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Effect Of Teachers' Subject And Pedagogical Knowledge On Junior Secondary School Students' Academic Performance In Mathematics

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ABSTRACT
Mathematics teachers with National Certificates in Education (NCE) qualification teaching at junior secondary schools must have a curtained level of subject and pedagogical knowledge to teach mathematical concepts effectively. This study aimed to determine how much mathematics teachers' subject and pedagogical knowledge can improve junior secondary school students' performance in Nigeria. Using a quasi-experimental design, a sample of 70 Mathematics teachers with NCE qualifications and 480 students from 16 secondary schools were selected purposively. The data collection instruments, namely the Teachers' Subject Knowledge Test, Teachers' Pedagogical Knowledge Assessment, and Students' Mathematics Education with a reliability coefficient of 0.75. Data was collected using t-test statistics at 0.05 significant levels. From the result obtained, the mean scores of teachers with high subject knowledge were statistically significantly different from those of teachers with high pedagogical knowledge. The mean score of students of teachers with low pedagogical knowledge was higher than that of students of teachers with low subject knowledge. The National Commission for Colleges of Education in Nigeria should formulate and enhance curriculum content for mathematics courses at our colleges of education in order to produce NCE graduates with excellent subject and pedagogical skills who can effectively teach in our secondary schools.

Keywords: Mathematics teachers, Pedagogical knowledge, Students' performance.

1. INTRODUCTION

The persistent mass failure and poor performance of students in public schools, both in internal and external examinations in Nigeria today, is a serious and challenging issue for the education sector, government, stakeholders, teachers, students, parents, and well-meaning Nigerians—the National Council of Teachers of Mathematics (NCTM) (2023). Bowie et al. (2019) see teacher characteristics such as subject knowledge and mathematical and pedagogical knowledge as vital in the teaching and learning mathematics at all levels of education. A teacher's effectiveness in teaching mathematics is intricately linked to their depth of knowledge in the subject matter. Proficient math educators possess a strong grasp of foundational concepts, advanced techniques, and pedagogical strategies. This comprehensive understanding allows them to convey complex ideas with clarity, adapt to diverse learning styles, and foster a positive learning environment. The synergy between a teacher's content knowledge and their ability to convey it is pivotal in shaping students' mathematical proficiency and fostering a lasting appreciation for the subject (Kelcey et al., 2019).

Therefore, mathematics teachers' knowledge of the content they teach is viewed as central to their work in classrooms by professional standards documents (Kelcey et al., 2019; Reza et al., 2023), especially in the context that mathematics is a tool to compute and conceptualize relationships among variables in science and is essential in nation-building. Thus, Mathematics can be viewed as the pillar of all knowledge (Wu et al, 2019; Klemer et al, 2019). Mathematics teachers' subject matter and pedagogical knowledge are interconnected for effective teaching. Mastery of mathematical concepts allows teachers to present material clearly, address student queries, and adapt to diverse learning needs. This synergy promotes mathematical literacy and student confidence in the subject.

A conceptualized definition of mathematics teachers' subject knowledge by Toom et al. (2019) in their research work is one's insightful readiness to act in response to a certain kind of mathematical challenge of a given situation and then to identify explicitly, formulate, and exemplify a set of mathematical content knowledge that can as independent dimensions in the spanning of mathematical knowledge. The mathematics teachers need to know the subject content they teach. Researchers have described teachers' mathematical subject knowledge as a thorough understanding of mathematics with breadth, depth, connectedness, and thoroughness (Bui et al., 2023; Nousheen et al., 2022). Knowing school mathematics in depth and breadth is an important dimension that proficient mathematics teachers need (Rigelman & Lewis, 2023; Shongwe, 2022)

Hanuscin et al. (2018) defined pedagogical content knowledge as (1) a distinct teacher-specific knowledge that connects teaching knowledge to subject matter knowledge, (2) the most powerful analogies, illustrations, examples, explanations, and demonstrations in a word, and (3) the most valuable ways of representing and formulating the subject that make it comprehensible to others. Thus, this approach regards pedagogical knowledge as the capacity of an individual to use a coordinated, synergistic combination of tangible resources (instruction materials such as books, articles, cases and technology such as software and hardware) and intangible resources (knowledge, skills, experience) to achieve efficiency and/or effectiveness in pedagogy (Janssen et al., 2019; Zakaryan & Riberio, 2019). The National Policy on Education (NPE, 2023) emphasizes the need for basic knowledge and application of Mathematics in science and technology for purposeful and meaningful economic development. The researcher asserts that our nation's system of training teachers with NCE qualifications needs adequate attention, especially those teaching mathematics at junior secondary schools. Mathematics teachers with an NCE qualifications in Kaduna state are exposed to a practical/functional school curriculum that enables them to teach any problematic mathematical concept effectively and efficiently (Kang et al., 2018; Wu et al., 2019).

