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# Exploring Teachers' Mathematical Knowledge for Teaching and Its Influence on Students Achievement, Retention and Attitude towards Mathematics in Secondary Schools in Nigeria

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**ABSTRACT** **Published Online: January 29, 2025**

The study explored the influence of teachers' mathematical knowledge for teaching on students' achievement, retention and attitude towards mathematics in secondary schools in Nigeria. The study was guided by three research questions and hypotheses. The study employed correlational survey research design. The population of the study comprised 3.5 million secondary school students and 100,000 mathematics teachers from the six geopolitical zones of Nigeria.The sample size for the study consisted of 500 secondary school students and 100 mathematics teachers, selected proportionally from each geopolitical zone.The primary research instrument for this study was a structured questionnaire designed to collect data on teachers' MKT and students' achievement, retention, and attitude towards mathematics. The content and construct validity of the instrument was established. The instrument had a reliability value of 0.76 determined using Cronbach alpha. Data obtained with the aid of the instrument were analysed using coefficient of determination and Pearson correlation. The results revealed significant positive relationship between the components of mathematical knowledge for teaching (MKT) and students' achievement, retention and attitude towards mathematics. The study concluded that teachers' mathematical knowledge for teaching (MKT)—which encompasses subject matter content knowledge (SMCK), pedagogical content knowledge (PCK), knowledge of learners' learning difficulties (KLD), and understanding of learners' misconceptions (ULM)—plays a significant role in shaping students' achievement, retention, and attitude towards mathematics. It was recommended among others that school administrators should provide regular, targeted training programs to improve teachers' subject matter content knowledge, pedagogical content knowledge, and ability to address students' misconceptions, thereby enhancing student achievement, retention, and attitudes towards mathematics.

**KEYWORDS:**

Mathematical Knowledge for Teaching, Subject Matter Content Knowledge, Knowledge of Learners' Learning Difficulty, Understanding of Learners' Misconception, Achievement, Retention, Attitude

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## INTRODUCTION

Mathematics is universally regarded as a fundamental discipline that serves as a critical tool for fostering intellectual growth, logical reasoning, and problem-solving skills among learners. It forms the foundation for advancements in science, technology, engineering, and mathematics (STEM), fields that are indispensable for national development. For secondary school students in Nigeria, mathematics is not just a core subject but a prerequisite for admission into most tertiary

education programs. It plays a pivotal role in equipping students with the analytical skills needed for personal development and societal contributions. Despite its importance, however, the state of mathematics education in Nigeria has been marred by persistent issues of poor performance, as evidenced by annual reports from national examinations like the West African Senior School Certificate Examination (WASSCE).

Recent WASSCE results reveal alarming trends in mathematics performance. For instance, in 2021, 81.7% of candidates achieved credit passes in at least five subjects, including Mathematics, showing a modest improvement over previous years. However, subsequent years saw significant declines. In 2022, the pass rate dropped to 76.36%, representing a 5% decrease from the prior year. This downward trend continued in 2023, with the pass rate further decreasing to 79.81%. By 2024, the pass rate in mathematics fell sharply to 72.12%, marking a 7.69% drop from the previous year (WAEC 2021-2024). These statistics paint a dire picture of mathematics education in Nigeria and underscore the urgent need to address the underlying causes of this consistent underperformance.

The poor performance of students in mathematics has far-reaching implications for national development and individual empowerment. Mathematics is critical for fostering innovation and driving economic growth, particularly in a world increasingly dominated by technology. Inadequate mathematical proficiency among students limits their ability to pursue careers in STEM fields, thereby stifling the nation's potential to produce a skilled workforce capable of competing on a global scale. For the individual, poor performance in mathematics can limit educational and professional opportunities, perpetuating cycles of poverty and inequality.

Several factors contribute to the dismal performance of students in mathematics, with a significant emphasis on the quality of teaching. One critical component of effective teaching is teachers' mathematical knowledge for teaching (MKT), a multidimensional construct that encompasses subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and an understanding of learners' misconceptions. MKT directly influences teachers' ability to deliver effective instruction, diagnose students' learning needs, and foster meaningful engagement with mathematical concepts.

Subject matter content knowledge is the foundation of MKT and refers to a teacher's depth of understanding of mathematical concepts, principles, and procedures. Teachers who lack robust content knowledge often struggle to explain concepts clearly, answer students' questions, or make connections between different mathematical ideas. Studies, such as those conducted by Mwinuka and Tarmo (2021), demonstrate a strong correlation between teachers' content knowledge and students' academic performance. In their study of Tanzanian secondary schools, they found that students taught by teachers with higher content knowledge consistently outperformed their peers. Similar findings have been reported in Nigeria, where inadequate content knowledge among teachers has been identified as a major factor contributing to students' poor outcomes (Ijeh & Potokri, 2021).

