Influence of Physics Teachers' Characteristics on Students' Physics Performance in Senior Secondary Schools in Ogun and Oyo States, Nigeria

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Abstract

In this paper, the author examined the relationships between teacher qualification and teaching experience and teacher teaching skills and the effects of the relationships on senior secondary school students' performance in Physics. Teachers who studied Physics and education in university and demonstrate appropriate teaching skills would encourage students to do well in Physics. To test these hypotheses, forty senior secondary school Physics teachers and 1560 senior secondary school Physics students were randomly selected in Ogun and Oyo States in Nigeria. Each teacher was observed for 10 lessons and rated using Teacher-students Interaction Observation Schedule (r=0.78). Physics Performance Test was administered to students after the classroom observation (r=0.88). The result of Pearson Product Moment Correlation Coefficient among teacher qualifications (r=.29, p<0.05), teaching experience (r=.07, p<0.05) have significant relation; 74% have a direct causal effect while 26% of the variables have an indirect effect on students' performance in Physics. Adjusted Goodness of Fit Index (AGFI), normed fit index (NFI), and comparative Fit Index (CFI) is 1.00. All these are perfect fits that reflect a good model fit. Results showed that there was a significant relationship between teacher factors and teaching skills on students' performance in Physics. Therefore, it was recommended that the most qualified and experienced teachers should teach physics at the senior secondary school level.

***Keywords*:** students' performance, teacher qualification, teaching experience, teaching skills, performance in physics

Introduction

Physics is a discipline of study that uses experiments, measurements, and mathematical analysis to discover quantifiable physical rules for everything in and around us. Physics is the empirical study of matter and natural processes based on quantitative measurements and empirical observations. Physics principles are used in a variety of fields, including agriculture, nursing, medicine, pharmacy, engineering, and other related subjects and fields in life. As a result, fundamental physics concepts and principles are essential for national and global technological growth. Performance According to the National Policy on Education (Federal Republic of Nigeria – FRN, 2013)), students in Nigerian secondary schools study physics for three years, which is equivalent to a senior secondary school (SSS). Teachers at the secondary school level are expected to engage students in hands-on activities such as conducting experiments to develop their scientific knowledge and experimental skills while also arousing, maintaining, and cultivating a positive attitude toward physics and physics-related phenomena.

According to data from public examining authorities such as the West African Examinations Council (WAEC) and the National Examinations Council (NECO), less than 60% of candidates who registered for Physics passed at the distinction and credit levels on average in between 2009 and 2015. Researchers in physics education in Nigeria (such as Olukoya, 2011; Adegoke, 2012, and Ajadi, 2017) discovered that the use of improper, ineffective teaching techniques, instructors, parents, and environmental-related factors are the key reasons responsible for pupils not doing well in physics (Ajadi, 2017). Furthermore, studies have demonstrated that interactions between teachers and students in the classroom have an impact on students' attitudes towards physics and, as a result, their physics accomplishment. Researchers from various parts of the world have confirmed the same findings. For instance, in a study conducted in the United Kingdom, Gok and Silay (2008) discovered that old or traditional methods of teaching, especially lecturing have detrimental effects on students' attitudes towards physics. The teacher, according to Adegoke (2012), is one determinant in students' academic accomplishment in a specific subject. As a result, the discouraging trend in students' performance in Physics external examinations could be ascribed to teacher-related classroom variables such as classroom practices, professional development, and characteristics outside of classroom practices.

A positive teacher-student relationship has been shown to improve students' learning results in school-based topics. Positive teacher-student classroom interactions, for example, were found to boost students' affective and cognitive development, raise enthusiasm for learning, and reduce negative student behaviour (Bradley, Pauley& Pauley, 2006). Situations in which the teacher manages classroom activities by giving directions to teaching and learning activities, stimulating students' participation in teaching and learning activities, asking questions and allowing them to ask questions, contributing ideas, and arousing students' interest in the topics are all characteristics of positive teacher-student relationships.