Mathematics studies have identified an association between measures of teachers' knowledge and student outcomes (Albeshree et al., 2022; Aliustaoglu & Tuna, 2021; Fabelico & Afalla, 2023). Classroom observation research explains these findings by noting that such knowledge enables a range of work with students, including the presentation of the topic clearly without error (Dursun et al. 2021; Geletu, 2022; Wiens et al., 2022), generating mathematical presentations and explanations (Christiansen & Erixon, 2021; Masters & Park Rogers, 2018), asking mathematical productive questions (Asare, 2023; Hu & Gao, 2021; Nijenhuis-Voogt et al., 2023), selecting and implementing tasks from curriculum materials (Kandjinga & Kapenda, 2022; Mlava et al., 2023) and responding productively to student questions and errors (Carrillo-Yanez et al., 2018; Konig et al, 2020; Parrella et al., 2022; Reza Adel & Azari Noughabi, 2023). Poor mathematics performance is frequently attributed to instructors' subject matter understanding and pedagogical skills. Teachers with a solid mathematical understanding can effectively transmit complicated ideas, however a lack of experience can impede engagement and teaching approaches.

However, some mathematics teachers with NCE qualifications who teach at junior secondary schools in the Kaduna state in Nigeria lack the knowledge to teach any mathematical concept effectively and increase the movement of students from our public schools to those mushroom private schools called miracle or solutions centers. In these centers, the mathematics teachers often solve mathematics questions for their students during external examinations to maintain their business, which have a negative effect on the students' future educational careers at higher institutions because some of them cannot defend the results they possess. This study aimed to examined the effect of teachers' subject and pedagogical knowledge on junior secondary school students' academic performance in mathematics

1.1 Empirical Research on Teachers' Pedagogical Knowledge on Students' Academic Performance in Mathematics.

Over 30 years, the development of teachers' pedagogical content knowledge (PCK) has become the subject of heated debate in mathematics. Scholars have long believed that teachers' knowledge of content influences both instruction and student outcomes (Yang et al., 2023; Thohir et al., 2022; Toivola et al., 2022; Mellone et al., 2020; Evens et al., 2019; Gamlem et al., 2019). Most conceptualizations of such teacher knowledge distinguish between purely disciplinary knowledge, for instance, the knowledge of mathematical presentations, examples, and explanations; what makes the learning of topics easy or difficult; and student preconceptions and misconceptions (Epstein et al., 2023; Lin 2022; Kang et al., 2018; Master & Park Rogers, 2018).

Reza and Azari (2023) recently described developing pedagogical content knowledge (PCK) through an enriched teacher education program: the case of four Iranian pre-service teachers. In Reza Adel and Azari Noughabi's (2023) study, data were gathered through video-stimulated recall, semi-structured interviews, field notes, and classroom observations. Their findings indicated that enriched teacher education programs could reflect on their pedagogical practices and develop their pedagogical content knowledge.

Mapulanga et al. (2022) investigated Zambian secondary school mathematics teachers' profiles of planned topic-specific pedagogical content knowledge for teaching respiration. Data were collected from nine teachers drawn from six secondary schools; the study used face-to-face lesson planning interviews, which were audio-recorded and transcribed verbatim. The study's findings revealed that conceptual teaching strategies, curricular saliency, and students' prior knowledge were central to integrating pedagogical content knowledge. Highlighting this gap, Mapulanga et al. (2022) had earlier noted the importance of finding and using any means to take a local approach to improve the curriculum content in mathematics courses.

