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Teachers' Pedagogical Content Knowledge, Self-Efficacy, and Students' Learning Outcomes in Junior Secondary School Basic Science in Southwestern Nigeria

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Abstract

The study examined the joint influence of teachers' pedagogical content knowledge (PCK) and self-efficacy on students' learning outcomes in Junior Secondary School Basic Science in Southwestern Nigeria. The aim was to provide empirical evidence on the role of effective PCK and self-efficacy in improving students' academic achievement and attitudes in Basic Science. A descriptive survey research design was adopted. The study population comprised 1,642 Basic Science teachers and 158,679 Junior Secondary School II (JSS 2) students in Southwestern Nigeria. A multistage sampling procedure yielded 27 Basic Science teachers and 850 JSS 2 students across three states. Four instruments were used: Basic Science Teachers' Pedagogical Content Knowledge Rating Scale (BSTPECKRS), Basic Science Teachers' Self-Efficacy Rating Scale (BSTSERS), Basic Science Achievement Test (BSAT), and Students' Attitude to Basic Science Questionnaire (SABSQ). Data were analyzed using descriptive and inferential statistics.

Findings revealed that teachers had a moderate level of PCK ($\bar{x}$ = 147.85, SD = 12.98, 82.1% of maximum score). Results further showed a significant joint influence of teachers' PCK and self-efficacy on students' academic achievement in Basic Science ($F(2, 847) = 109.032$; $p < 0.05$) and on students' attitude towards Basic Science ($F(2, 847) = 10.076$; $p < 0.05$).

The study concluded that Basic Science teachers in Southwestern Nigeria possess substantial PCK and self-efficacy, which significantly and positively influence students' attitudes and academic achievement.

Keywords: Pedagogical Content Knowledge, Self-Efficacy, Achievement, Attitude, Influence, and Learning Outcomes

1. Introduction

Education is the foundation for significant and long-lasting progress in disciplines like the arts, sciences, and technology. It is seen as a methodical and ongoing education that seeks to convey the integration of skills, information, and deep understanding that can be applied to every facet of life. The Federal Republic of Nigeria (2004) [14] said in the National Policy on Education that education is a vital instrument for change; a revolution in education must be paved for society to undergo significant and important intellectual and social transformations. Citizens must become more scientifically knowledgeable to compete globally as the world has become increasingly science-driven. The advancement and development of nearly every country worldwide may be attributed significantly to science and technology (National Science Foundation, 2010) [28].

Science is commonly recognized as exploring information about the material and natural world. The term 'science', derived from the Latin "Scientia", signifying 'knowledge' or 'the act of knowing', emphasizes facts and how knowledge is procured. Science is an organized knowledge acquired through investigation and experimentation (Nworgu, 2009) [29]. Science education, therefore, emphasizes teaching concepts, improving methodologies, and rectifying students' misconceptions about scientific principles (Aina, 2013) [3]. Science education disseminates science content and methods to individuals without a science background. Fundamental science education's objective is to elevate scientific literacy, cultivating students' inquisitiveness in science and technology (Agboola & Oloyede, 2013) [2]. Recent trends in science education emphasize students' active engagement, hands-on learning, and deep comprehension rather than rote memorization (Owolabi, 2007) [32]. Basic Science, formerly Integrated Science, is the foundation for higher-level scientific studies. It represents students' first formal introduction

to science at the junior secondary school level and plays a central role in preparing them for further education (Kim, 2008) [19]. It integrates traditionally separate scientific disciplines, providing students with a holistic understanding of scientific inquiry. Effective Basic Science teaching requires student-centered engagement that bridges prior knowledge with new ideas, laying a strong foundation for future scientific learning.

In Nigeria, however, students' achievement in Basic Science has not been encouraging despite its importance for national development. Challenges include teachers' lack of science process skills (Oyagbile & Bello, 2018) [33], inadequate laboratory equipment (Bello, 2012) [8], and reliance on poor teaching strategies (Agboola & Olajide, 2015) [1]. Teaching science is a complex cognitive task that requires teachers to draw on knowledge from multiple domains, and the effectiveness of instruction largely depends on the teacher's pedagogical approach (Hiebert, 2003) [16].