Many related previous studies used the quantitative method of multiple correlations to investigate the relationship between students' academic performance and teacher's classroom practices, as well as other aspects of teaching, such as the professional development of teachers. Goe (2007) defines teachers' classroom practices as including activities undertaken in the classroom (such as lesson planning or preparation, the introduction of the lesson, communication, organisation, assessment, classroom management, and teachers–students interactions. However, the activities may extend even out of the classroom such as sports activities, and co-curricular activities. Thus, there is a need to determine whether classroom practices/skills assessment would have impact on students' academic performance in physics.

Attention-getters is one approach to arouse students' interest. It could be expressed in the form of a statement, a story, or an inquiry. The teacher could propose a topic for debate and urge students to engage in an open dialogue, either in small groups or as a whole class, with individual students being encouraged to contribute (Henrietta, Eziashi & Emeke, 2014). As a result, communication refers to the transfer, transmission, or exchange of ideas, knowledge, opinions, attitudes, or feelings from one person to another. This is a constant process because feedback leads to new actions. When teaching in the classroom, teachers are aware of their students' emotions.

The teacher presents the concepts or facts of the lesson step-by-step as carefully planned in the lesson note during the development stage. To arouse and maintain students' attentions in the class, a variety of strategies are employed (Adjai, 2001). At appropriate times, for example, oral questioning and response are used. They are used not just to carry the students along, but also to go from one phase or stage of the instruction to the next (Ajadi, 2017). Some of these questions, as well as suggested responses, should be written down in the lesson note by the teacher. Provision should be available for the usage of relevant instructional resources at the appropriate stage of the lesson development (McFarland, 2003).

No matter how creative or imaginative a teacher is, if he or she lacks organizational abilities, he or she may not be able to apply other teaching skills effectively. This is because the organization provides the foundation for students' learning, and poor organization results in educational waste (Kelly, 2014). The class is made up of people from multiple backgrounds and with various personalities. These students' actions can have a beneficial or bad impact on the teacher's morale. Controlling the class is easier with effective classroom organization. Teachers should actively plan for students' learning in such a way that it necessitates a thorough study of the aim and the careful selection of acceptable content for students (Eggen & Kauchak, 2001).

The assessment of cognitive learning entails using oral or written tests to assess students' knowledge and understanding of a subject. The teacher will be able to determine the amount to which the students have grasped the topics of the lesson by doing so. According to McFarland (2003), teachers can value or quantify the progress that students have made in their learning by conducting a thorough review of the instructional goals. During the assessment period, a skilled teacher should ask questions that bridge the levels of classical Benjamin Bloom's behavioural objectives (knowledge, comprehension, application, analysis, synthesis, and assessment), testing both the lower and higher levels of cognition.

