PHYSICS TEACHERS' CONTENT AND PEDAGOGICAL KNOWLEDGE AS CORRELATES OF PHYSICS ACHIEVEMENT OF SENIOR SECONDARY SCHOOLS STUDENTS IN BORGU, NIGER STATE

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Abstract
This study investigated Physics Teachers' Content and Pedagogical Knowledge as correlates of Physics achievement of Senior Secondary Schools Students in Borgu, Niger State. The design adopted for this study was Ex-post Facto design. The population of this study covered all Senior Secondary Schools offering Physics with target population of nine hundred and fifteen (915) SS II physics students as at 2016/17 academic session. The sample of the study comprised of six Physics teachers purposively sampled out of 21 Physics teachers and ninety Physics students (48 males and 42 females) were selected from six sampled schools out of 17 secondary schools using random sampling technique. Two validated instruments developed by the researcher namely; Physics Teachers content knowledge Test (PTCKT) and Physics Teachers Pedagogical Knowledge Survey (PTPKS) with reliability coefficients of 0.85 and 0.79 respectively. Two research questions were raised and two null hypotheses were tested at 0.05 level of significance. Research questions were answered with Linear regression while hypotheses were tested with Linear regression and Analysis of Varience. The major findings from the study were; No significance relationship in the extent of variation in Physics achievement of Students that is related to Physics teachers' content knowledge and no significant in the extent of variation in Physics achievement of Students that is related to Physics teachers' pedagogical knowledge. Base on the findings, recommendations were made and these include among other that government should encourage Physics teachers training programmes to update their content knowledge and pedagogy skills for effective teaching. Also teachers should encourage positive study habit among students which will consequently improve students achievement.

Keywords: Physics Teachers, Content Knowledge, Pedagogical Knowledge, Physics, Achievement

Introduction

In the modern world, there is an emphasis on the need for the provision of good qualitative Science and Technology Education for effective living and Physics is crucial for effective living in the modern age of Science and Technology. Ogumogu (2011), buttressed that, without adequate background and knowledge of physics in our society, the scientific and technological advancement in Nigeria will be a mirage.

Physics is a natural science that involves the study of matter and its motion through space-time, along with related concepts such as energy and force. It is the fundamental and most basics of natural science. It is a discipline of questioning, experimenting and thinking "outside the box", making it critical that learners engage in inquiry, innovation and creativity within the science classroom (Okonkwo, 2014). It encompasses the study of the universe and is the basis for the study of many other science related disciplines. Physics is an integral science subject which provides contents in the training of students who want to study

Engineering, Medicine, Nursing, Pharmacy, Fisheries and Physical Sciences and other related courses in Higher Institutions. At least for credit pass in Physics is a requirement for admission to pursue studies in science-related disciplines in tertiary institution.

It is one of the subjects in the National curriculum for senior secondary schools, first published by the Federal Ministry of Education in 2009. It curriculum has a spiral arrangement of content. The content of Physics curriculum are: Concept of space, time and motion; Conservation principle; Waves; Fields and Quanta. Based on this spiral arrangement, the concepts to be taught are arranged in such a way that topics are repeated yearly, throughout the three years of the Senior Secondary School, to cover the units in it curriculum. Any repeated concept is discussed in greater complexity and depth as the course matures over the three years of senior Secondary School. The contents of the senior secondary school Physics curriculum places emphasis on understanding the concept, functionality and ability to apply concept learnt skills acquired to relevant field.

The objectives of secondary school Physics curriculum have been derived from the National Policy on Education first introduced in 1985 and revised in 2013 are to provide basic literacy in physics for functional living in the society, stimulate and enhance creativity, acquire essential skills and attitudes as a preparation for technological application of physics and acquire basic concept and principles of physics as preparation for further studies. To achieve these objectives, the Physics curriculum is expected to reflect contents and methods, which will provide relevant and useful knowledge and skills useful for technological and industrial development. This implies that curriculum of Physics is expected to take care of the challenges of the modern world.

