

Assessment of Senior Secondary School Physics Teachers' Content Knowledge in Kogi Central Zone of Kogi State, Nigeria

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Abstract

The performance of senior secondary school science students in physics external examinations has continued to witness a downward trend over the years. Several studies have been carried out to find out the causes of this unimpressive development with divergent findings. Many researchers concluded that physics teachers do not have sufficient knowledge of the subject, but failed to specify what aspects of physics knowledge are lacked by the teachers. This study therefore focused on the Physics teachers' subject content knowledge. It adopted a survey research design using the physics teachers in Kogi central zone of Kogi State, Nigeria. Thirty-five senior secondary school physics teachers were drawn purposively from the forty-five public secondary schools in the zone. Three research questions and two null hypotheses guided the study. The research questions were answered using mean and standard deviation while the hypotheses were tested using t-test at .05 level of significance. Relevant data were collected using Content Knowledge Assessment Instrument for Physics Teachers (CoKA IPT). Results of this study revealed high incidence of educationally non-qualified physics teachers in Kogi central zone of Kogi State. It also showed that there was no statistically significant difference between the mean content knowledge of the educationally qualified and non-qualified physics teachers. The implications of the findings were discussed. Based on the findings of this study, the researcher recommended among others, that a retraining programme be organized periodically for the physics teachers to update their subject content knowledge.

Key words: *physics, content knowledge, Kogi Central, teachers.*

Introduction

The federal government of Nigeria recognized the need for scientifically and technologically literate population that would steer the nation's economic engines. Hence, it prioritized the teaching of science and technology at all levels of her educational structure (Federal Republic of Nigeria, *FRN*, 2013) via two main modes: Basic Science at the basic education level, and separate science subjects such as biology, chemistry and physics at the senior secondary school level and beyond.

However, for students opting for sciences beyond the basic education level, physics is a core subject. Its curriculum is structured in such a way that upon completing the course at the senior secondary school level, the students would have been provided with basic literacy in physics for functional living in the society as well as acquired the basic concepts and principles

of physics as a presentation for further studies. The students would have also acquired essential scientific skills and attitudes as a preparation for the technological application of physics and the basic skills of creativity (Federal Ministry of Education, 2011).

Unfortunately, the teaching and learning of physics in Nigerian secondary schools are fraught with numerous challenges that prevent students from performing well in the subject in external examinations. Researchers have identified low enrolment in physics in secondary schools and tertiary institutions in Nigeria (Akanbi, 2003; Bamidele, 2004; Adeyemo, 2010; Udoh, 2012), poor performance of senior secondary school students (West African Examinations Council, WAEC, 2014) and dwindling interest in physics (Bangbade, 2004; Esiobu, 2005; Udoh, 2012).

For Bamidele (2004), the dwindling interest in physics among the senior secondary school students is due to the preconceived idea that physics is a difficult subject. Akanbi (2003) linked students' negative perception of physics as a difficult to the abstract nature of some of its concepts - a situation that renders the teaching of the subject difficult for physics teachers. Isola (2010), Obioma (2012), Danjuma and Adeleye (2015) also share similar views with Akanbi (2003). These authors submitted that students' negative attitude towards physics is connected with the teaching style adopted by the predominantly unqualified teachers.

These studies did not, however, specify which aspects of teachers' professional knowledge are either insufficient or lacking in the teachers. Hence, this study aims at providing a more detailed assessment of the secondary school physics teachers' professional knowledge with a view to finding the specific characteristics that teachers need improvement to enhance both the students' enrolment and achievement in the subject. Specifically, this study focuses on a very vital aspect of teachers' professional knowledge - subject content knowledge.

Concept of Content Knowledge

In attempts to identify what should constitute teachers' subject content knowledge, and which researchers can look out for when assessing it, different nomenclatures were used by different authors. Hill and Ball (2004) referred to it as 'common knowledge of content', Ferrini-Mundy, Floden, McCrory, Burril and Sandow (2005) described it as 'core content knowledge'.