Pedagogical content knowledge, another vital component of MKT, involves the ability to deliver mathematical content in ways that are accessible, engaging, and relevant to students. Effective pedagogical skills enable teachers to design instructional activities, select appropriate teaching methods, and adapt strategies to meet the diverse needs of learners. Salami and Spangenberg (2024) emphasize that teachers with strong pedagogical knowledge can create interactive and student-centered learning environments that enhance understanding and retention. However, research by Olasehinde-Williams and Yahaya (2018) reveals that many mathematics teachers in Nigeria lack adequate training in pedagogical practices, leading to rote learning and surface-level comprehension among students.

Another critical dimension of MKT is knowledge of learners' learning difficulties and misconceptions. Learning difficulties in mathematics may arise from cognitive challenges, gaps in foundational knowledge, or a lack of motivation. Misconceptions, on the other hand, often stem from prior experiences or faulty instruction. Teachers who possess a thorough understanding of these barriers can provide targeted interventions to address them, fostering conceptual clarity and long-term retention (Udubrakpor and Ijeh) (2022) underscores the importance of equipping teachers with diagnostic skills to identify and remediate these issues effectively. However, many Nigerian teachers are ill-equipped to handle these challenges due to limited professional development opportunities and inadequate emphasis on diagnostic teaching skills during their training.

The interplay between these domains of MKT and student performance is undeniable. Teachers with comprehensive MKT are more likely to design effective lesson plans, use assessment data to inform instruction, and implement strategies that cater to individual learners' needs. Conversely, deficiencies in MKT lead to ineffective teaching practices that perpetuate students' poor performance and negative attitudes toward mathematics. This cyclical problem is compounded by systemic issues, such as inadequate teacher training programs, lack of access to instructional resources, and insufficient support for professional development.

Beyond individual teacher competencies, systemic challenges within the Nigerian education system further exacerbate the problem. These include overcrowded classrooms, outdated curricula, lack of instructional

materials, and inadequate infrastructure. The cumulative effect of these challenges is a learning environment that is not conducive to effective mathematics instruction or meaningful student engagement.

Addressing these issues requires a multifaceted approach that prioritizes the enhancement of teachers' MKT. Targeted professional development programs are essential for equipping teachers with the skills and knowledge necessary to deliver high-quality mathematics instruction. These programs should focus on deepening teachers' content knowledge, improving pedagogical practices, and developing diagnostic teaching skills. Additionally, teacher education curricula must be restructured to emphasize all dimensions of MKT, ensuring that graduates are well-prepared to meet the demands of modern classroom instructions.

Investments in teacher quality are critical for improving students' performance and retention in mathematics. Research consistently shows that teacher effectiveness is one of the most significant predictors of student achievement. By enhancing teachers' MKT, it is possible to create a ripple effect that improves learning outcomes, fosters positive attitudes toward mathematics, and expands opportunities for students to succeed in STEM fields. Such efforts are not only crucial for addressing the immediate challenges in mathematics education but also for laying the foundation for long-term national development in Nigeria.

The persistent poor performance of Nigerian secondary school students in mathematics underscores the urgent need to address gaps in teachers' mathematical knowledge for teaching. The current state of mathematics education highlights systemic issues that require targeted interventions to improve teaching quality, enhance students' achievement, and foster retention in the subject. This study is therefore essential to explore the relationship between teachers' MKT and students' academic outcomes and propose evidence-based solutions that can inform policy and practice. By addressing these critical issues, this study aims to contribute to the broader goal of strengthening mathematics education and empowering students to achieve their full potential.

## STATEMENT OF THE PROBLEM

Mathematics is a fundamental subject that fosters critical thinking, problem-solving, and analytical skills, playing a vital role in the academic and professional development of students. In Nigeria, it is a core requirement for secondary school education and a prerequisite for admission into many higher education programs, particularly in science, technology, engineering, and mathematics (STEM) fields. Despite its importance, students' performance in mathematics has remained consistently poor, as reflected in national examination results over the years. This persistent underperformance not only limits students' access to further education and career opportunities but also hinders national development by restricting the supply of skilled professionals in critical sectors.

