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Teachers' Pedagogical Skills as Predictor of Students' Academic Achievement in Senior Secondary School Chemistry in Adamawa State, Nigeria

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ABSTRACT

This research looked at the link between instructors' pedagogical qualities and students' academic achievement in Chemistry at senior secondary schools in Adamawa State, Nigeria. The study addressed particular topics and assessed hypotheses using a 0.05 significance level. Using a correlational design, the research included 35,525 SS II students and 834 Chemistry professors, with 420 individuals chosen by multistage selection. Data were gathered using the Teachers' Pedagogical Skills Questionnaire (TPQ), which was derived from Ozdemir's work, as well as a student proforma. Experts in Physical Sciences Education validated the instrument, which demonstrated high reliability (Cronbach's alpha = 0.86). The findings suggested that Chemistry professors had a moderate degree of pedagogical abilities, which had a substantial impact on students' academic progress. Furthermore, instructors' topic knowledge and instructional skills were significant determinants of student performance. Statistical study, including correlational approaches, confirmed these findings. The research emphasised how instructors' skills and instructional strategies affect student achievement. To improve learning results, school administrators should maximise teachers' potential by supporting professional development activities. Strengthening pedagogical abilities and topic understanding may result in a more effective learning environment for Chemistry students. This study emphasises the critical role that teachers play in student accomplishment and the necessity for continued investment in teacher training and development within Nigeria's educational system.

Keywords: Teachers, Chemistry, Education, Schools, Pedagogical skills.

INTRODUCTION

Education and its benefits can never be over emphasized as the root of economic, industrial, political, scientific and technological, and even religious development. All aspects of development are centered on education. Education is one of the vital instruments for development in any nation. Every educational system at every level depends heavily on teachers for the execution of its programmes. Teachers are highly essential for successful operation of the educational system and important tools for the educational development. Teachers at all levels of education play the decisive role in pivoting the growth and the direction of education [1]. In fact, teacher is the most important in the educational machine and that teachers are highly instrumental to the success of any educational programme embarked upon by any government. This is because apart from being at the implementation level of any educational policy, the realization of these programmes also depends greatly on teacher's dedication and commitment to their work [2]. [3], describes a good teacher in the following way: in the classroom of a good teacher, students are visible, engaged, attentive and participating. In good teaching, students are responsible for their learning; they are accountable for their understanding. Good teaching is passionate, and it induces an emotional response in students, it starts with inducing habits of mind, but doesn't stop there. A teacher to be able to teach effectively and efficiently is predicated on not

only knowledge of subject matter, it is also necessary to have a wide repertoire of pedagogical skills. Pedagogy or what is commonly referred to as teacher's technical skills is what distinguishes professional teachers from nonprofessionals. In our today's educational practice, pedagogical skills appear to be a rare and scarce commodity even among professionally trained teachers [4]. [4], argued that with the rise of professional teachers rather than the tradition of practitioners who apprenticed students, notably with the sophist in classical Greece, the distinction between the practice of a discipline and the teaching of the discipline gave rise to the notion of skills and knowledge independent of the discipline and particular to teaching. Hence, [4], define pedagogical skills as "consisting primarily of knowledge about classroom, assessment, and methods for the motivation of students, personal knowledge about particular students and their families, socio-interactional skills. From this, we can infer that not everyone in the classroom today possesses the needed pedagogical skills to influence student learning and by extension, their academic performance.