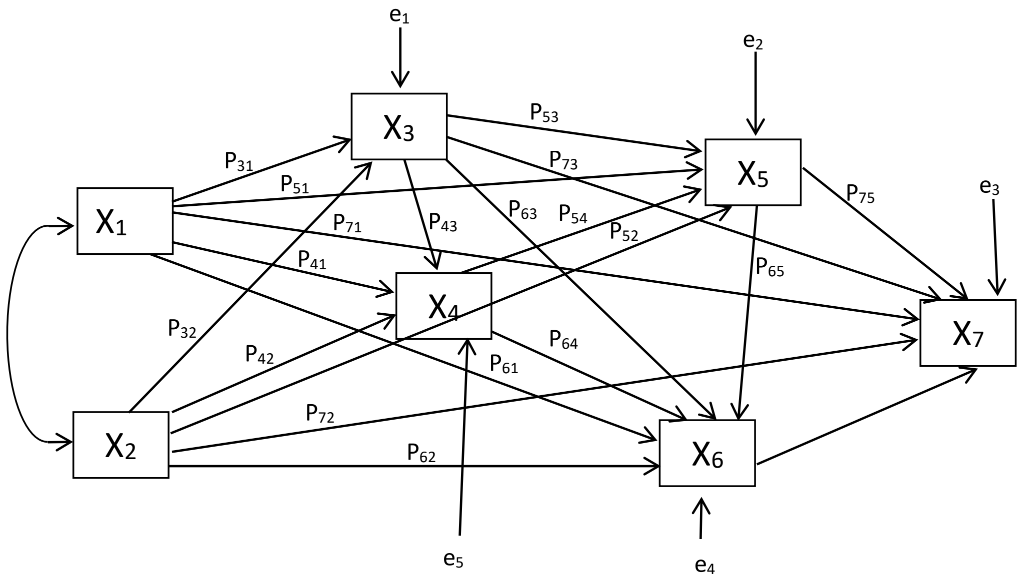

Figure. 1. *Recursive Path Model of Students' Performance in Physics Factors*

Key: X_1 = Teacher Qualification; X_2 = Teaching Experience; X_3 = Lesson preparation; X_4 = Lesson Introduction;

X_5 = Lesson Development; X_5 = Teaching Assessment; X_7 = Students Performance in Physics.

Research questions

The study sought to answers to the following three research questions.

1. What is the pattern of correlation among variables of teacher characteristics (teacher qualification, and teaching experience), teaching skills (preparation, introduction, development, and assessment) and students' performance in physics?

2. What are the fit indices of the model? What are the fit indices of the hypothesised model for teacher factors (teacher qualification, and teaching experience), teaching skills (preparation, introduction, development, and assessment) and students' performance in physics?
3. Is the model which describes the causal effects among the teacher characteristics (qualification and teaching experience), teaching skills (preparation, introduction, development, and assessment), and students' performance in Physics consistent with the observed model?
4. If the model is consistent, what are the estimated direct, indirect, and total effects among the variables?

Methodology

No factors were modified in this study, which used a correlational research method. Physics students in senior secondary school (SSS II) and their teachers in Ogun and Oyo States in Nigeria made up the population. Using a simple random sampling technique, twenty schools were chosen from each state, resulting in a total of forty senior secondary schools with a total of 1560 students and forty Physics teachers. In this investigation, the researcher used and created two instruments. TSIOS (r = 0.78) and PAT (r = 0.88) are the Teacher-Students Interaction Observation Schedule and Physics Performance Test, respectively. The TSIOS included two sections. Section A had five items on teacher's gender, teacher's qualifications, class observed, time lesson started, and time lesson stopped, and Section B had five items on teacher gender, teacher qualification, class observed, time lesson started, and time lesson stopped. Section B had 20 questions covering four aspects of the teaching-learning process: preparation, introduction, development, and assessment. Section B measured teacher qualification as NCE = 1; HND = 2, B.Sc. (Physics and Education) = 3; Master Degree in Physics = 4; PhD (Physics and Education) = 5 and scored as Poor = 1, Fair = 2, Good = 3; Very Good = 4 and Excellent = 5. PAT was used to assess students' intellectual ability in seven senior secondary school physics areas. A total of 40 items were used, each with a four-point response structure. Using the table of specifications, the test items were created based on the first three domains of cognition (knowledge, comprehension, and application).

Data collection and analysis

During the normal teaching periods at each school, forty physics teachers were monitored for ten lessons. This was done to avoid any disruptions to educational programmes. Two research assistants were used to observe and code teachers' actions according to the TSIOS guidelines. Each class was 40 minutes long. Scot's

Pi was used to determine the inter-rater reliability of the coding, which ranged from 0.81 to 0.86. To establish the association and test the hypothesized model among the variables, data was analyzed by the assistance of SPSS Pearson Product Moment Correlation and AMOS 23.