Pedagogical content knowledge (PCK) means understanding the basic principles guiding instruction and classroom management. It is an essential aspect of a teacher's expertise in effectively imparting subject matter (Koh *et al*. 2010) [22]. PCK is the insights or knowledge the teachers acquire through experience, and it pertains to the methods employed in delivering specific subject matter to enhance students' comprehension (Koehler, 2011) [21]. The pedagogical content knowledge possessed by teachers is of paramount influence in molding students' learning and achievements (Gess-Newsome, 2013) [15]. It involves identifying student misconceptions, selecting age-appropriate concepts, and applying contextual knowledge to instruction (Gess-Newsome, 2013) [15].

The pedagogical knowledge foundation of a teacher comprises the necessary cognitive insights to establish productive teaching and learning settings. Pedagogical knowledge (PK) was defined by Sorge *et al*. (2017) [35] and Liepertz and Borowski (2018) [26] as the integration of instructional techniques, classroom management, student learning dynamics, and evaluation of student achievements. Moreover, content knowledge (CK) means teachers' understanding of the material. Bertram and Christiansen (2012) [9] contended that content knowledge involves not only the declarative aspects, often referred to as 'knowing what,' but also the procedural aspects, denoted as 'knowing why,' within a given field of study. Teachers must not only understand scientific facts but also the principles, frameworks, and processes that shape the discipline.

Equally important is teachers' self-efficacy, which refers to their confidence in their capacity to attain the intended student results. Self-efficacy is an individual's conviction about their judgment and ability to plan the necessary actions to accomplish their objectives (Bandura, 1977) [7]. Teachers' self-efficacy significantly impacts their effectiveness, influencing their triumphs and setbacks (Jaafari *et al*. 2012) [18]. Correspondingly, Lauermann and Butler (2021) [24] articulated that teacher self-efficacy is a mediating factor that influences classroom behavior and practice, improving student achievement. Teachers with elevated self-efficacy typically persist through setbacks or use a broader variety of teaching strategies that may be more appropriate for the unique and different issues they confront in the classroom, and positively influence student achievement (Chambers & Hardy, 2005 [10]; Lauermann & Hagen, 2021) [24]. Prior research showed that teachers' content knowledge and self-efficacy significantly impact student learning outcomes and attitudes toward science (Ishola & Udofi, 2017) [17]. The extent of teachers' knowledge concerning a given subject and their ability to effectively convey that knowledge to students are crucial factors, as students' academic achievements hinge on these aspects.

Students' attitudes also play a critical role in science learning. An attitude is the entirety of a person's leaning toward an object, institution, or idea. During secondary education, students view science as disconnected from real-life relevance (Anwar & Bhutta, 2014) [5]. Fasakin (2012) [13] opined that attitude greatly influences the choice of subject. A positive attitude, however, promotes interest, persistence, and improved students' academic achievement (Fasakin, 2012 [13]; Ruiz-Jiménez, Martínez-Jiménez, Licerán-Gutiérrez, and García-Martí, 2022) [34].

Despite the extensive research on teachers' PCK and self-efficacy (SE), there is a dearth of studies corroborating the joint influence of teachers' PCK and SE on students' learning outcomes, particularly in Southwestern Nigeria. This study, therefore, investigates the joint influence of teachers' pedagogical content knowledge and self-efficacy on students' academic achievement and attitudes toward Basic Science in Junior Secondary Schools.

Statement of the Research Problem

Despite the recognized importance of teachers' pedagogical content knowledge (PCK) and self-efficacy in effective teaching, many Basic Science teachers struggle to integrate scientific understanding with appropriate instructional strategies. This gap reduces student engagement and comprehension, ultimately hindering academic achievement in junior secondary schools in Nigeria.