Teachers pedagogical skills enable classroom teachers to have a good and thorough understanding of the subject they teach and appreciate how the knowledge gained overtime in their subject areas can be created, organized and linked to other areas of knowledge [4]. Also, pedagogical skills make teachers to be aware of the preconceptions and background knowledge that students typically bring to each subject and of strategies and instructional materials that be of assistance in addition to understanding and solving the possible difficulties likely to arise in the classroom and modify their practice accordingly [4]. Also the elements are needs assessment, professional growth, classroom culture, strategy, resource management, problem-solving, and orchestration. In summary, though there seems to be more theoretical research on pedagogy but little empirical evidence linking teacher's pedagogical skills to students' performance is available. However, the findings of [4], confirmed that there is a positive relationship between teacher's technical expertise and students' performance. One other characteristic of teacher's competencies to consider when assigning teaching duties is teaching experience. Mastery of subject matter is another variable that one might think could be related to teacher competency. While there is some support for this assumption, the findings are not as strong and consistent as one might suppose. [5], study teacher's scores on the subject matter tests of the National Teacher Examination (NTE) have found no consistent relationship between this measure of subject matter knowledge and teacher performance as measured by student outcome or supervisory ratings. [6], is of the opinion that effective teaching is more of experience than training. Therefore, subject matter knowledge is not the key to successful teaching. [6], concluded that there is no correlation between subject content knowledge and academic achievement. Although, subject matter knowledge is only one component of teachers competence. Nevertheless, it is a crucially important component and so necessary to investigate the relationship between teachers subject matter knowledge and senior secondary students' academic achievement in Chemistry. It is to be noted that the influence of teacher's subject matter knowledge on students' academic achievement is not direct. Rather, it is mediated by the techniques employ in teaching the students. The science of teaching is technically termed Pedagogy is an accurate characterization of the field of study that deals with the theory and practice of teaching. Pedagogy is concerned with understanding how learning takes place and developing effective teaching strategies that can facilitate that learning process. The term is often used in the context of formal education and can refer to teaching at all levels, from early childhood education to postgraduate studies. The science of teaching is technically termed Pedagogy [7]. A teacher to be able to teach effectively and efficiently is predicated on not only knowledge of subject matter, it is also necessary to have a wide repertoire of pedagogical skills. The existing body of research lacks substantial investigation into the impact of teachers' pedagogic skills on the issue of subpar academic performance among Chemistry students in Adamawa state. This study is positioned to bridge this research gap by examining how teachers' pedagogic skills function as a predictive factor for students' academic achievement in Chemistry at the senior secondary school level in Adamawa State, Nigeria.

Statement of the problem

The poor academic achievements of students in both internal and external examinations constitute a subject of discourse among educational stakeholders especially Chemistry subject. Chemistry is one of the examinable subjects offered by senior secondary school students in Adamawa State. It enables students to explore and understand the relationship between the dilution of chemistry and its people through the study of reaction and environment. In recent times, a negative trend in the academic achievement of students in Chemistry was observed in the study area. This observation was in tandem with the WAEC Chief Examiners' reports as contained in the works of [8] and [9] which indicated a fluctuating trend in the academic achievement of students in the subject. This further settled with the submission of [10], which stated that the academic

achievement of candidates at the SSCE conducted by both WAEC and NECO had constantly declined. Several factors have been advanced to justify the reasons for the underachievement of students in Chemistry. One of the probable factors identified was teacher's pedagogical skills and subject mastery. The teachers teaching Chemistry as a subject in various senior secondary schools in Adamawa State would probably be among the said over 49 per cent unqualified teachers. If this is true, it will negatively impact on students' academic achievement in Chemistry. The efforts by past Adamawa state government to recruit teachers into public secondary schools have brought numbers of teachers into schools but the recent poor performance of students in the subject like Chemistry subject makes one to debate on what next after having Chemistry teachers to make students perform. This emphasizes the need to not only have Chemistry teachers who are subject specialist but those who can also deliver content effectively to enhance students' understanding and improve academic achievement. This imbalance could be the reason for teachers following the methodology in the teachers' guide without any change or adaptation, as they have little pedagogical or methodological foundation and subject mastery on which to draw. This study investigated the teacher pedagogical skills as predictor of students' academic achievement in Chemistry in Adamawa State, Nigeria.

Purpose of the study

The purpose of this study was to investigate Teachers pedagogical skills as predictor of chemistry students' academic achievement in senior secondary school of Adamawa State, Nigeria. The specific objective of the study is to determine whether: Teachers' pedagogical skills predict students' academic achievement in Chemistry.

Research Question

The following research question were raised to guide this study:

1. What is the level of Chemistry teacher's pedagogical skills in senior secondary schools of Adamawa state?
2. What is the level of Chemistry teacher's subject mastery in senior secondary schools of Adamawa state?

Hypotheses

The following null hypotheses formulated were tested in the study.

1. Teacher's pedagogical skill does not significantly predict students' academic achievement in Chemistry.
2. Teachers' mastery of subject mastery does not significantly predict students' academic achievement in Chemistry.

Research method and materials

This chapter describes the methods employed in conducting this study under the following subheadings: area of the study, population of the study, sample and sampling techniques. Similarly, the instruments for data collection, validation and reliability of the instruments, procedure for data collection and method of data analysis were also discussed.