Researchers have also investigated the role of teachers' pedagogical knowledge on students' performance in mathematics. In a recent study, Wiens et al. (2022) assessed teacher pedagogical knowledge by using a video assessment of teachers' knowledge. After removing some questions, the analyses indicated that the measure is sensitive to teachers' pedagogical knowledge differences. In an explanatory study, Wiens et al. (2022) designed a

two-factor (subject knowledge and pedagogical knowledge) instrument for measuring t PCK of teachers. They examined the potential role of professional development interventions on teachers' PCK in two years. The program allowed teachers to study the materials and broaden their content knowledge to implement the curriculum. Wiens et al. (2022) presented evidence of teachers' PCK development and student performance. However, a significant limitation of their study was the need for a control group to confirm students' progress. They discovered that the program facilitated mathematics teachers' professional development and allowed them to experience new instructional practices.

To the best of our knowledge, the study of Konig et al. (2017) is one of the rare research projects that have adopted the notion of PCK to interpret the teachers' effectiveness of mathematics teaching in Germany. They trained Germany teachers and examined their PCK through self-report forms and test scores. The findings indicated a significant impact of mathematics teachers on promoting pre-service teachers' PCK. Although their cross-sectional study had a relatively large sample (N=444), the quantitative analysis of PCK might not shed light on practical aspects of teaching in classroom situations. In addition, Germany teacher preparation might be adequate in its immediate context, and generalizing the results would take much work.

Regarding the complicated nature of PCK, Avcu (2019) examined Turkish pre-service middle-level mathematics teachers' knowledge of teaching fractions. Avcu (2019) highlighted the role of the pre-service teachers' mathematics knowledge in fractions. Avcu (2019) findings showed that participants' mathematical knowledge for teaching fractions was satisfactory. Meanwhile, they had sound common content knowledge for teaching fractions.

One factor that may account for the difficulty in understanding mathematics may be teachers' PCK of the topic. Findings from the reviewed literature showed that researchers from other countries have worked on the teachers' pedagogical knowledge of students' performance in mathematics and found it effective for students' better academic performance (Reza & Azari, 2023; Mapulanga et al., 2022; Wiens et al., 2022; Konig et al., 2020; Avcu, 2019).

Moreover, all the reviewed literature available to the researcher at the time of this research work are similar in terms of the variables involved: PCK of secondary school students, but this study differs concerning its timing, location, duration, statistical tools for the data analysis, sample and sampling techniques among other discrepancies, thereby making it different from the reviewed literature. Therefore, this study examined the effect of teachers' subject and pedagogical knowledge to improve junior school students' academic performance in mathematics in Kaduna State, Nigeria.

The objectives are to:

- determine the performance of students taught mathematics by teachers with high subject knowledge and students taught by teachers with high pedagogical knowledge.
- determine the performance of students taught mathematics by teachers with high subject knowledge and those taught by Teachers with low pedagogical knowledge.
- determine the performance of students taught mathematics by teachers with low subject knowledge and those taught by teachers with high pedagogical knowledge.

1.2 Research Questions

Research questions answered include:

- is there any difference between the mean performance of students taught mathematics by teachers with high subject knowledge and those taught by teachers with high pedagogical knowledge?
- are there any differences in the performance of students taught mathematics by teachers with high subject knowledge and students taught by teachers with low pedagogical knowledge?
- what is the difference between the mean achievement of students taught mathematics by teachers with low subject knowledge and those taught by teachers with high pedagogical knowledge?

1.3 Research Hypotheses

Based on the research questions, the following null hypotheses were formulated and tested at a 0.05 level of significance:

- there is no statistically significant difference between the mean performance of students taught mathematics by teachers with high subject knowledge and those taught by teachers with high pedagogical knowledge.
- there is no statistically significant difference in the mean performance of students taught mathematics by teachers with high subject knowledge and students taught by teachers with low pedagogical knowledge.
- there is no significant difference between the mean performance of students taught mathematics by teachers with low subject knowledge and those taught by teachers with high pedagogical knowledge.

2. THEORETICAL FRAMEWORK

2.1 Constructivism Theory

Constructivism is a widely influential educational theory that emphasizes the active role of learners in the construction of knowledge. Rooted in the works of Piaget (1977), Vygotsky, (1978), constructivism posits that learning is a dynamic process where individuals actively engage with new information, assimilate it into their existing cognitive structures, and develop a deeper understanding. Constructivism challenges traditional views of education that treat students as passive recipients of knowledge. Instead, it emphasizes the importance of learners' prior experiences, cultural background, and social interactions in shaping their understanding of the world. According to Piaget, cognitive development occurs through assimilation and accommodation, where individuals either incorporate new information into existing mental structures or adjust those structures to accommodate new experiences (Piaget, 1977).