It is in this regard that Nigerian Government in it National Policy on Education (FRN, 2013) made Physics compulsory subject of study at senior secondary schools for all Science students. Therefore, for a candidate to gain admission into science related courses in particular College of Education (COE), Polytechnics and universities, candidate must have at least credit pass in Physics. Majority of senior secondary school science students choose Physics in the West African Senior School Certificate Examinations (WASSCE) or National Examination Council's Senior School Certificate Examinations (NECOSSCE).

However, there is ample evidence showing that performance of students in Physics over the past decade has been very poor and not encouraging. The Chief Examiners' Reports (WAEC, 2014; 2015) revealed that candidates' poor performance in physics is due to lack of knowledge of the basic principles and concepts in Physics. This may lead to students having misconceptions of Physics concepts. Chee (2010) buttressed that students' misconceptions in Physics do impede meaningful understanding of and good performance in the subject.

Students' misconceptions of Physics concepts may originate from many factors, these include: Physics' teachers weakness, poor infrastructures, non-availability of equipment, poor utilization of instructional materials and abstract nature of some topics in Physics (Omosewo, 2012). Onyeka, Nneka and Augusta (2012) attributed poor performance to inadequate certified teachers, equipment, poor attitude of students and poor comprehension of the concepts due to abstract nature of the topics.

In the same vein, it is generally recognized that there is low enrolment in number of students learning physics at all levels in many African countries (Semela, Buabeng & Ntow, 2010). Among factors that cause low enrolment of students offering Physics in the schools include: poor science and mathematics foundation of the students, lack of job outside

teaching profession, poorly equipped laboratory, poor remuneration, inadequate motivation of the teacher, in appropriate teaching strategies employed by the teachers, and low number of qualified Physics teacher as well as possession of below standard content and pedagogical knowledge (Semela *et al*, 2010; Jegede & Adedayo, 2013). This indicates that Physics teachers lacking content and pedagogical knowledge might transfer misconceptions in Physics to students and in this way add to students' conceptual difficulties.

It is a common ideology in society that, if a Physics teacher knows Physics very well, then that teacher will teach it very well. But research evidence has shown that, knowing Physics is only an aspect of Physics teaching. There are other knowledge necessary for the Physics teaching and learning that goes with content knowledge such as student knowledge of cognition and knowledge of teaching.

Teachers' Content Knowledge (TCK) is the actual subject knowledge a teacher possessed and also is the knowledge about actual subject matter that is to be taught by the teacher. Hence for effective learning to take place there must be an effective Physics teacher who must be competent in Content Knowledge (CK) and Pedagogical Knowledge (PK). Schmidt (2009) opined that teachers must know about the content to be taught and how the nature of this knowledge is different for various content areas. The Teacher's Content Knowledge (TCK) is essentially important to the improvement of teaching and learning.

Another critical factor to be considered in teaching by physics teachers is Pedagogical Knowledge (PK). Pedagogical knowledge (PK) refers to the knowledge teachers develop through experience over a long period of time, about how to teach specific content in particular ways in order to lead to enhanced learner understanding (Loughram, 2012). Pedagogical knowledge (PK) includes understanding which teaching skills fit the content and how element of the content can be arranged for an effective science teaching (Nuangchalerm, 2011). This implies that pedagogical knowledge (PK) is concerned with how teachers relate content knowledge (CK) to pedagogical knowledge and how content knowledge (CK) is related to the process of pedagogical reasoning (Adedoyin, 2011). Teachers who have acquired sufficient academic preparation – usually are effective in both content knowledge and pedagogical knowledge in classrooms (Hendriks, Luyten, Scheerens, Sleegers, & Steen, 2010). Therefore, this study made an effort to investigate the Physics Teachers' Content (TC) and Pedagogical Knowledge (PK) as correlates of Physics achievement of secondary school students in Borgu, Niger State.

The main objective of physics education programmes of various institutions of learning in Nigeria is to p rovide basic literacy in physics for functional living in the society (FRN, 2004). In spite of Nigerian government's desire to promote Physics education programme in the country, the quality of Physics students produced by the secondary schools seem to be deteriorating. From the literature, it has been observed that students are not doing well in Physics in WAEC (Niger State Ministry of Education, Minna, 2013 – 2016 school examiners report). In 2013 the percentage of failure was 58.90%, and 73.72% in 2014. The rate of failure increased to 77.83% in 2015 and 92.92% in 2016. In this vein, Physics teacher factor has been linked to be one of the causes of students' poor performance in the examination, in this sense there is need to look into the quality of Physics teachers in our secondary schools because effective teaching elicit effective learning.