Research Design

The design for this study was correlational research design. This type of design seeks to establish what relationship exists between two or more variables. Rather than direct cause-effect relationships, correlational survey designs are typically cross-sectional [11]. This design is used to examine if changes in one or more variable are related to changes in another variable(s), which is referred to as co-variance. Correlations analyze direction, degree, magnitude, and strength of the relationships or associations [11]. To buttress this submission, [12], argued that a correlational survey research design involves collecting data to determine whether and to what extent (degree) a relationship exists between two or more variables. [12], added that the purpose of correlational survey research is often to detect the existence of a relationship between or among variables, which suggests a possible base for causality. Specifically, the predictive correlational survey design type was used in the current study. According to [13], predictive correlational studies predict the variance of one or more variables based on the variance of another variable(s). The authors added that the study variables are classified as independent (predictor) and dependent (outcome). In this study, the outcome variables-students' academic performance in Chemistry, with the predictor variable (teacher competency variables) to determine both their joint and relative predictive values. The teacher competency variables in this study serving as predictors of students' academic performance include: qualification, subject mastery, experience and pedagogical content knowledge.

Population of the Study

Population of the study consisted of 35,525 SS II students offering chemistry and 834 Chemistry teachers in senior secondary schools in Adamawa state (Adamawa State Post Primary Schools Management Board, 2019).

Instruments for Data Collection

One instrument called Teachers pedagogical skill Questionnaire (TPQ) was adapted from [14]. The TPQ was used to elicit information on teacher pedagogical skill variables. The TPQ consists of two sections (Sections A and B). Section A sought for background information of Chemistry teachers such as pedagogical skills while Section B, consist of 40 items that elicits responses on Chemistry teachers' mastery of subject matter. Both sections A and B was a modified five-point Likert scale response type of Very High Level (VHL): 5; High Level (HL): 4; Moderate Level (ML): 3; Low Level (LL): 2; and Very Low Level (VLL): 1. All the negatively coded options were reversed before conducting the analysis. Also, to determine the academic performance of Chemistry students in Adamawa state senior secondary schools; a pro-forma of the 2019/2020 session of Chemistry results were obtained from the examination officers of the selected schools.

Validation of the Instruments

Content validity was used for the instrument; the instrument for data collection (TPQ) was subjected to thorough scrutiny and vetting by four experts in different fields in the Department of Physical Science Education, Modibbo Adama University, Yola. In the content validation which is critical, the subject matter experts were asked to evaluate whether the questionnaires items assessed defined contents. Here, the experts also scrutinized each item in the instrument, ensuring that it measures the intended outcomes of the study. The experts also looked at the contents of the instruments simultaneously with the topic, purpose, objectives, research questions and hypotheses, ensuring that they are in tandem with one another. All necessary criticisms and corrections proffered by the validators guided the production of the final draft of the instruments.

Reliability of the Instruments

To establish the internal consistency of the instrument for this study (TPQ), trial test was conducted by engaging 20 Chemistry teachers in public senior secondary schools. The schools, teachers selected for the trial tests were not part of the sample for this study. The reliability coefficient of the TPQ was established using Cronbach alpha statistic and the reliability coefficient of 0.714 was obtained as in Appendix C. This is because Cronbach alpha is best suited in analyzing data that have options with no correct answer; as it was with the TPQ.

Method of Data Analysis

Data were analyzed using descriptive and inferential statistics. Hence, descriptive statistics of mean and standard deviation were used to answer research questions. The remark for the research questions of the TPQ are: Very High Level (VHL) with 4.5-5.00 real limit; High Level (HL) with 3.50-4.49 real limits; Moderate Level (ML) with 2.50-3.49 real limit; Low Level (LL) with 1.50-2.49 real limit; and Very Low Level (VLL) with 0.50-1.49 real limit. However, for the hypotheses, the simple linear regression statistic was employed to test null hypotheses one and two ($H0_1$ - $H0_2$), while multiple regression statistic was used for testing hypothesis. All analysis was done using IBM Statistical Product and Service Solution (SPSS) version 23, and the probability value of $p < 0.05$ is considered statistically significant. The decision rule for testing the null hypotheses was to reject null hypotheses when $p < 0.05$ or otherwise not to reject when $p > 0.05$.

RESULTS

Data collected were analyzed using descriptive statistics and inferential statistics. Mean and standard deviation were used to answer the research questions while regression analysis was used to test the null hypotheses at 0.05 level of significance.