Results

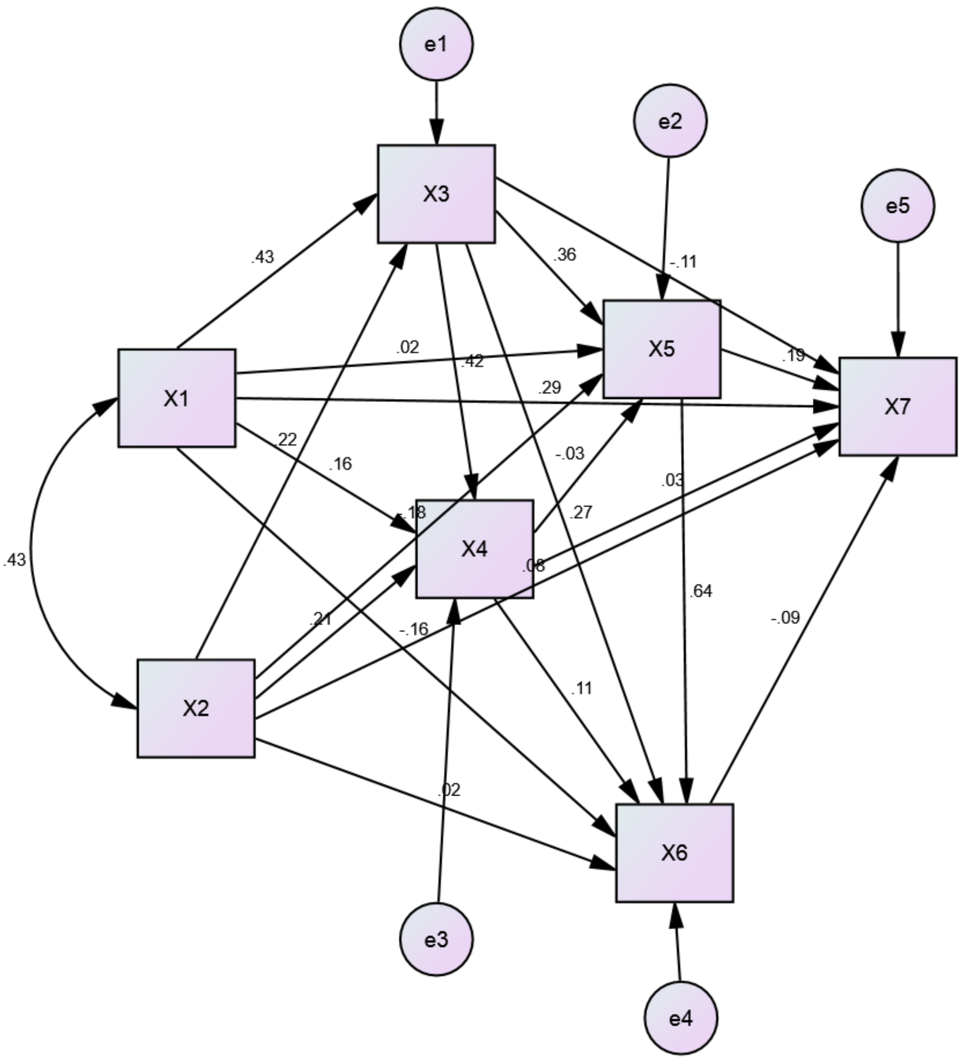

Figure. 2: *Structural Model of the Antecedents, Mediators and the Criterion Variables*

Key: X_1 = Teacher Qualification; X_2 = Teaching Experience; X_3 = Lesson Preparation; X_4 = Lesson Introduction; X_5 = Lesson Development; X_5 = Teaching Assessment; X_7 = Students Performance in Physics.

Research question 1: What is the pattern of correlation among variables of teacher characteristics (teacher qualifications, and teaching experience), teaching skills (preparation, introduction, development, and assessment), and students' performance in physics? Data analysis employed a matrix of Pearson product-moment correlation coefficients, presented in Table 1 among the teacher qualification, teaching experience, skills (preparation, introduction, development, and assessment) and performance in physics (criterion) scores were calculated.