In Borgu, it is observed that expected learning outcomes in Physics are not achieved in most schools, resulting in many schools not performing satisfactorily on the standardize examination been conducted by West Africa Examination Council (WAEC). One way to

analyze these discrepancies in providing quality education may be through studying the variables of Physics Teachers Content and pedagogical Knowledge.

Aim and Objectives of the Study

The aim of this study is to determine the Physics Teachers' Content and Pedagogical Knowledge as correlates of Physics achievement of Senior Secondary School Sudents in Borgu, Niger State. Specifically, the study will achieve the following objectives by find out the:

(i) Extent of variation in Physics achievement of students as related to Physics teachers' content knowledge in Borgu, Niger State.
(ii) Extent of variation in Physics achievement of students as related to Physics Teachers' pedagogical knowledge in Borgu, Niger State.

Research Questions

The following research questions guided the study:

(i) To what extent of variation is Physics achievement of students related to Physics teachers' content knowledge in Borgu, Niger State?
(ii) To what extent of variation is Physics achievement of students related to Physics teachers' Pedagogical knowledge in Borgu, Niger State?

Research Hypotheses

HO_1: There is no significant relationship in the extent of variation in Physics achievement of students that is related to Physics teachers' content knowledge.

HO_2: There is no significant relationship in the extent of variation in Physics achievement of students that is related to Physics teachers' pedagogical knowledge.

Methodology

The research design adopted for this study is causal comparative design also know as Ex-post Facto design. Ex-post Facto design is a systematic empirical inquiry in which the researcher does not have direct control on independent variable because they are inherently not easy to manipulate (Ngwagu; 2005). Ex-post Facto design was used by the researcher to establish that values of the independent variables have a significant effect on the dependent variable. An Ex-post Facto design is most appropriate for this study because it allows variables to show if they have a negative or positive relationship. The independent variables in this study are Teachers' Content Knowledge and Teachers' Pedagogical Knowledge and the dependent variable is Physics students achievement.

The population for the study comprised all Senior Secondary Schools two (SSII) students offering Physics of 2016/2017 in Borgu educational zone. The population of Senior Secondary School two (SSII) students offering physics was 915 Students (523 male and 392 female) (Schools Examination Officers). The population of Physics teachers were twenty-two (21 male and 1 female) in Borgu educational zone.

Purposive technique was used to select 6 schools based on certified teachers and 6 Physics teachers used for the main study but 10 for pilot study. The sample for this study was 90 Senior Secondary School two (SSII) Physics Students from 6 out of 17 Secondary Schools in Borgu educational zone. Simple random procedure (hat draw) was employed to select 90

Physics students for which 48 were male students and 42 were female students for the study.

Two instruments were used for the study, first was Physics Teachers Content Knowledge Test (PTCKT) which was used for the measurement of Physics teachers content knowledge while the other instrument used in this study for data collection was named Physics Teachers' Pedagogical Knowledge Survey (PTPKS). PTCKT contained a 40 structured multiple choice questions was an adapted from light and wave concepts. Physics Teachers' Pedagogical Knowledge Survey (PTPKS) is questionnaire that contained twenty items (20) based on teaching procedures, class management and evaluation of work. The PTPKS is an adopted four – point likert scales coded as follows: Strongly agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2 Strongly disagree (SD) = 1.

Physics Teachers' Content knowledge Test (PTCKT) and Physics Teachers' Pedagogical Knowledge Survey (PTPKS) were subjected to content and face validation by two expert science lecturers from Science Education Department, Federal University of Technology, Minna. From the validation report, the following amendments were made: Grammatical editing were made and items that cannot measure pedagogical skills were considered irrelevant and removed. The final instruments were modified based on the suggestion and feedback from the validations.