Pedagogical content knowledge, which blends subject matter knowledge with appropriate teaching strategies, is central to student learning. However, previous studies have largely emphasized curriculum content and resource availability rather than the interplay between teachers' professional knowledge, their confidence in teaching, and students' achievements. Existing studies have mainly examined teachers' content knowledge (Ball *et al*. 2008 [6]; Kleickmann, *et al*. 2013) [20] with limited attention to PCK or self-efficacy in Basic Science.

There is also insufficient evidence on how teachers' PCK and self-efficacy jointly influence students' learning outcomes in Basic Science, particularly in Southwestern Nigeria. Therefore, this research aims to empirically investigate the influence of teachers' pedagogical content knowledge and self-efficacy on students' learning outcomes in Basic Science in junior secondary schools.

The specific objectives of the study are to:

a. determine the level of teachers' pedagogical content knowledge in junior secondary schools Basic Science in Southwestern Nigeria.
b. examine the joint influence of teachers' pedagogical content knowledge and self-efficacy on students' academic achievement in junior secondary schools Basic Science in the study area; and
c. assess the joint influence of teachers' pedagogical content knowledge and self-efficacy on students' attitude towards junior secondary schools Basic Science in the study area.

Research Question

This question was raised to guide the study:

1. What is the level of teachers' pedagogical content knowledge in junior secondary schools Basic Science in Southwestern Nigeria?

Hypotheses

The following hypotheses were formulated to guide the study;

$H_0$1: There is no significant joint influence of teachers' pedagogical content knowledge and self-efficacy on students' academic achievement in junior secondary schools Basic Science in Southwestern Nigeria.

$H_0$2: There is no significant joint influence of teachers' pedagogical content knowledge and self-efficacy on students' attitude towards junior secondary schools Basic Science in Southwestern Nigeria.

2. Research Methodology

The study employed the descriptive survey research design. The study's population consisted of all Basic Science teachers and students in junior secondary schools II (JSS 2) classes. The sample for the study included Basic Science teachers and JSS 2 students in their intact classes, selected using a multistage sampling procedure. Three states out of the six in southwestern Nigeria were selected using a simple random sampling technique. One senatorial district was chosen from each state using a simple random sampling technique. In each senatorial district, three Local Government Areas (LGAs) were selected, and from each LGAs, three junior secondary schools were randomly chosen. One Basic Science teacher and an intact JSS 2 class were selected from each school. The study sample comprised 27 Basic Science teachers and 850 JSS 2 students. Four instruments were used for data collection: Basic Science Teachers' Pedagogical Content Knowledge Rating Scale (BSTPECKRS), Basic Science Teachers' Self-Efficacy Rating Scale (BSTSERS), Basic Science Achievement Test (BSAT), and Student Attitude to Basic Science Questionnaire (SABSQ).

BSTPECKRS assessed teachers' PCK during classroom instruction. It has four sections: Section A (demographic information such as school, qualification, and sex); Section B (17 items on knowledge of Basic Science pedagogical observable traits); Section C consisted of 12 items on knowledge of Basic Science subject-matter observable traits); Section D (11 items on teachers' knowledge of students' understanding). Rating scale for each item has five different levels: Excellent (E) = 5, Very Good (VG) = 4, Good (G) = 3, Fair (F) =2, and Weak (W) = 1. BSTSERS has four sections: Section A (teachers' demographic backgrounds), Section B (25 items on teachers' self-efficacy). Rating scale for each item has four different levels: Very High (VH =4), High (H =3), Low (L =2), and Very Low (VL =1). BSAT was a researcher-developed test with two sections: Section A (bio-data of respondents) and Section B (25 multiple-choice questions covering Basic Science topics taught in the second term). Each item had four options (A–D), with one correct answer. The instruments were validated by an expert in test construction, and their suggestions were incorporated into the final draft. SABSQ measured students' attitudes. Section A included demographic information, while Section B contained 20 items rated on a 4-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). All instruments were pilot-tested with respondents outside the study area to establish reliability. Cronbach's Alpha yielded reliability coefficients of 0.94 for BSTPECKRS, 0.94 for BSTSERS, and 0.89 for SABSQ. The BSAT had a Kuder-Richardson (KR-20) reliability coefficient of 0.84. Data collected were analyzed using descriptive statistics (mean and standard deviation) to answer the research question, while linear regression analysis was used to test the two hypotheses.

