasers, that change our lives. Physics encompasses the study of the universe from the largest galaxies to the smallest subatomic particles. It is the basis of many other sciences such as chemistry, oceanography, seismology, and astronomy. Increasingly, physicists are turning their talents to molecular biology, biochemistry and biology itself. Even medicine has a niche for physicists; medical-physics is a rapidly growing discipline.

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

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

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

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

To explain the nature of science;

To use science resources effectively;

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

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

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

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

To recognize the difficulties students face with their physical learning;

To remedy students misconception in physics;

To develop pupil's use of physics language; and

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

The objectives of physics education listed above are drawn from three major basic expectations:

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

ii. The effective dissemination or transfer of this knowledge to learners by the use of appropriate method(s), skills and incentives; and

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

The skills, ethics and methodology acquired during training by a teacher make him/her able to disseminate knowledge in his/her area of specialization effectively. A teacher is trained to teach a subject and/or in some cases some subjects. Of what use is the training acquired by a teacher if he/she lacks necessary and required knowledge about laws, principles, concepts and its applications in the immediate and global environments. In such a situation, no effective teaching and meaningful learning takes place as a result of interaction between the teacher and his/her students and the very essence of teaching has been defeated.

Physics Teacher's Quality

A major determinant of quality of physics teachers being produced in every teacher training institute is his/her level of understanding of the curriculum content of the subject. The impact of teacher in the performance of students is very relevant. The teacher is the resource person and facilitator who imparts into the students concepts expected to be learnt. Research studies (Olarenwaju, 1986; Nwagbo, 1995) revealed that most Physics teachers are ignorant of the curriculum content of the subject. The students taught by these rather incompetent teachers would invariably have shallow knowledge of Physics concepts and principle. It is towards this end that this paper attempts to analyze the NCCE minimum standard for Physics education to ascertain whether enough practical activities that would aid the understanding and comprehension of physics concepts is given enough and appropriate consideration.

No effective Physics teaching can take place without necessary equipment and practical activities. It is therefore necessary that physics laboratories must be adequately stocked with the necessary equipment/facilities, and practical activities conducted to reinforce theory for meaningful learning to occur in the learners. Ajayi (2008) while assessing the level of students' involvement in practical activities in Physics laboratories concluded that only 23.23% of the schools in Nigeria did allow their students to carry out practical activities. The practical activities on various aspects of physics are inadequately performed in schools. This inadequacy is one of the major reasons for poor understanding of physics concepts by teachers and hence their students because teachers can only dish out what is inside of them. A cursory look into Physics curriculum in Colleges of Education in Nigeria as stipulated in the NCCE minimum standard reveals what is shown in the following table:

Table 1: List of Courses in Physics Department in Nigerian Colleges of Education as stipulated in NCCE Minimum Standard

Course Code	Course Title	Credit Unit	Course Code	Course Title	Credit Unit
NCE I (100 LEVEL)					
FIRST SEMESTER			**SECOND SEMESTER**		
PHY 111	Mathematics for Physics I	1	PHY 121	Thermal Physics I	2
PHY 112	Electromagnetism I	2	PHY 122	Astronomy and Environmental Phys.	2
PHY 113	Mechanics & Properties of Matter I	2	PHY123	Basic & Digital Electronics	2
PHY 114	**Introduction to Physics Practical**	1	PHY 124	Acoustics	1
			PHY 125	**Physics Practical**	1
NCE II (200 LEVEL)					
FIRST SEMESTER			**SECOND SEMESTER**		
PHY 211	Atomic & Quantum Physics	1	PHY 221	Workshop Practice	1
PHY 212	Electromagnetism II	2	PHY 222	Optics	2
PHY 213	Mechanics & Properties of Matter II	3	PHY 223	Thermal Physics II	2
PHY 214	Mathematics for Physics II	1	PHY 224	Physics Methodology	1
PHY 215	**Physics Practical II**	1			
NCE III (300 LEVEL)					
FIRST SEMESTER			**SECOND SEMESTER**		
	Teaching Practice		PHY 321	Electromagnetism III	2
			PHY 322	Atomic & Quantum Physics II	1
			PHY 323	**Physics Practical III**	1

Source: NCCE Minimum Standard: TETF Project, 2012.