In order to check the reliability of the Physics Teachers Content knowledge Test (PTCKT) and Physics Teachers Pedagogical Knowledge Survey (PTPKS), 10 Physics teachers were selected from teachers within the population but not selected for the main study. Test-retest techniques were used to establish the reliability coefficient of the test items. The responses were scored after the first and second administrations of their tests. The scores obtained were correlated using person product correlation coefficient for PTCKT while Cronbach Alpha coefficient for PTPKS, which yielded reliable coefficients of 0.85 and 0.79 for PTCKT and PTPKS respectively.

The researcher visited the schools for this study to seek for official permission from the school authorities through a letter of introduction from the Department of Science Education, Federal University of Technology Minna before the commencement of the research. After the permission, the Physics teachers were acquainted on the purpose and significances of the research. The total number of 90 Senior Secondary school (SSII) Physics Students from 6 sampled secondary schools in Borgu used for the study. The termly examination results of the 90 physics students collected in the sampled schools were used as the Physics students' achievement from the examination office for the study.

The Physics teachers in each sampled schools for the study were asked to answer Physics Teachers Content Knowledge Test (PTCKT) and also to complete Physics Teachers Pedagogical Knowledge Survey (PTPKS) and collected back by the researcher. Also students termly examination scores were collected as Physics achievement. Based on the data collected with PTCKT, PTPKS and students termly examination score, the researcher then analyzed the amount of variation in students' achievement of Physics that is related to Physics teachers' content and pedagogical knowledge.

Table 4: The Strategic Plan and Time Frame for the Research

1.	Visitation	Visitation to the schools for awareness	2weeks
2.	Orientation	Teachers and Students orientation about the research	2weeks
3.	Administration	Collection of students scores (PSTR)	2weeks
4.	Administration	Answering and collection of PTCKT and PTPKS	2week

Results

The research questions were answered using Linear regression while hypotheses were tested at 0.05 level of significant using Linear Regression and Analysis of Variance (ANOVA) to determine if there were relationship among the independent variables and Physics achievement.

Research Question One: To what extent of variation is Physics achievement of Students is related to Physics teachers' content knowledge in Borgu, Niger State?

Table 2: Regression Analysis of Physics Teachers' Content Knowledge and Physics Achievement of students

R	R. Square	Adjusted R. Square	Std. Error of the Estimate
0.275*	0.075	-0.156	6.509

*Predictors (Constant), Physics Teachers content knowledge

The scores from the responses of the Physics Teachers' content knowledge were regressed with Physics achievement of Students. Table 2 shows that the correlation between Physics Teachers' content knowledge and Physics achievement of Students is 0.275 with a coefficient of determination of 0.075. This implies that 7.5 % in Physics achievement of Students is related to Physics Teachers content knowledge. This is an indication that 92.5 % of the variation in Physics achievement of Students can be attributed to other factors than Physics teachers' content knowledge.

Research Question Two: To what extent of variation is Physics achievement of Students is related to Physics teachers' pedagogical knowledge in Borgu, Niger State?

Table 3: Regression Analysis of Physics Teachers' Pedagogical Knowledge and Physics Achievement of Students

R	R. Square	Adjusted R. Square	Std. Error of the Estimate
0.395*	0.156	-0.055	6.220

*Predictors (Constant), Physics Teachers' pedagogical knowledge

The scores from the responses of the Physics Teachers' pedagogical knowledge were regressed with Physics achievement of Students. Table 3 shows that the regression between Physics Teachers pedagogical knowledge and Physics achievement of Students is 0.395 with a coefficient of determination of 0.156. This implies that 15.6 % in Physics achievement of Students is related to Physics Teachers content knowledge. This is an indication that 84.4 % of the variation in Physics achievement of Students can be attributed to other factors than Physics teachers' pedagogical knowledge.

Hypotheses Testing

Hypothesis One: There is no significant relationship in the extent of variation in Physics achievement of Student that is related to Physics teachers' content knowledge.

Table 4: Analysis of variance of physics achievement of students and physics teachers content knowledge

Source of Variation	Sum of Square	df	Mean Square	F	Sig
Regression	13.840	1	13.840	0.327	0.598
Residual	169.493	4	42.373		
Total	183.333	5			

Table 4 shows that the probability value associated with the calculated of F(1,4)= 0.327 is 0.598. The probability value of 0.598 was compared with 0.05 level of significance for testing the hypothesis and it was found not significant. The null hypothesis is retained. Inference drawn was that the extent of variation in Physics achievement of Students that is related to Physics teachers' content knowledge is not significant (F(1,4)=0.327, P > 0.05). This shows that there is a weak contribution of Physics teachers' content knowledge to Physics achievement of Students.