3. Presentation of Results

Research question: What is the level of teachers' pedagogical content knowledge (PCK) in junior secondary schools Basic Science in Southwestern Nigeria?

Data on teachers' PCK were analysed using mean and standard deviation in SPSS Statistics. The results are presented in Tables 1.1 and 1.2

Table 1.1: Level of Teachers' Pedagogical Content Knowledge (TPCK)

Level of PCK	Score Range	Frequency	Percentage (%)
Low	124.00 - 141.00	7	25.9%
Moderate	141.01 - 158.00	15	55.6%
High	158.01 - 177.00	5	18.5%
Total		**27**	**100.0%**

Findings in Table 1.1 revealed that 25.9% of Basic Science teachers exhibited a low level of PCK, 55.6% demonstrated a moderate level, and 18.5% showed a high level. These levels were determined based on teachers' total scores across three PCK components: pedagogical knowledge (PK), content knowledge (CK), and knowledge of students' learning (KSL). Furthermore, the total mean value of teachers' PCK was $\bar{x}$ = 147.85 with a standard deviation of 12.98, based on a maximum possible score of 180. This corresponds to 82.1% of the total score, placing the overall level of teachers' PCK within the moderate range (see Table 1.2). Therefore, Basic Science teachers in Southwestern Nigeria exhibited a moderate level of pedagogical content knowledge in the teaching and learning of Basic Science.

Table 1.2: Descriptive Statistics for Teachers' Pedagogical Content Knowledge (PCK)

Component	N	Minimum	Maximum	Mean $(\bar{x})$ (SD)	Std. Deviation
PK	27	55.00	79.00	65.78	6.39
CK	27	37.00	50.00	42.63	3.90
KSL	27	27.00	52.00	39.44	5.44
Total TPCK	27	124.00	177.00	147.85	12.98

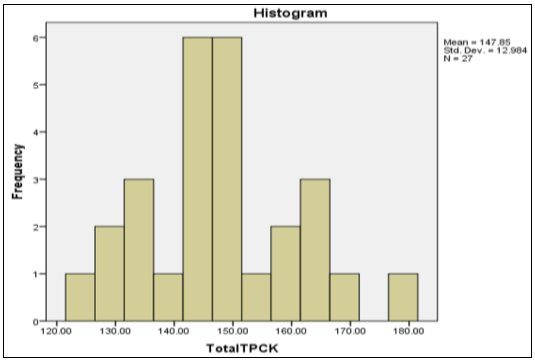

Fig 1: Histogram showing the distribution of teachers' total PCK scores (N = 27)

Hypothesis One: There is no significant joint influence of teachers' pedagogical content (TPCK) knowledge and teachers' self-efficacy (TSE) on students' academic achievement in junior secondary schools Basic Science.

Data collected on how TPCK and their self-efficacy jointly influenced students' academic achievement in JSS Basic Science were analysed using Multiple Regression Analysis to test the Hypothesis, and Table 2a displays the results.

Table 2a: Regression analysis of TPCK and self-efficacy on students' academic achievement in junior secondary schools Basic Science

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2747.570	2	1373.785	109.032	0.000[b]
Residual	10672.025	847	12.600		
Total	13419.595	849			
R = 0.452[a], **R Square** = 0.205, **Adjusted R Square** = 0.203					

(F = 109.032, p < 0.05)

a. Dependent variable: Students' Academic Achievement

b. Predictors (Constant): Teachers' Pedagogical Content Knowledge, Self-Efficacy

Results in Table 2a revealed that TPCK and TSE significantly predict the students' academic achievement in junior secondary schools Basic Science F(2, 847 = 109.032; $p < 0.05$, $R^2 = 0.205$). Therefore, the null hypothesis that TPCK and teachers' self-efficacy have no significant joint influence on students' academic achievement in junior secondary schools Basic Science, is thus not accepted. The R value of 0.452[a] represents the multiple correlation coefficient and indicates a good level of TPCK and TSE that predicts academic achievement of students in JSS Basic Science. Also, the R^2 value (coefficient of determination) of 0.205, teachers' pedagogical content knowledge and self-efficacy explain 20.5% of the variability of the students' academic achievement in junior secondary schools Basic Science.