Vygotsky's sociocultural theory further highlights the role of social interactions in learning. He introduced the concept of the Zone of Proximal Development (ZPD), which represents the range of tasks a learner can perform with the help of a more knowledgeable person. In a classroom setting, teachers play a crucial role in facilitating students' learning within their ZPD, promoting cognitive development (Vygotsky, 1978). Constructivism emphasizes the need to go beyond rote memorization and encourage students to actively explore mathematical concepts. Constructivist approaches often involve problem-solving, hands-on activities, and collaborative learning to engage students in meaningful mathematical experiences. This is in stark contrast to traditional methods that rely heavily on lectures and drills.

Teachers' subject knowledge is a critical factor in implementing a constructivist approach effectively. A deep understanding of mathematical concepts allows teachers to guide students through meaningful explorations, connect abstract ideas to real-world applications, and address misconceptions. A well-versed teacher can scaffold students' learning experiences, providing support as they grapple with challenging mathematical tasks. Moreover, teachers' subject knowledge enables them to create a curriculum that aligns with the principles of constructivism. Designing activities that promote inquiry, critical thinking, and problem-solving requires a profound understanding of mathematical content and the ability to present it in an accessible manner.

In addition to subject knowledge, teachers must possess strong pedagogical knowledge to effectively implement constructivist practices. Pedagogical knowledge involves understanding how students learn, identifying appropriate instructional strategies, and adapting teaching methods to meet the diverse needs of learners. Constructivist classrooms require teachers to be facilitators rather than mere disseminators of information. Teachers must be adept at designing tasks that challenge students, fostering a collaborative learning environment, and providing timely feedback. Moreover, a solid grasp of assessment techniques is crucial for evaluating students' understanding in a constructivist framework. Numerous studies have investigated the impact of constructivist approaches on student performance in mathematics. A meta-analysis by Hiebert and Grouws (2007) found that students in constructivist classrooms consistently outperformed their peers in traditional settings. The research suggests that when teachers implement constructivist practices effectively, students develop a deeper conceptual understanding of mathematical concepts.

Furthermore, studies such as the TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) have highlighted the positive correlation between student achievement in mathematics and instructional practices aligned with constructivist principles. These findings underscore the importance of adopting constructivist approaches to enhance mathematical learning outcomes (Hiebert & Grouws, 2007). Constructivism offers a powerful framework for understanding how students learn and how teachers can facilitate meaningful learning experiences in mathematics. The theory's emphasis on active engagement, social interaction, and the construction of knowledge aligns with the evolving landscape of education. Teachers' subject and pedagogical knowledge play pivotal roles in implementing constructivist practices effectively, creating a learning environment that fosters deeper mathematical understanding and improved student performance. As education continues to adapt to the needs of the 21st century, constructivism remains a relevant and valuable theory for shaping the future of mathematics education.

3. METHODOLOGY

3.1. Research Design

The research design used for this study was a quasi-experimental research design involving a single testing technique that consisted of two groups: experimental and control. The researcher evaluates teachers' mathematics knowledge using rigorous testing, content assessments, and classroom management abilities. The researcher also considers teaching methodologies, student outcomes, and student opinions when determining their competence levels. The Experiment Group (EG) comprised teachers with high subject and pedagogical knowledge, while the Control Group (CG) included teachers with low subject and pedagogical knowledge

3.2 Sample

The study population comprised all junior secondary school mathematics teachers with NCE qualifications and year two students at public junior secondary schools in Kaduna State. Junior Secondary School 2 students were considered for the study because Junior Secondary School 3 students had written their JSCE/BECE, and the study took place at the time of the third-term promotion exam. Thus, the researcher assumed they must have covered the Junior Secondary School 1to2 curriculum content syllabus. There were 12 educational zones, with 218 teachers and 35,468 students, comprising 19,383 male students and 16,085 female students.

The multi stage sampling procedure was used to select the participants for the study. The first stage involved purposive random sampling, teachers with NCE qualifications teaching Mathematics at junior secondary schools in four educational zones, including Kaduna, Sabon Tasha, Zaria, and Zonkwa, were selected for the study.