However, for Ferrini-Mundy *et al* (2005) core content knowledge refers to an individual's understanding of the subject matter concepts as well as how these concepts relate to form a larger body of knowledge. This implies that physics teachers who claim to have sufficient content knowledge must have full grasp of the various concepts in physics and their interrelatedness and should also be able to use such knowledge as a way of thinking, correcting students' misconceptions and explaining physical phenomena.

In the context of this study, content knowledge shall refer to all the central facts, concepts, theories and procedures in physics; a knowledge of explanatory frameworks that organize and connect physics ideas, as well as knowledge of the rules of evidence and proof. It is an understanding of the information and concepts in physics domain, an evidence of mastery of the computational skills, procedures, as well as a conceptual understanding of the subject truth.

Purpose of the study

The general purpose of the study is to assess the subject content knowledge of senior secondary school physics teachers in Kogi Central Zone of Kogi State. Specifically, the study sought to assess the

1. physics teachers' level of subject content knowledge,
2. influence of experience on the physics teachers' content knowledge;
3. influence of educational qualifications of the physics teachers on their content knowledge

Research Questions

The following research questions guided the study:

- i. What is the level of senior secondary school physics teachers' content knowledge?
- ii. Is there any statistically significant difference between the mean content knowledge scores of experienced and less experienced physics teachers?
- iii. Is there any statistically significant difference between the mean content knowledge scores of educationally qualified and non-qualified physics teachers?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance to guide this study

Ho1: There is no statistically significant difference between the mean subject content knowledge scores of experienced and less experienced physics teachers.

Ho2: There is no statistically significant difference between the mean subject content knowledge scores of educationally qualified and non-qualified physics teachers.

Methodology

This study adopted a survey research design, as it collected and analyzed data from a few people that formed a representative sample of the entire population (Emaikwu, 2012). The survey design was adopted for this study because it is interested in describing the physics teachers' subject content knowledge in quantitative terms.

The population for this study comprises of all the senior secondary school Physics teachers in the forty five (45) public secondary schools in Kogi Central Zone of Kogi State. However, the sample for this study consists of thirty-five (35) physics teachers drawn using multi-stage sampling technique. Firstly, the secondary schools were stratified according to Local Government Areas (LGAs). The second stage involved selection of 3 LGAs (Okene, Okehi and Adavi) using simple random sampling technique. This constituted 60% of the LGAs in the zone. Finally, purposive sampling was used to select all the 35 physics teachers in the selected schools.

Content Knowledge Assessment Instrument for physics Teachers (CoKAIPT) was used to collect data for this study. It is a researcher-developed instrument for assessing Physics teachers' content knowledge using statements that focus on conceptual understanding, critical thinking and problem-solving abilities of the physics teachers. The CoKAIPT comprises of two sections: A and B. Section A sought demographic information on the physics teachers such as educational qualifications and length of service (teaching experience) while section B contains nine items that measured the teachers' content knowledge. Each item in section B was rated on a 4-point scale as follows: 1 = very poor, 2 = poor, 3 = Good 4 = Very Good.

To establish the reliability index for the instrument, ten physics teachers that were not part of the final sample were assessed using the instrument. The reliability of the instrument was computed using the Cronbach alpha reliability estimate. The internal consistency coefficient for the instrument was .731 (N = 9) which, according to George and Mallery (2003) is good.

The researcher observed each physics teachers in their regular classrooms twice (on different days and topics) and personally rated the teachers on each item of the instrument. The average score of each teacher for the two observations was used for final analyses. Mean and standard deviation were used to answer the research questions while the hypotheses were tested using t-test at 5% level of significance.

Results

Research question 1: What is the level of the physics teachers' content knowledge?