Table 1**:** *Correlation Matrix and Descriptive Statistics of the Variables*

Variables	**QLFT**	**EXPC**	**PREP**	**INTR**	**DEVT**	**EVAT**	**PHAT**
Qualification (QLFT)	1.00						
Experience (EXPC)	0.43*	1.00					
Preparation (PREP)	0.43*	0.22*	1.00				
Introduction (INTR)	0.16*	0.20*	0.42*	1.00			
Development(DEVT)	0.02	-0.17*	0.36*	-0.02	1.00		
Assessment (EVAT)	-0.16*	0.01	0.26*	0.10*	0.64*	1.00	
Physics Performance (PHAT)	0.29*	0.07*	-0.11*	0.03	0.19*	-0.08*	1.00
N	**1560**	**1560**	**1560**	**1560**	**1560**	**1560**	**1560**
Mean	2.69	2.78	13.46	14.16	36.86	19.08	32.65
Stan. Dev.	1.22	1.24	1.75	1.89	6.20	3.28	3.71

* Reported correlation is significant at, $p < 0.05$

Table 1 shows that the bivariate relationship between students' performance in physics and each of the predictors was low, except for teacher qualification (0.29; p<.05). The correlation coefficient between qualification, teaching experience, and lesson preparation (0.43; p<.05) was high. However, the table shows very good relationships between teaching experience, lesson preparation (0.22; p<.05) and introduction of the lesson (0.20; p<.05). Similarly, it show good relationship between the teaching skills – preparation and introduction (0.42; p<.05); lesson development (0.36; p<.05), and lesson assessment (0.26; p<.05). The table also shows the perfect relationship between lesson development and lesson assessment. These relationships explain that teacher characteristics such as qualification and experience are related to his/her teaching skills. For example the higher the qualification of the teacher, the better he or she is in lesson preparation, introduction and development of the lesson. In the same vein, the more experienced the physics teacher is, the better the teacher is in the teaching of physics.

Research question 2: What are the fit indices of the hypothesised model for teacher factors (teacher qualification, and teaching experience), teaching skills (preparation, Introduction, development, and assessment), and students' performance in physics? Data for this question was analysed using path analysis. The results are presented in Table 2.

Table 2**:** *Annotated Fit Summary for the 'Just' – Identified Model*

	Fit Summary
Chi-Square	.00
Chi-Square DF	0
AGFI	1.00
NFI	1.00
CFI	1.00
RMSEA	.32
SRMR	.00
CMIN	.00

Table 2 several fit indices are computed for the model. For example, the model fit chi-square is 0 and the corresponding degrees of freedom is also 0. This indicates that the model is 'just' identified. The Adjusted Goodness of Fit Index (AGFI) is 1.00; the Normed Fit Index (NFI) is 1.00, and the Comparative Fit Index (CFI) is 1.00. All these are perfect fits that reflect a good model fit. The Standardised Root Mean Square Error (SRMR) is .00, which indicates a very good fit. However, the Root-Mean-Square Error of approximation (RMSEA) is .38 which is too large to be an acceptable model for the data. All values of these indices fall within the suggested guidelines as indicative of overall satisfactory model fit (Browne & Cudeck, 1993, Hu & Bentler, 1999; Steiger & Lind, 1980). The structural equation modelling and the standardised estimates of the path coefficients of the effects of teacher qualification, teacher teaching experience, preparation, introduction, development, and assessment on students' performance in physics are presented in Figure 2.

Model testing

The hypothesised path model of Figure 1 was fitted to a covariance matrix constructed from the correlations and standard deviations of Table 1 with AMOS 23. This entailed assessing the overall fit of the data's hypothetical structural equation model.

Research question 3: Is the model which describes the causal effects among the teacher characteristics (qualification and teaching experience), teaching skills (preparation, introduction, development, and assessment), and students' performance in Physics consistent with the observed mode? Data for this question was analysed using path analysis. The results are presented in Table 3.