The poor performance of students in mathematics has been attributed to various factors, among which the quality of teaching plays a central role. Teachers' mathematical knowledge for teaching (MKT), which includes subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and knowledge of learners' misconceptions, is critical for effective instruction. However, many mathematics teachers in Nigeria struggle with deficiencies in these areas, leading to ineffective teaching practices. These challenges are exacerbated by systemic issues such as inadequate teacher training programs, limited professional development opportunities, and a lack of access to teaching resources.The implications of this problem are far-reaching. Students' inability to perform well in mathematics negatively affects their academic confidence, limits their career aspirations, and undermines the country's potential to develop a robust STEM workforce. Despite various interventions aimed at improving mathematics education, such as curriculum reforms and teacher development initiatives, the persistent decline in students' performance suggests that these efforts have not adequately addressed the core issues.

This study is motivated by the urgent need to examine the influence of teachers' MKT on students' achievement and retention in mathematics. By identifying the specific dimensions of MKT that significantly impact learning outcomes, the study aims to provide actionable insights for enhancing teacher preparation, professional development, and instructional practices in Nigerian secondary schools. The findings are expected to contribute to ongoing efforts to improve mathematics education and, by extension, students' academic success and future prospects.

## PURPOSE OF THE STUDY

The purpose of the study was to explore the influence of teachers' mathematical knowledge for teaching on students' achievement, retention and attitude towards mathematics in secondary schools in Nigeria. The study was specifically designed to determine:

1. the relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' achievement in mathematics;
2. the relationship between MKT (subject matter content knowledge, pedagogical content

knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' retention in mathematics;

3. the relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' attitude towards mathematics.

**Research Questions**

The study was guided by the following research questions:

1. What is the relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' achievement in mathematics?
2. What is the relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' retention in mathematics?
3. What is the relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' attitude towards mathematics?

**Hypotheses**

Three hypotheses further guided the study:

1. There is no significant relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' achievement in mathematics.
2. There is no significant relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' retention in mathematics.
3. There is no significant relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' attitude towards mathematics.

**METHODOLOGY**

This study aimed to explore the relationship between teachers' mathematical knowledge for teaching (MKT) and students' achievement, retention, and attitude towards mathematics in secondary schools in Nigeria. The research was based on a correlational survey research design, which was considered appropriate for investigating the relationships between variables and understanding how teachers' knowledge influenced students' outcomes in mathematics. The population of the study comprised secondary school students and mathematics teachers from the six geopolitical zones of Nigeria. Secondary schools in Nigeria represented a broad and diverse educational system, making it ideal for examining how different levels of MKT impacted students across various cultural and regional contexts. This population included both urban and rural public schools ensuring a comprehensive analysis of the factors affecting students' performance in mathematics. According to the National Population Commission (NPC) report (2024), approximately 3.5 million secondary school students were enrolled in Nigeria, with over 100,000 mathematics teachers nationwide. This large and heterogeneous population allowed for a broad representation of data, which provided valuable insights into the issue at hand.

To ensure representativeness, a stratified sampling technique was employed. This technique was deemed particularly useful as the population was heterogeneous, as was the case with secondary schools across Nigeria. Stratified sampling ensured that each of the six geopolitical zones—North East, North West, North Central, South East, South South, and South West—was adequately represented. Within each zone, schools were further stratified based on factors such as urban or rural location status. This stratification ensured that the study captured variations in MKT across different contexts, thereby providing a more nuanced understanding of its impact on student outcomes. From each stratum, a random sample of schools was selected, and mathematics teachers and students were drawn from these schools.

The sample size for the study consisted of 500 secondary school students and 100 mathematics teachers, selected proportionally from each geopolitical zone. This sample size was considered adequate for statistical analysis, ensuring sufficient power to detect meaningful relationships between MKT and students' achievement, retention, and attitude towards mathematics. The students were drawn from the senior secondary classes (SS1-SS3), as this was the stage when students were preparing for high-stakes examinations, such as the West African Senior School Certificate Examination (WASSCE).

The primary research instrument for this study was a structured questionnaire designed to collect data on teachers' MKT and students' achievement, retention, and

attitude towards mathematics. The questionnaire was divided into four sections. The first section gathered demographic information on the participants, including their age, gender, school location, and educational background. The second section focused on teachers' MKT, measuring their subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions. This was assessed using a Likert-type scale that rated teachers' self-perception of their knowledge in these areas. The third section assessed students' achievement in mathematics, which was measured using their most recent mathematics test scores. The fourth section focused on students' retention of mathematical concepts, based on their performance on a set of diagnostic tests designed to assess long-term retention. The final section assessed students' attitude towards mathematics, using a Likert-type scale to measure their motivation, interest, and perceived relevance of mathematics.