Discussion of the Findings

Research questions were raised and answered in this study. The research questions sought to establish the background data for the independent and dependent variables used for testing the hypotheses. Descriptive statistics of mean and standard deviation were used to answer the research questions.

Research Question one: What is the level of Chemistry teachers pedagogical skills in senior secondary schools of Adamawa state?

Table 1b: Summary of Descriptive Statistics of Mean and Standard Deviations of Teachers Pedagogical Skills

S/N	ITEM n = 24	Mean	St.d	Remark
1.	Understanding of the fundamental concepts of Chemistry and how to effectively teach them	4.21	1.062	HL
2.	Knowledge of how to design and implement effective laboratory experiments	3.96	1.122	HL
3.	Understanding of safety procedures and protocols for working with chemicals in the classroom	4.17	.917	HL
4.	Ability to effectively use technology and multimedia resources to enhance instruction	4.21	.779	HL
5.	Knowledge of how to differentiate instruction to meet the needs of diverse learners	4.17	.761	HL
6.	Understanding of how to integrate real-world examples and applications into Chemistry instruction	3.63	.711	HL
7.	Knowledge of effective assessment strategies for Chemistry learning objectives	4.29	.859	HL
8.	Ability to effectively communicate and explain complex Chemistry concepts to students	4.54	.588	VHL
9.	Understanding of how to address and correct student misconceptions in Chemistry	4.25	.676	HL
10	Knowledge of strategies for promoting student engagement and motivation in Chemistry.	3.96	.806	HL
	Average Mean	**4.14**		**HL**

Table 1a displays the teachers' pedagogical skills in senior secondary schools of Adamawa state. Descriptive statistics of mean and standard deviation was used to answer this research question. Real limits of numbers were used for the remark. Out of the 10 items stated, items 1,2,3,4,5,6,7,9 and 10 demonstrated high level of teachers pedagogical skills in senior secondary school, while item 8 demonstrated very high level of teachers pedagogical skills. With a grand mean of 4.14, it could be inferred that Chemistry teachers demonstrated high level of teachers pedagogical skills in the teaching of Chemistry.

Table 1b: Model Summary of Regression Analysis between Teachers Pedagogical Skill and Students' Academic Achievement in Chemistry

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.417[a]	.174	.136	.65251

a. Predictors: (Constant), Pedagogical skills

Table 1b shows the model summary between teacher's pedagogical skill and students' academic achievement in Chemistry. The result summarized in the table shows an R value of 0.417, R^2 value 0.174 and adjusted R^2 value of 0.136. This implies that only 17.4% of the total variance in students' academic achievement in Chemistry can be accounted for by teachers' pedagogical skill.

Table 1c: Summary of Regression Coefficients between Teachers Pedagogical Skill and Students' Academic Achievement in Chemistry

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	P-Value
1	Constant	1.324	.868		1.526	.141
	Pedagogical Skill	.465	.216	.417	2.149	.043

a. Dependent Variable: academic achievement in chemistry

The relative contribution of teachers' pedagogical skill to the observed variance in the students' academic achievement in Chemistry is indicated by the R and R^2 values. The result in Table 1c further emphasizes the results in the preceding tables which shows that teachers' pedagogical skill significantly predict students' academic achievement in Chemistry ($\beta = 0.417$, $t = 2.149$, $p < 0.05$). Hence, the null hypothesis of no significant prediction is hereby rejected.

Research Question Two: What is the level of Chemistry teachers' subject mastery of matter in senior secondary schools of Adamawa state?

Table 2: Summary of Descriptive Statistics of Mean and Standard Deviations of Teachers Mastery of Subject Matter

S/N	ITEM n = 24	Mean	S. D	Remark
1	Adapt teaching strategies to suit different learners.	4.17	.917	HL
2	Assess students' learning while delivering lesson	3.67	1.049	HL
3	Construct questions that are valid	3.79	1.215	HL
4	Give students take home assignment	4.17	.816	HL
5	Connect new concept with previous experiences	4.21	.658	HL
6	Demonstrates breadth and depth of subject matter mastery	3.92	1.283	HL
7	Offer explanation of concepts in variety of ways	3.87	1.361	HL
8	Relate contents in Chemistry with real life situations	3.88	.992	HL
9	Connect theoretical knowledge with practical	4.04	.859	HL
10	Maximize the quantity of instructional time	4.17	1.049	
	Average Mean	**3.99**		

Table 2 displays the Chemistry teachers' mastery of subject matter in senior secondary schools of Adamawa state. Real limits of numbers were used for the remark. Out of the 10 items stated, Chemistry teachers demonstrated high level of mastery of matter in items. With a grand mean of 3.99, it could be inferred that Chemistry teachers demonstrated high level of mastery of matter in the teaching of Chemistry.