Table 3: *Significant Paths of the Hypothesized Model*

Paths	Path Coefficient	Significance	Decision
Preparation <--- Qualification	0.43*	S	Retain
Preparation <--- Experience	0.22*	S	Retain
Introduction <--- Qualification	0.16*	S	Retain
Introduction <--- Experience	0.20*	S	Retain
Introduction <--- Preparation	0.42*	S	Retain
Development <--- Qualification	0.02	NS	Deleted
Development <--- Experience	-0.17*	S	Retain
Development <--- Preparation	0.36*	S	Retain
Development <--- Introduction	-0.02	NS	Deleted
Assessment <--- Qualification	-0.16*	S	Retain
Assessment <--- Experience	0.01	NS	Deleted
Assessment <--- Preparation	0.26*	S	Retain
Assessment <--- Development	0.64*	S	Retain

Assessment	<--- Introduction	0.10*	S	Retain
Performance	<--- Qualification	0.29*	S	Retain
Performance	<--- Experience	0.07*	S	Retain
Performance	<--- Preparation	-0.11*	S	Retain
Performance	<--- Introduction	0.03	NS	Deleted
Performance	<--- Development	0.19*	S	Retain
Performance	<--- Assessment	-0.08*	S	Retain

Key: S = Significant Path, NS = Non-Significant, (*) = Significant Correlation Coefficient.

Table 3 presents the significant and non-significant paths for 20 paths that show the causal relationship among the variables (predictor and criterion). The 17 significant paths were retained and 3 non-significant causal relationships were trimmed off to arrive at a meaningful causal model to explain teacher qualification, teaching experience, lesson preparation, lesson introduction, lesson development, assessment, and students' performance in Physics. The new criteria for the significant path as recommended by Blacklock as cited in Kerlinger and Pedhazor (1973); Kline (2005); Adegoke (2012), and Ajadi (2017) was that both path coefficient and zero-order correlation must be significant at $p<.05$.

Research question 4: If the model is consistent, what are the estimated direct, indirect, and total effects among the variables? Data for this question was analysed using path analysis. The results are presented in Table 4.

Direct effects

The second phase in model testing is to examine the statistical significance of each of the hypothesised direct and indirect effects if the model has achieved an overall good fit.

Table 4: *Direct, Indirect, and Total Effect of Teacher Factors, Skills, and Physics Performance Model*

Path	Direct Effect	Indirect Effect	Total Effect
To Lesson Preparation			
Teacher Qualification (QLFT)	.43	.00	.43
Teaching Experience (EXPT)	.23	.00	.23
To Lesson Introduction			
Teacher Qualification (QLFT)	.16	.18	.34
Teaching Experience (EXPT)	.21	.09	.30
Lesson Preparation (PREP)	.42	.00	.42
To Development			
Teacher Qualification (QLFT)	.02	.26	.28
Teaching Experience (EXPT)	-.18	.03	-.15
Lesson Preparation (PREP)	.37	-.01	.36
Lesson Introduction (INTR)	-.03	.00	-.03
To Assessment			
Teacher Qualification (QLFT)	-.17	.26	.09
Teaching Experience (EXPT)	.02	.03	.05
Lesson Preparation (PREP)	.27	.27	.54
Lesson Introduction (INTR)	.11	-.02	.09
Lesson Development (DEVT)	.64	.00	.64
To Physics Performance			
Teacher Qualification (QLF)	.29	-.01	.28
Teaching Experience (EXP)	.08	-.04	.04
Lesson Preparation (PREP)	-.11	.04	-.07
Lesson Introduction (INTR)	.03	-.01	.02
Lesson Development (DEVT)	.19	-.06	.13
Lesson Assessment (EVAT)	-.09	.00	-.09
TOTAL	2.87	1.01	3.9

Table 5: *Proportion of Direct and Indirect Effect of Independent Variables on Student Performance in Physics*

Effect	Frequency	Percentage
Direct	2.89	74%
Indirect	1.01	26%
Total	3.9	100%

Table 5 shows the result that 74% of the causal effects among teacher qualification, teaching experience, lesson preparation, lesson introduction, lesson development, lesson assessment, and students' performance in physics are direct while 26% of the causal relationship among the variables in the model is indirect. This result is in line with the recommendation that variables in the model should be directly influenced by the criterion variable than for the effects to be indirect (Kerlinger & Lee, 2000).