Data collected on how teachers' pedagogical content knowledge and TSE influenced students' academic achievement in junior secondary schools Basic Science were analysed using Multiple Regression Analysis. Table 2b presents the results.

Table 2b: Coefficients table

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig
(Constant)	-8.165	1.706		-4.785	.000
Teacher Self-Efficacy	0.221	0.016	0.451	13.891	.000
TPCK	0.003	0.022	0.005	0.139	.890

a. Dependent Variable: Students' Academic Achievement

From Table 2b, the results revealed that TSE (Beta = 0.451; t = 13.891) had a more significant influence on students' academic achievement in JSS Basic Science than Teachers' Pedagogical Content Knowledge (Beta = 0.005; t = 0.139). Then, the unstandardized coefficient, β_1, for teachers' self-efficacy is equal to 0.221, and this implies that for each increase in self-efficacy value, there is an increase in students' academic achievement of 0.221. Also, β_2, for teachers' PCK is equivalent to 0.003, and this implies that for a unit rise in TPCK value, there is a growth in students' academic achievement of 0.003. In addition, both independent variables added statistically significantly to the prediction of the dependent variable, $p < 0.05$.

Hypothesis Two: There is no significant joint influence of teachers' pedagogical content knowledge and teachers' self-efficacy on students' attitude towards junior secondary schools Basic Science.

Data gathered on TPCK and TSE and students' attitude toward junior secondary schools Basic Science were put through Multiple Regression Analysis to test the hypothesis. Table.3a displays the findings.

Table 3a: Regression analysis of teachers' pedagogical content knowledge and self-efficacy on students' attitude towards junior secondary schools Basic Science

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1158.094	2	579.047	10.076	0.000[b]
Residual	48674.207	847	57.467		
Total	49832.301	849			
R = 0.152[a], R Square = 0.023, Adjusted R Square = 0.021					

(F = 10.076, p < 0.05)

a. Dependent variable: Students' Attitude

b. Predictors (Constant): Teachers' Self-Efficacy, Teachers' PCK

Results in Table 3a displayed that TPCK and teachers' self-efficacy statistically significantly predict the students' attitude towards junior secondary schools Basic Science F(2, 847 = 10.076; $p < 0.05$, $R^2 = 0.023$). Thus, the null hypothesis that there is no significant joint influence of TPCK and teachers' self-efficacy on students' attitude towards junior secondary schools Basic Science is hereby rejected. The R value of 0.152 represents the multiple correlation coefficient and indicates a good level of TPCK and teachers' self-efficacy that predicts students' attitude towards junior secondary schools Basic Science. Also, the R^2 value (coefficient of determination) of 0.023 TPCK and teachers' self-efficacy explain 2.3%of the variability of the students' attitude towards junior secondary schools Basic Science.

Multiple Regression Analysis was utilized to examine the hypothesis by analysing data on teachers' pedagogical content knowledge, their self-efficacy, and students' attitude towards junior secondary schools' Basic Science. Table 3b shows the finding.