Table 1: Overall assessment of Secondary School physics teachers' Content Knowledge

Items that assessed content Knowledge	Mean, \bar{X}	Std. Dev.	Remarks
1. Identifies specific activities that will extend and deepen students' learning of concept/topic	3.200 3.000	.633 .594	Good Good
2. Explains concepts in appropriate, simple and clear language	2.886 2.800	.583 .632	Good Good
3. Connects content/concept to students' prior experiences	2.314 3.343	.583 .591	Poor Good
4. Identifies and corrects pupils' misconceptions about the concept taught	3.371 3.257	.910 .657	Good Good
5. Uses a variety of familiar examples to explain concept	2.286	.622	Poor
6. Appropriateness of topic to students' level			
7. Relevance of instructional material to concept being taught			
8. Quality of instructional materials (title, labelling, readability)			
9. Effective use of instructional materials			
No of teachers = 35,	Overall Mean = 2.94		good

Decision rule: Mean score less than 2.5 = poor while mean score equal to or greater than 2.5 = good

Table 1 shows the overall assessment of the physics teachers on the nine items that measured their content knowledge. It can be seen from the table that the physics teachers' mean scores were good for items other than 5 and 9. The physics teachers underperformed in the use of familiar examples to explain physics concepts and effective use of instructional materials.

Research question 2: Is there any statistically significant difference between the mean content knowledge scores of experienced and less experienced physics teachers?

Table 2: Mean content knowledge scores of experienced and less experienced physics teachers

Variable	Group	N	Mean, \bar{X}	Std. Deviation
Content knowledge	Experienced Teachers	26	26.58	1.92
	Less Experienced Teachers	9	26.11	2.08

From table 2 above, the experienced physics teachers had a higher mean score of 26.58 with a standard deviation of 1.92 than the less experienced physics teachers whose mean score of 26.11 with a standard deviation of 2.08.

Hypothesis 1: There is no statistically significant difference between the mean Content Knowledge scores of Experienced and Less Experienced Physics teachers.

Table 3: t-test of significance of difference between the Mean Content Knowledge scores of Experienced and Less Experienced physics teachers

Group	N	\bar{X}	t-test for Equality of Means					95% confidence interval of the difference	
			t	df	Sig (2-tailed)	Mean difference	Std error difference	Lower	Upper
Experienced	26	26.57							
Less Experienced	9	26.11	0.613	33	0.544	0.46	0.759	-1.079	2.011

Decision: Reject H_0 if the p-value is less than or equal to 0.05, otherwise Accept H_0 . From table 3 above, the p-value 0.544 (equal variances assumed) is greater than 0.05. This indicates that there is no reason to reject H_0 . Hence, it is concluded that there is no statistically significant difference between the mean content knowledge scores of experienced and less experienced Physics teachers at .05 level of significance. The 95% confidence interval for the difference between two means is (-1.079, 2.011).

Research question 3: Is there any statistically significant difference between the mean content knowledge scores of educationally qualified and non-qualified physics teachers?

Table 4: Mean content knowledge scores of educationally qualified and non-qualified physics teachers

Variable	Group	N	Mean, \bar{X}	Std. Deviation
Content Knowledge	Qualified Teachers	24	26.79	1.956
	Non-Qualified Teachers	11	25.73	1.794

Table 4 above shows the mean content knowledge scores of educationally qualified and non-qualified physics teachers. From the table, out of the thirty-five physics teachers assessed, twenty-four are educationally qualified while eleven have no teaching qualifications. For the educationally qualified teachers the mean score is 26.79 with a standard deviation of 1.956 while the non-qualified teachers have a mean score of 25.73 with a standard deviation of 1.794. From the information above, the educationally qualified teachers have higher mean content knowledge score than their non-qualified counterparts.

Hypothesis 2: there is no significant difference between the mean content knowledge scores of educationally qualified and non-qualified physics teachers.

Table 5: t-test of significance of difference of mean content knowledge scores of educationally qualified and non-qualified physics teachers

Group	N	Mean	t-test for Equality of Means					95% confidence interval of the difference	
			t	df	Sig(2-tailed)	Mean difference	Std Error difference	Lower	Upper
Experienced	24	26.79	1.532	33	0.135	1.06	0.695	-0.349	2.478
Less Experienced	11	25.73							

Decision: Accept H_0 if the p-value is greater than 0.05; Reject H_0 if the p-value is less than or equal to 0.05.