Indirect effects

Indirect effects are estimated statistically as the product of direct effects, which comprise them (Kline, 2005). They have also been interpreted just as path coefficients. For example, the standardised indirect effect of teacher qualification on students' Physics performance is estimated as the product of the standardised coefficients for the paths as follows: (QLFT to PREP)(PREP to PHAT)+ (QLFT to PREP)(PREP to DEVT) (DEVT to PHAT) + (QLFT to EVAT)(EVAT to PHAT) + (QLFT to INTR)(INTR to DEVT)(DEVT to PHAT) + (QLFT to INTR)(INTR to PHAT) + (QLFT to INTR)(INTR to EVAT) + (QLFT to PREP)(PREP to INTRO)(INTR to PHAT) + (QLFT to PREP)(PREP to INTRO)(INTR to DEVT) (DEVT to EVAT)(EVAT to PHAT)+ (QLFT to PREP)(PREP to DEVT)(DEVT to EVAT)(EVAT to PHAT). In numerical terms, this equals (-0.0473) + (0.029412) + (-0.0304) + (-0.000608) + (0.0048) + (0.016) + (0.005418) + (-0.0001849344) + (-0.00792576) = -0.0307886944 (Approximately -0.03). Similarly, an indirect effect of teaching experience on students' Physics performance is approximately -0.35. Others were calculated using the same method. However, note that the path from Teacher Qualification (TQ) to Teaching Experience (TE) was **not** analysed because they were the exogenous variables in the model.

Discussion

An essential goal of this study was to develop a causal model that could explain the hypothesis that the effect of teacher qualification and experience on students' performance in physics would be mediated by teaching skills in the classroom. The findings of this study show that although there were significant relationships among teacher qualification, teaching experience, skills in lesson preparation and development, the mediating effects of teachers' skills in lesson preparation, and introduction on students' performance in physics were strong. The most influential factors in this study were teacher qualification and teaching experience. This finding is consistent with other research findings such as Mayer, Mullens, and Moore (2000), Adeyemi (2008) and Allen (2010). According to Mayer, Mullens, and Moore (2000), the most important factor in improving students' performance is having a well-qualified teacher in every classroom. Mayer, Mullens, and Moore (2000) found that good teaching is enhanced when teachers teach in the field in which they are trained and have more than a few years of experience. It was also reported that positive relationship between students' performance in Physics and teachers' Physics teaching experience and mastery of subject matter are crucial.

According to Adeyemi, students taught by more experienced teachers tend to achieve at a higher level than their colleagues taught by inexperienced teachers. This is because experienced teachers have mastered the content of the subject matter and have acquired classroom skills to deal with different types of classroom problems. Adeyemi further explained that experienced teachers can concentrate more on the most appropriate ways to teach particular topics to students of different learning abilities and psychological orientations. Supporting these findings, Allen (2010) reported that inexperienced teachers typically express concern about lacking effective means of organising the classroom and handling significant disruptive behaviour of students. The overwhelming evidence currently available in the literature such as Goldhaber and Brewer (2000), Oladokun (2010), Akinsolu, 2010) suggests that inexperienced teachers are less effective than the more senior teachers. For example, Oladokun reported that students taught by experienced teachers performed significantly better than those taught by less experienced teachers in science process skill acquisition. Similarly, Akinsolu (2010) found out that teachers who have spent more time studying and teaching are more effective overall and they develop higher thinking skills for meeting the needs of diverse students and, hence, increasing their performance.

Recommendations

The following recommendations are made based on the study findings:

i. Quality teaching abilities, particularly in lesson development, lesson organization, and teaching assessment, should be possessed by all secondary school physics teachers to improve students' academic progress in physics.

ii. For efficient teaching and learning in the classroom, practising physics teachers with NCE, HND, and/or B. Sc. should participate in in-service training programmes such as seminars and the Post Graduate Diploma Course in Education (PGDE).

iii. The government ought to provide incentives and worthwhile science allowances to instructors, particularly physics teachers.

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