Table 2a: Regression of Teachers Mastery of Subject Matter and Students' Academic Achievement in Chemistry

Model		Sum of Squares	Df	Mean Square	F	P-Value
1	Regression	1.933	1	1.933	4.523	.045[b]
	Residual	9.401	22	.427		
	Total	11.333	23			

a. Dependent Variable: academic achievement in chemistry

b. Predictors: (Constant), mastery of subject matter

Table 2a show how well the regression equation fits the data; the table indicates that the regression model predict the dependent variable significantly. This implies that teachers mastery of subject matter significantly predict students' academic achievement in Chemistry ($F(1, 23) = 4.523$, $p < 0.05$). This affirms that the regression model is a good fit for the data.

Table 2b: Model Summary of Regression Analysis between Teachers Mastery of Subject Matter and Students' Academic Achievement in Chemistry

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.413[a]	.171	.133	.654

a. Predictors: (Constant), mastery of subject matter

Table 2b shows the model summary between teachers' mastery of subject matter and students' academic achievement in Chemistry. The result summarized in the table shows an R value of 0.413, R^2 value 0.171 and adjusted R^2 value

of 0.133. This implies that only 17.1% of the total variance in students' academic achievement in Chemistry can be accounted for by teachers' mastery of matter.

Table 2c: Summary of Regression Coefficients between Teachers Mastery of Subject Matter and Students' Academic Achievement in Chemistry

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	Constant	1.353	.863		1.568	.131
	Subject Mastery	.455	.214	.413	2.127	.045

a. Dependent Variable: academic achievement in chemistry

The relative contribution of teachers mastery of matter to the observed variance in the criterion variable (students' academic achievement in Chemistry) is indicated by the R and R^2 values. The result in Table 6c further emphasizes the results in the preceding tables which shows that teachers mastery of matter significantly predict students' academic achievement in Chemistry ($\beta = 0.413$, $t = 2.127$, $p < 0.05$). Hence, the null hypothesis of no significant prediction is hereby rejected. The summary of frequency counts and percentages of levels of students' academic achievement in Chemistry depicts that 152 of the 396 students representing 39.0% had A grade (70-100) in Chemistry. Students whose scores fell between the ranges of 60-69 (B) were 52 representing 13.0%. C (50-59) and D grades (40-49) had 57 students each representing 14.2%. Students with F grade (0-44) are 78 representing 19.5%. This result placed the students with A grade in Chemistry at the highest level, tailed by those with F grade, then C and D grades, and lastly, those with B grade. This shows that a large chunk of the students performed better in Chemistry. The scores assigned to the 400 students that fell in any of the five levels were further used to test the hypotheses.

Findings of the Study

The major findings of the study are as follows:

1. Teachers pedagogical skills significantly predict students' academic achievement in Chemistry ($F(1, 23) = 4.619$, $p < 0.05$).
2. Teachers mastery of matter significantly predict students' academic achievement in Chemistry ($F(1, 23) = 4.523$, $p < 0.05$).

CONCLUSION

The study revealed that teachers' pedagogical skills and mastery of subject matter significantly predict students' academic performance in Chemistry.

RECOMMENDATIONS

Despite the shortcoming associated with the teacher, his pedagogical and subject mastery, the situation is not irredeemable. The teachers can still be helped to reach his or her full potential if appropriate steps are taken by the authorities concerned. It is based on this premise that the following recommendations were made.

1. Educational stakeholders should design and mount programme that considers the teaching pedagogical as a tool that can enhance students' academic performance in Chemistry.
2. Government should organize periodic conferences, seminars and workshops to enable teachers update themselves on knowledge of subject mastery and development of teacher characteristics that engender good teacher interpersonal relationships with students.
3. Teachers Pedagogical had been shown to predict students' academic performance in Chemistry. Therefore, the Government should emphasize training and re-training of teachers in her programmes to keep teachers abreast with modern teaching methodologies to enhance students' academic performance in Chemistry.
4. It was recommended among others that principals should ensure that the potentials of the teachers are well harnessed and utilized to reflect the true picture of their quality in the academic performance of students.

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