Table 3b: Coefficients table

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig
(Constant)	77.750	3.644		21.337	.000
Teacher Self-Efficacy	-.083	0.034	-.088	-2.444	.015
TPCK	-.126	0.046	-.099	-2.746	.006

a. Dependent Variable: Students' Attitude

From Table 3b, the results revealed that Teachers' Self-Efficacy (Beta = -.088; t = -2.444) significantly influenced students' attitude towards junior secondary schools Basic Science more than Teachers' Pedagogical Content Knowledge (Beta = -.099; t = -2.746). Then, the unstandardized coefficient, β_1, for teachers' self-efficacy is equivalent to -0.083and this means that for each increase in self-efficacy value, there is a decrease in students' attitude of 0.083. Also, β_2, for TPCK, is equivalent to -0.126, implying that for a unit rise in TPCK value, there is a decrease in students' attitude of 0.126. In addition, both

independent variables added statistically significantly to the prediction of the dependent variable, $p < 0.05$.

4. Discussion of Findings

The result revealed that 25.9% of Basic Science teachers exhibited a low level of PCK, 55.6% demonstrated a moderate level, and 18.5% showed a high level of PCK. The total mean score of teachers' pedagogical content knowledge was 147.85, and the standard deviation was 12.98, based on a maximum possible score of 180, corresponding to 82.1% of the total score. These findings showed that Basic Science teachers generally possess a moderate level of pedagogical content knowledge in the teaching and learning Basic Science at the junior secondary schools in Southwestern Nigeria. This result aligns with the findings of Yusof *et al*. (2012) [38], who reported that teachers demonstrated a moderate level of general PCK and a high level of Mathematics knowledge and education dimension in their study.

The results showed that teachers' pedagogical content knowledge (TPCK) and self-efficacy (TSE) significantly predict students' academic achievement in junior secondary schools Basic Science in junior secondary schools in the study area. Olfos *et al*. (2014) [31] and Ishola and Udofia (2017) [17] corroborate this claim by demonstrating a significant correlation between TPCK and students' understanding of science learning. Also, Usak *et al*. (2022) [37] discovered that student achievement was found to be statistically significantly impacted by the science teachers' academic content knowledge. Similarly, Taştan *et al*. (2018) [36] noted that teachers' motivation and their self-efficacy have significantly affected educational achievement goals in science education. Conversely, Odumosu *et al*. (2018) [30] invalidated this finding by showing that mathematics teachers' content knowledge did not significantly affect students' academic achievement in algebra.

Lastly, the results revealed that TPCK and TSE significantly predict the students' attitude towards junior secondary schools Basic Science. The findings add credence to Akpan's (2022) [4] findings, which established a correlation between the proficiency of teachers and the disposition of students towards Biology in Akwa Ibom State, Nigeria. Although research conducted by Ekiz-Kiran *et al*. 2021 [12]; Kutluca, 2021 [23]; Mikeska *et al*. 2021 [27] had indicated that experienced teachers might be more adept at some PCK components, like students' challenges and teaching tactics, the results of this study revealed that students' achievement and attitude were unaffected by teaching experience. Likewise, Chukwunyerem and Ayodele (2021) [11] outcomes of the investigation unveiled a noteworthy impact of the belief in self-efficacy on teachers' attitudes toward the supervision of instruction.

5. Conclusion

The hypotheses of the present study were verified and demonstrated a noteworthy affirmative relationship among TPCK, TSE, and students' learning outcomes in junior secondary schools' Basic Science. More so, Basic Science teachers are very efficacious and have a substantial amount of pedagogical content knowledge, both of which have a beneficial influence on students' attitudes and crucially on their academic achievement. Furthermore, it was concluded that teachers' PCK and SE significantly predict both students' academic achievement and attitude in JSS Basic Science in Southwestern Nigeria.

6. Recommendations

Based on the conclusion of the findings of the study, it is hereby advised that;

1. Basic Science teachers should possess strong content knowledge and be prepared to acquire various teaching methodologies for successfully and efficiently teaching science concepts.
2. Government and professionals are implored to concentrate on helping teachers grow their self-efficacy through initiating appropriate training and focusing on embracing self-efficacy, which can also drive students' motivation to learn Basic Science.
3. Teachers are encouraged to amplify their subject matter knowledge and self-efficacy through active participation in seminars, workshops, and ongoing professional training.

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