Table 5 above shows that the p-value (0.135) is greater than 0.05. This indicates that there is no reason to reject H_0 . Hence, it is concluded that there is no significant difference between the mean content knowledge scores of educationally qualified and non-qualified physics teachers in Kogi Central Zone of Kogi State. The 95% confidence interval for the difference between the two means is (-0.349, 2.478).

Summary of findings

The results of this study revealed that

1. There are a high number of unqualified physics teachers in the area covered by this study. Out of the thirty-five (35) senior secondary school physics teachers in Kogi Central zone of Kogi State, eleven (11) are educationally not qualified to teach the subject as they have no teaching qualifications. This represents about 31.4% of the physics teachers.

2. The physics teachers had good overall content knowledge. However, the teachers performed poorly in terms of using a variety of familiar examples to explain concepts and effective use of instructional materials.

3. Although the experienced teachers had higher mean content knowledge score ($\bar{x} = 26.58$) than the less experienced teachers ($\bar{x} = 26.11$), further statistical analysis showed that the difference between the mean scores of the two groups of teachers was not significant. Hence, this study concludes that there is no statistically significant difference between the physics content knowledge of experienced and less experienced physics teachers. However, if the works of Boyd, Landford, Loeb, Rockoff & Wyckoff (2008) and Agharuwhe (2013) that found positive correlation between teachers' experience and students' achievement hold, then there ought to have been improved performances of the students in Physics in the area currently studied since they have sufficient numbers of experienced Physics teachers. Hence, whatever differences in achievement between students taught by experienced and less experienced physics teachers in the area studied should be attributed to factors other than experience. This study, therefore adopts Aina and Olanipekun's (2015) caution about emphasis on teachers' experience especially in Nigeria as many teachers might have been in the teaching profession for several years without updating or developing themselves professionally.

4. The educationally qualified Physics teachers had higher mean content knowledge score ($\bar{x} = 26.79$) than the non-qualified physics teachers ($\bar{x} = 25.73$). Further statistical analysis indicates that the difference between the mean scores of the two groups of teachers is not significant.

Implications of the findings of this study

The findings of this study have several implications. First, the inability of the teachers to use a variety of familiar examples in the class implies that the authors of physics textbooks used in Nigerian classrooms do not provide sufficient examples drawn from our local environments. It also implies that many teachers do not go beyond whatever examples cited in the recommended textbooks. Drawing examples from our local environment will enhance good connection between what the students know and the new knowledge provided in the classroom.

Secondly, the teachers poorly used instructional materials during their lessons. This makes the subject more of 'chalk and talk' than meaningful teaching and consequently hinder understanding of physics concepts by the students.

Thirdly, the high percentage of non-qualified Physics teachers in Kogi Central zone of Kogi State points to great likelihood of some gaps being created during teaching or poor teaching of physics to the students. Some of the gaps could be in terms of teaching methods.

Recommendations

Based on the findings of this study, the researcher makes the following recommendations:

1. In-service or retraining programmes should be organized urgently and periodically too, to update the teachers' knowledge, especially in terms of use of instructional materials in the classroom. This may be done through seminars, conferences and workshops.
2. Teacher-training institutions such as Colleges of Education, Schools of Education in Polytechnics and Faculties of Education in Universities should re-organize their curriculum to emphasize contemporary teaching methods. This will acquaint their products with the knowledge these methods as they undergo microteaching and teaching practice and subsequently be able to apply same during actual practical teaching after graduation.
3. The observed differences between the mean content knowledge scores of educationally qualified and non-qualified physics teachers indicate that the former category of physics teachers has an edge over their counterparts. The researcher recommends that the cluster-school model of teacher professional development should be adopted for senior secondary school physics teachers. This would offer the physics teacher's ample opportunities to interact with each other and discuss the teaching challenges they encounter in their various classrooms as well as proffer realistic solutions.
4. Authors of textbooks used in Nigerian schools should reflect our cultural backgrounds in their books by citing examples drawn from our local environments. This will make physics concepts presented in classrooms easier to understand than using foreign examples.

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