Table 5: Regression Analysis of Physics Achievement of Students and Physics Teachers' Content Knowledge Showing t-value

Variable	Unstandardized Coefficients		Standardaized Coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	94.202	59.321	1.588	0.187	
Physics Teachers Content Knowledge	-0.399	0.699	-0.275	-0.572	0.598

In addition Table 5 also confirms the fact that there existed a weak relationship of Physics teachers' content knowledge to Physics achievement of Students since the t-value of -0.572 with associated exact probability value of 0.598 was obtained. The partial correlation coefficient of Physics teachers' content knowledge has a negative relationship with Physics achievement of students.

Hypothesis Two (HO_2): There is no significant relationship in the extent of variation in Physics achievement of Students that is related to Physics teachers' pedagogical knowledge.

Table 6: Analysis of variance of physics' achievement of students and physics teachers' pedagogical knowledge

Source of Variation	Sum of Square	df	Mean Square	F	Sig
Regression	28.588	1	28.588	0.739	0.438
Residual	154.745	4	38.686		
Total	183.333	5			

Table 6 shows that the probability value associated with the calculated of F(1,4)= 0.739 is 0.438. The probability value of 0.438 was compared with 0.05 level of significance for testing the hypothesis and it was found not significant. The null hypothesis is retained. Inference drawn was that the extent of variation in Physics achievement of Student that is related to Physics teachers' pedagogical knowledge is not significant (F(1,4)=0.739, P > 0.05). This shows that there is a weak contribution of Physics teachers' pedagogical knowledge to Physics achievement of Students.

Table 7: Regression analysis of physics achievement of students and physics teachers pedagogical knowledge showing t-value

Variable	Unstandardized Coefficients		Standardaized Coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	89.804	34.376	1.588	0.187	
Physics Teachers Pedagogical Knowledge	-0.353	0.411	-0.395	-0.860	0.438

In addition Table 7 also confirms the fact that there existed a weak relationship of Physics teachers' pedagogical knowledge to Physics achievement of Students since the t-value of -0.860 with associated exact probability value of 0.438 was obtained. The partial correlation coefficient of Physics teachers' pedagogical knowledge has a negative relationship with Physics achievement of students.

Discussion

7.5 percent variation in students' achievement of Physics can be attributed to Physics teachers content knowledge. While 92.5 percent of the variation in students achievement of Physics can be attributed to other factors than Physics teachers content knowledge that were not considered in the study. Meanwhile the extent of variation in students' achievement of Physics concepts that is related to Physics teachers content knowledge is not significant. However the partial correlation coefficient of Physics teachers' content knowledge has negative relationship with students' achievement of Physics. This implies that low level of Physics teachers' content knowledge might have a result of negative effect on students achievement of Physics 15.6 percent variation in students' achievement of Physics can be attributed to Physics teachers pedagogical knowledge. While 84.4 percent of the variation in students achievement of Physics can be attributed to other factors than Physics teachers pedagogical knowledge that were not considered in the study. Meanwhile the extent of variation in students' achievement of Physics concepts that is related to Physics teachers' pedagogical knowledge is not significant. That is, there is a weak contribution of Physics teachers' pedagogical knowledge to students achievement of Physics. This implies that decrease in the Physics teachers' pedagogical knowledge would have a negative effect on students achievement of Physics. Carmen (2002) who investigated on the relationship among teachers pedagogical knowledge and students achievement score. The result of the study showed that there is no significant relationship between teachers' pedagogical knowledge and students achievements score.

Recommendations

Based on the findings of this study, the following recommendations were made:

(i) Government should encourage Physics teachers training programmes to update their knowledge and to improve on the classroom practices. Such programmes should be focused toward linking the subject matter with pedagogy to enable the trainee acquire appropriate technical skills necessary for effective Physics teaching.

(ii) The study calls for the need to encourage teachers to further their education, consequently teachers would become more competent in discharging their duties.

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