In the second stage, the four schools were selected for their socioeconomic backgrounds and active participation, ensuring a representative sample and a collaborative environment for data collection and intervention implementation, enhancing the study's external validity and generalizability in Kaduna State. Four schools were purposely selected from each educational zone, with two as controls and two as experimental groups, giving 16 schools.

In the third stage seventy mathematics teachers were randomly assigned to participate in the study: (22) were from the Kaduna Education Zone, (21) were from the Sabon Tasha Education Zone, (18) were from the Zaria Zone and (9) were from the Zonkwa Education Zone. In the fourth stage, the students were screened with Students' Mathematics Performance Test (SMPT) and those who scored a threshold of 30 and below were selected.

3.3 Data Collection

Research assistants from the Educational Zones assisted the researcher. The teachers ensured compliance to respond appropriately to the test instruments. The study utilized three instruments. They included the Teachers' Subject Knowledge Test (TSKT), Teachers' Pedagogical Knowledge Assessment (TPKA), and Students' Mathematics Performance Test (SMPT). All the test were based on the prescribed junior secondary schools' mathematics curriculums.

The researcher develops the TSKT in line with National Examination Council (NECO) standards to determine the teachers' mathematics subject-matter knowledge. The TSKT test covered the main topics taught in mathematics from JS1 to JS3. The time allocation for the test was 2 hours to answer 100-items multiple-choice questions, each having five options A to E, according to the NECO standard. All questions were based on the prescribed junior secondary school mathematics curriculum content. The correct option was to be ticked by the teachers. Teachers with High Subject Knowledge (HSK) designations were given to them based on their teachers' subject knowledge test results: teachers who scored between 60 – 100% and teachers with Low Subject Knowledge (LSK). That is, teachers who scored between 0 – 59%. The teacher personally conducted and supervised the administration of the Students' Mathematics Performance Test (SMPT) to make corrections where necessary. Each educational zone selected mathematics teachers with only NCE qualifications to take the test.

As a strong technique, teachers' written assessments and classroom observations were evaluated using the instructors' Pedagogical Knowledge (TKPA). Written assessments, such as organised exams or case-based evaluations, offer a measurable way to assess instructors' theoretical understanding and application of pedagogical concepts. These evaluations use scenarios patterned after real-world classroom experiences. Classroom observations supplement this by allowing researchers to directly examine teachers' instructional approaches and evaluate their ability to apply theoretical knowledge to effective teaching practices. Combining these techniques yields a more comprehensive evaluation that includes both theoretical understanding and practical application of teacher pedagogical skills.

The researcher developed the SMPT to determine the students' level of comprehension of mathematical concepts and their corresponding teachers' pedagogical skills/approaches. Teachers' Pedagogical Knowledge Assessment (TPKA) and Students' Mathematics Performance Test (SMPT) was re-validated for cultural suitability with students and teachers at Government College Ibadan, Oyo state, Nigeria, achieving a Cronbach alpha of.79 and .89 in a pilot test.

The test was administered to JSS2 students in each of the selected schools. The students' test covered the main topics taught in mathematics from JSS1 to JSS2 content. The time allocation for the test was 30 minutes to answer a 20-item multiple choice questions with five options A to E, according to the NECO standard. The students were asked to tick the correct option only.

3.4 Data Analysis

Descriptive and inferential statistics were employed to analyze the gathered data. First, percentages display the respondents' demographic data. The average and standard deviation display the pre-test and post-test results. Secondly, t-test statistics were used at a significance level of 0.05 to test the null hypotheses.

3.5 Quality Measures

A pilot research was done to revalidate the instruments used in the study, with 30 participants (30 Teachers and Students at Government College, Ibadan, Oyo State, Nigeria). The research instruments were tested for reliability and yielded Cronbach alpha values of α=0.75 for TSKT, α=0.79 for SMPT, and α=0.89 for TPKA.