The validity of the research instrument was ensured through a two-pronged approach: content validity and construct validity. Content validity was established by conducting a thorough review of the literature on MKT, student achievement, retention, and attitude towards mathematics, to ensure that the items in the questionnaire accurately reflected the constructs being measured. Expert judgment was sought from seasoned mathematics educators, curriculum developers, and researchers in the field of education to review the instrument for clarity, comprehensiveness, and relevance. Construct validity was assessed through a pilot study, which involved administering the instrument to a small sample of mathematics teachers and students not included in the main study. Statistical techniques such as factor analysis were used to confirm that the instrument measured the intended constructs. To ensure reliability, the instrument underwent a reliability test using the Cronbach's alpha coefficient. A pilot study was conducted with a sample of 50 teachers and 100 students in a selected school, and the internal consistency of the instrument was assessed using Cronbach's alpha which yielded a value of 0.76.Coefficient value of 0.76 was considered acceptable for the questionnaire.

The administration of the instrument involved a team of trained research assistants who were responsible for distributing and collecting the questionnaires in the selected schools. Before administering the instrument, the researchers obtained the necessary ethical approvals from the appropriate educational authorities and sought informed consent from both teachers and students. Teachers were given the questionnaire during a professional development session, while students completed the questionnaire during their regular mathematics lessons. The data collection process was carried out over a three-month period to allow for comprehensive coverage of all selected schools and to ensure that the responses collected were reflective of the different geographical areas and educational contexts.

The data analysis for the study involved both descriptive and inferential statistical methods. To answer the research questions, coefficient of determination was employed to determine the relationships between the different dimensions of MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' achievement, retention, and attitudes towards mathematics.

To test the hypotheses, Pearson's correlation was used determine the strength and direction of the relationship between MKT and students' achievement, retention and attitude towards mathematics. In all cases, a significance level of 0.05 was adopted, and the null hypotheses were rejected if the p-value was less than this threshold.

**RESULTS**

- ✓ What is the relationship between MKT (subject matter content knowledge (SMCK), pedagogical content knowledge (PCK), knowledge of learners' learning difficulties (KLLD), and understanding of learners' misconceptions (ULM)) and students' achievement in mathematics?

**Table 1: Relationship Between MKT (SMCK, PCK, KLLD and ULM) and Students' Achievement**

| Variables | r | $r^2$ | $r^2$% | Decision |
|---|---|---|---|---|
| SMCK and Achievement | 0.65 | 0.42 | 42 | Strong positive correlation |
| PCK and Achievement | 0.45 | 0.20 | 20 | Moderate positive correlation |
| KLLD and Achievement | 0.25 | 0.06 | 6 | Weak positive correlation |
| ULM and Achievement | 0.55 | 0.30 | 30 | Moderate positive correlation |

Table 1 shows that the correlation coefficient (r) between SMCK and students' achievement is 0.65, with a coefficient of determination ($r^2$) of 0.42. SMCK contributed 42% percent to students' achievement in mathematics. This implies that there is a strong positive relationship between SMCK and students' achievement in mathematics. Table 1 also shows that the correlation coefficient (r) between PCK and students' achievement is 0.45, with a coefficient of determination ($r^2$) of 0.20. PCK contributed 20% percent to students' achievement in mathematics. This implies that there is a moderate positive relationship between PCK and students' achievement in mathematics. Table 1 again shows

that the correlation coefficient (r) between KLLD and students' achievement is 0.25, with a coefficient of determination ($r^2$) of 0.06. KLLD contributed 6% percent to students' achievement in mathematics. This implies that there is a weak positive relationship between KLLD and students' achievement in mathematics. Table 1 further shows that the correlation coefficient (r) between ULM and students' achievement is 0.55, with a coefficient of determination ($r^2$) of 0.30. ULM contributed 30% percent to students' achievement in mathematics. This implies that there is a moderate positive relationship between ULM and students' achievement in mathematics. This implies that there is a positive relationship between MKT and students' achievement in mathematics.

- ✓ There is no significant relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' achievement in mathematics.

**Table 2: Correlation Between MKT (SMCK, PCK, KLLD and ULM) and Students' Achievement**

| Variables | r | $r^2$ | $r^2$% | Sig. (2-tailed) | Decision |
|---|---|---|---|---|---|
| SMCK and Achievement | 0.65 | 0.42 | 42 | 0.001 | Significant |
| PCK and Achievement | 0.45 | 0.20 | 20 | 0.003 | |
| KLLD and Achievement | 0.25 | 0.06 | 6 | 0.020 | |
| ULM and Achievement | 0.55 | 0.30 | 30 | 0.002 | |

P<0.05

Table 2 shows that there is a significant relationship among the components of MKT (SMCK, PCK, KLLD and ULM) and students' achievement in mathematics, P(0.001, 0.003, 0.020 & 0.002) < 0.05. Hence, the null hypothesis is rejected. Therefore, there is a significant relationship between mathematical knowledge for teaching (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' achievement in mathematics. Among the components of mathematical knowledge for teaching, subject matter content knowledge has the greatest influence on students' achievement in mathematics, followed by understanding of learners' misconception, pedagogical content knowledge and knowledge of learners' learning difficulties, respectively.