For greater understanding of information display in Table 1 above, the table has been analyzed, summarized as in Table 2 below.:

Table 2: The Analysis of Theoretical and practical content of NCE Physics Curriculum

LEVEL	SEMESTER	NO OF THEORETICAL COURSES.	NO OF PRACTICAL COURSES.	TOTAL NO OF COURSES.
NCE I	First	3	1	4
	Second	4	1	5
NCE II	First	4	1	5
	Second	4	NIL	4
NCE III	First	NIL	NIL	NIL
	Second	2	1	3
	TOTAL	**17**	**4**	**21**

Practical demonstration of physics concepts through practical activities in the laboratory has great effect on the understanding of concepts and principles of physics by the learners. The classroom teaching of concepts of physics was therefore recommended to be reinforced through practical activities in the laboratory for better understanding on the part of learners. From table 2 above, out of four Physics courses being offered in First Semester by NCE I students, only one is practically oriented while the remaining three courses are theory. Only two or three concepts in each of the theoretical courses are being demonstrated by practical activities in the laboratory. This is an indication that less than 20% of the concepts taught in each of the courses are being demonstrated through practical activities. In Second semester of the same NCE I, one course out of five courses to be register is a practical course while the remaining four courses are theory based. NCE II students has a practical course to do in First semester out of total five courses to be offered in the First semester while no practical physics was included in four courses listed for registration in Second semester of NCE II. NCE III students have no course for registration in First semester because of Practice Teaching but out of three courses to be registered in Second semester only one course is practical physics. In general, out of total 21 physics courses to be offered by NCE physics students 17 are theory while only 4 involved practical activities. This revelation shows that the consideration given to practical activities in Physics in Colleges of Education in Nigeria by the curriculum planners is grossly inadequate. Going by the established fact that practical activities play complementary role to classroom teaching in the understanding of physics concepts, the quality of physics teachers produced in Colleges of Education in Nigeria as reflected in their curriculum should be of great concern stakeholders of education in Nigeria. The curriculum needs to be fortified by inclusion of more practical courses in physics curriculum in Colleges of Education in Nigeria.

Conclusion

No effective Physics teaching and meaningful concept learning can take place without necessary equipment and practical activities since classroom teaching and practical activities play complementary roles in the understanding of laws, principle and concepts of physics as well as its application in the resolution of social and environmental problems. It is therefore expedient for curriculum planners of Colleges of Education in Nigeria to peruse the current Physics curriculum with the aim of bringing in innovations through increase in number of practical courses coupled with provision of modern laboratories together with necessary facilities and provision adequate and contemporary equipment for effective demonstration of practical activities for better understanding of physics.

Recommendations

To improve the mastery of physics laws, principles and concepts and hence quality of physics teachers being produced in Colleges of Education in Nigeria, the following recommendations are therefore made:

a. Practical courses should not be separated from theoretical courses. All courses should consist of both theoretical and practical aspect;

b. The theory and practical components of every course taught in school should be equally rated. In other words, for every course, practical activities should carry 50 marks and the theory aspect should also carry 50 marks;

c. Number of courses to be registered and passed by students in institutions of higher learning may be reduced to allow for practical activities in all courses since this is not about how much but how well;

d. Government, at all levels, should make provisions for modern physics laboratory structure in every institution of learning in Nigeria with necessary and adequate facilities;

e. Every laboratory should be sufficiently and adequately stocked with modern and contemporary physics apparatus and equipment by the government;

f. Alternative source of energy, preferably solar energy source, should be provided in all laboratories for unhindered access to practical activities by the students at any period of the day;

g. Adequate measures should be put in place for proper and continuous maintenance of the apparatus and equipment in every physics laboratory by education administrators of each institution.

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