36 Ethical Considerations

Permission was granted by Ahmadu Bello University Zaria, Kaduna State's ethical committee, to conduct this study. The researcher sought the permission of the principals of the selected schools. Consent forms were completed by students in these schools agreeing to participate in the study after discussing the students' consent, objectives, and activities. The researcher ensured that all works cited were referenced and paraphrased. After considering all ethical issues, a plagiarism check was conducted on the study to ensure high originality. The researcher also sought the support of mathematics teachers with higher qualifications (Bachelor of mathematics education) in the selected secondary schools who served as the research assistants while administering the treatments to the experimental groups in their respective schools.

4. RESULTS

4.1 Research Question 1

Is there any difference between the mean performance of students taught mathematics by teachers with High Subject Knowledge and those taught by Teachers with High Pedagogical Knowledge?

From Table 1 below state, Is there a difference in the mean performance of students taught mathematics by instructors with high subject knowledge and those taught by teachers with high pedagogical knowledge, and the result obtained from descriptive statistics shows a statistical difference in the mean performance of students taught Mathematics by teachers with High Subject Knowledge (HSK) =36.69 with those taught by teachers with High Pedagogical Knowledge (HPK) =33.12. Thus, Subject matter mastery is the ultimate factor in students' performance.

Table 1: Descriptive Statistic for Students' Performance by Teachers' Category

Performance	N	Mean	Std. Deviation	Mean difference
High Subject Knowledge	240	36.69	15.40	
				3.57
High Pedagogical Knowledge	330	33.12	14.85	
Total	570			

4.2 Research Question 2

Are there any differences in the performance of students taught mathematics by teachers with high subject knowledge and students taught by teachers with low pedagogical knowledge?

From Table 2 below state, are there any differences in the performance of students taught Mathematics by teachers with high subject knowledge and students taught by teachers with low pedagogical knowledge, and the result revealed that the mean performance of students taught Mathematics by teachers with High Subject Knowledge (HSK) =36.69 was statistically different from those taught Mathematics by teachers with Low Pedagogical Knowledge (LPK) =29.03. Hence, it is clear that teachers' subject knowledge is a significant factor in students' performance in Mathematics

Table 2: Descriptive Statistic for Students' Performance by Teachers Category

Performance	N	Mean	Std. Deviation	Mean difference
High Subject Knowledge	240	36.69	15.40	
				7.66
Low Pedagogical Knowledge	150	29.03	13.53	
Total	390			

4.3 Research Question 3

What is the difference between the mean achievement of students taught mathematics by teachers with low subject knowledge and those taught mathematics by teachers with high pedagogical knowledge?

From Table 3 below state, what is the difference between the mean achievement of students taught mathematics by teachers with low subject knowledge and those taught mathematics by teachers with high pedagogical knowledge, and the result revealed that the mean score of students of teachers with Low Subject Knowledge (LSK) =27.02 was different from those taught by teachers with High Pedagogical Knowledge (HPK) = 33.12, which revealed how vital mastery of mathematics is.

Table 3: Descriptive Statistic for Students' Performance by Teachers Category

Performance	N	Mean	Std. Deviation	Mean difference
Low Subject Knowledge	240	27.02	11.94	
				6.10
High Pedagogical Knowledge	330	33.12	14.85	
Total	570			

4.4 Research Hypotheses 1

There is no significant difference between the performance of students taught mathematics by teachers with High Subject Knowledge and those taught by Teachers with High Pedagogical Knowledge.

From Table 4 below state, there is no significant difference between the performance of students taught mathematics by teachers with High Subject Knowledge and those taught by Teachers with High Pedagogical Knowledge and the result revealed that the difference between HSK group and HPK groups on the performance of students taught mathematics by teachers. It is shown that High Subject Knowledge (HSK) groups had significant influence on students' performance in mathematics [t (568) = 2.77; p < .01]. Further, High Subject Knowledge (HSK) groups (x = 36.69; SD = 15.40) reported higher of student performance in mathematics than those with High Pedagogical Knowledge groups (x = 33.12; SD =14.85). This is because students' performance in mathematics requires high Subject Knowledge by teachers

Table 4: t-test Compared Mean Scores of Students of Teachers with High Subject and Pedagogical Knowledge

Variable	N	Mean	SD	df	t-value	p-value	Decision
High Subject Knowledge Group	240	36.69	15.40	568	2.77	0.005	Ho Rejected
High Pedagogical Knowledge Group	330	33.12	14.85				

*Significant at p ≤0.05

4.5 Research Hypotheses 2

Performance between students taught Mathematics by Teachers with High Subject Knowledge and students taught by Teachers with Low Pedagogical Knowledge is the same.

From Table 5 below state, the performance between students taught mathematics by teachers with High Subject Knowledge and students taught by Teachers with Low Pedagogical Knowledge is the same and the result revealed that High Subject Knowledge (HSK) groups had significant influence on students' performance in mathematics [t (388) = 7.69; p < .01]. Further, High Subject Knowledge (HSK) groups (x = 36.69; SD = 15.40) reported higher performance in mathematics than those with Low Pedagogical Knowledge groups (x = 29.03; SD =13.53).

Table 5: t-test Compared mean of Students Of teachers with High Subject Knowledge by Low Pedagogical Knowledge

Variable	N	Mean	SD	df	t-value	p-value	Decision
High Subject Knowledge Group	240	36.69	15.40	388	7.69	0.001	Ho Rejected
Low Pedagogical Knowledge Group	150	29.03	13.53				

*Significant at p ≤0.05

4.6 Research Hypotheses 3

The performance of students taught mathematics by teachers with high pedagogical knowledge, and those taught mathematics by teachers with low subject knowledge is the same.

From Table 6 below state, performance of students taught mathematics by teachers with high pedagogical knowledge, and those taught mathematics by teachers with low subject knowledge is the same and the result revealed that that High Pedagogical Knowledge (HPK) groups had significant influence on students' performance in mathematics [t (568) = 5.24; p < .01]. Further, High Pedagogical Knowledge (HPK) groups (x = 33.12; SD = 14.84) reported higher performance in mathematics than those with Low Subject Knowledge groups (x = 27.02; SD =11.94).

Table 6: t-test Compared Mean of Students of Teachers with High Pedagogical Knowledge by Low Subject Knowledge

Variable	N	Mean	Std Dev	df	t-value	p-value	Decision
High Pedagogical Knowledge Group	330	33.12	14.848	568	5.248	0.001	Ho Rejected
Low Subject Knowledge Group	240	27.02	11.944				

*Significant at p ≤0.05

5. DISCUSSION

The results of analyses in Tables 4, 5, and 6 show that the null hypotheses were all rejected, which suggests that the performance of teachers with good subject knowledge was significantly better than those of teachers with high pedagogical knowledge, teachers with weak subject knowledge, and teachers with weak pedagogical knowledge, respectively. This research finding is in line with the research findings of Asare (2023), who found that students performed poorly in the hands of teachers with weak Subject Knowledge than in the hands of teachers with good subject-matter knowledge. In a research study, Avcu (2019) also reported that teachers with the correct mathematics Subject Knowledge scored better than those taught by teachers with poor Subject Knowledge. The conclusion also corresponds with the research finding of König et al. (2020), who showed that the perennial poor performance in Mathematics in the National mathematics examinations arises from teachers' weak subject knowledge teaching mathematical ideas. Poor mathematics achievement is strongly linked to teachers' lack of subject matter. Teachers act as guides, influencing students' knowledge. A teacher's lack of strong arithmetic skills impedes effective knowledge transmission. Students may fail to grasp concepts, which impede their academic performance. Strengthening teacher knowledge is critical for promoting mathematical proficiency in children.

Results in Table 6 show that students taught mathematics by teachers with High Pedagogical Knowledge performed better than those taught by Teachers with Low Subject Knowledge. Thus, the result of this study is in agreement with the findings of Wiens et al. (2022), which state that poor teaching strategies (pedagogical approaches) applied during the teaching and learning of Mathematics, especially problem-solving by Mathematics teachers will continue to double, students poor performance in Mathematics at all levels of schooling. It also suggested that the difference between the performance of teachers with weak subject knowledge and those with low pedagogical knowledge was not significant. The reason for this is apparent:

teachers with good knowledge of mathematics subject matter and teaching skills should be able to make any concept simple, clear, and comprehensible to learners.

6. CONCLUSION AND RECOMMENDATIONS

Poor mathematical performance is frequently associated with teachers who lack subject understanding. This issue undermines successful instruction because teachers struggle to express difficult mathematical concepts. When teachers lack a thorough comprehension of the subject area, students struggle to grasp fundamental principles. This knowledge gap contributes to a cycle of academic underperformance, affecting students' confidence and enthusiasm for mathematics. Addressing this issue necessitates investing in teacher professional development programmes to ensure they have a solid understanding of mathematical principles. Strengthening teachers' subject knowledge is essential for creating a positive learning environment and improving students' mathematical proficiency.

The main focus of this study was to examine the effect of teacher subject and pedagogical knowledge on improving junior school students' academic performance in mathematics in Kaduna State, Nigeria. Based on the outcome of the study, the result obtained from descriptive statistics shows a statistical difference in the mean performance of students taught Mathematics by teachers with High Subject Knowledge (HSK) =36.69 with those taught by teachers with High Pedagogical Knowledge (HPK) =33.12.

the result revealed that the mean performance of students taught Mathematics by teachers with High Subject Knowledge (HSK) =36.69 was statistically different from those taught Mathematics by teachers with Low Pedagogical Knowledge (LPK) =29.03. Also it was revealed that the mean score of students of teachers with Low Subject Knowledge (LSK) =27.02 was different from those taught by teachers with High Pedagogical Knowledge (HPK) = 33.12, which revealed how vital mastery of mathematics is. More so, the result revealed that the difference between HSK group and HPK groups on the performance of students taught mathematics by teachers. It is shown that High Subject Knowledge (HSK) groups had significant influence on students' performance in mathematics [t (568) = 2.77; $p < .01$]. Further, High Subject Knowledge (HSK) groups (x = 36.69; SD = 15.40) reported higher of student performance in mathematics than those with High Pedagogical Knowledge groups (x = 33.12; SD =14.85). The result also revealed that High Subject Knowledge (HSK) groups had significant influence on students' performance in mathematics [t (388) = 7.69; $p < .01$]. Further, High Subject Knowledge (HSK) groups (x = 36.69; SD = 15.40) reported higher performance in mathematics than those with Low Pedagogical Knowledge groups (x = 29.03; SD =13.53). Lastly, the result revealed that that High Pedagogical Knowledge (HPK) groups had significant influence on students' performance in mathematics [t (568) = 5.24; $p < .01$]. Further, High Pedagogical Knowledge (HPK) groups (x = 33.12; SD = 14.84) reported higher performance in mathematics than those with Low Subject Knowledge groups (x = 27.02; SD =11.94).

Based on the empirical evidence presented above, the teacher teaching mathematics, loaded with sound subject knowledge of mathematics and suitable pedagogical approaches, will always make the teaching of any concept simple, clear, and comprehensible to his students. It was revealed that teachers with weak or shallow subject and pedagogical knowledge will always need help teaching concepts effectively and efficiently. Hence, it is true that teachers' knowledge of the subject matter content of a discipline influences students' performance. Therefore, the secondary school Mathematics teachers' Subject-matter knowledge and pedagogical approach must be strengthened and expanded in our Colleges of Education. As a matter of urgency, the National Commission for Colleges Education (NCCE) should revisit its mathematics curriculum content at the NCE level, especially on problem-solving and current issues in mathematics and its pedagogical approaches. Some teachers with NCE qualifications need to improve their mathematics subject matter knowledge further to better their delivery during teaching and learning. Teachers' pedagogical knowledge should be given more attention during the training of Students of the National Certificate of Education (NCE) to acquire enough teaching skills to give a concrete foundation of Mathematics at the secondary school level. A Mathematics Teachers' Subject Knowledge test should be conducted regularly by the Ministry of Education in order to ensure Mathematics teachers are always alive. Governments should collaborate with the National Commission for Colleges of Education (NCCE) to design and improve curriculum content on mathematics courses at our colleges of education in the country to help in producing NCE graduates with High content and pedagogical knowledge, which will enable them to teach effectively in our secondary schools.

The study was constrained since there was little literature on pedagogical subject understanding in most Nigerian junior schools, as required by the study. There was also an issue of creativity on the part of the instructors in responding to the teachers' topic and pedagogical knowledge because they are frightened to involve their schools, even after the researcher clarified to them that the exercise was exclusively for research purposes.

Based on these findings, the government and educational stakeholders should prioritise continual professional development for teachers in order to improve their subject knowledge and pedagogical competence. Junior secondary school students should be encouraged to ask questions and develop problem-solving skills in order to improve their learning outcomes. Conferences, workshops and in-service training programmes for junior secondary school maths teachers

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