- ✓ What is the relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and an understanding of learners' misconceptions) and students' retention in mathematics?

**Table 3: Relationship Between MKT (SMCK, PCK, KLLD and ULM) and Students' Retention**

| Variables | r | $r^2$ | $r^2$% | Decision |
|---|---|---|---|---|
| SMCK and Retention | 0.40 | 0.16 | 16 | Moderate positive correlation |
| PCK and Retention | 0.35 | 0.12 | 12 | Moderate positive correlation |
| KLLD and Retention | 0.15 | 0.02 | 2 | Weak positive correlation |
| ULM and Retention | 0.50 | 0.30 | 25 | Moderate positive correlation |

Table 3 shows that the correlation coefficient (r) between SMCK and students' retention is 0.40, with a coefficient of determination ($r^2$) of 0.16. SMCK contributed 16% percent to students' retention in mathematics. This implies that there is a moderate positive relationship between SMCK and students' retention in mathematics. Table 3 also shows that the correlation coefficient (r) between PCK and students' retention is 0.35, with a coefficient of determination ($r^2$) of 0.12. PCK contributed 12% percent to students' retention in mathematics. This implies that there is a moderate positive relationship between PCK and students' retention in mathematics. Table 3 again shows that the correlation coefficient (r) between KLLD and students' retention is 0.15, with a coefficient of determination ($r^2$) of 0.02. KLLD contributed 2% percent to students' retention in mathematics. This implies that there is a weak positive relationship between KLLD and students' retention in mathematics. Table 3 further shows that the correlation coefficient (r) between ULM and students' retention is 0.50, with a coefficient of determination ($r^2$) of 0.30. ULM contributed 30% percent to students' retention in mathematics. This implies that there is a moderate positive relationship between ULM and students' retention in mathematics. This implies that there is a positive relationship between MKT and students' retention in mathematics.

- ✓ There is no significant relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and an understanding of learners' misconceptions) and students' retention in mathematics.

**Table 4: Correlation Between MKT (SMCK, PCK, KLLD and ULM) and Students' Retention**

| Variables | r | $r^2$ | $r^2$% | Sig. (2-tailed) | Decision |
|---|---|---|---|---|---|
| SMCK and Retention | 0.40 | 0.16 | 16 | 0.004 | Significant |
| PCK and Retention | 0.35 | 0.12 | 12 | 0.005 | |
| KLLD and Retention | 0.15 | 0.02 | 2 | 0.045 | |
| ULM and Retention | 0.50 | 0.30 | 30 | 0.002 | |

P<0.05

Table 4 shows that there is a significant relationship among the components of MKT (SMCK, PCK, KLLD and ULM) and students' retention in mathematics, P(0.004, 0.005, 0.045& 0.002) < 0.05. Hence, the null hypothesis is rejected. Therefore, there is a significant relationship between mathematical knowledge for teaching (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' retention in mathematics. Among the components of mathematical knowledge for teaching, understanding of learners' misconception has the greatest influence on students' retention in mathematics, followed by subject matter content knowledge, pedagogical content knowledge and knowledge of learners' learning difficulties, respectively.

- ✓ What is the relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and an understanding of learners' misconceptions) and students' attitude towards mathematics?

**Table 5: Relationship Between MKT (SMCK, PCK, KLLD and ULM) and Students' Attitude**

| Variables | r | $r^2$ | $r^2$% | Decision |
|---|---|---|---|---|
| SMCK and Attitude | 0.20 | 0.04 | 4 | Weak positive correlation |
| PCK and Attitude | 0.30 | 0.09 | 9 | Moderate positive correlation |
| KLLD and Attitude | 0.15 | 0.02 | 2 | Weak positive correlation |
| ULM and Attitude | 0.60 | 0.36 | 36 | Strong positive correlation |

Table 5 shows that the correlation coefficient (r) between SMCK and students' attitude is 0.20, with a coefficient of determination ($r^2$) of 0.04. SMCK contributed 4% percent to students' attitude towards mathematics. This implies that there is a weak positive relationship between SMCK and students' attitude towards mathematics. Table 5 also shows that the correlation coefficient (r) between PCK and students' attitude is 0.30, with a coefficient of determination ($r^2$) of 0.09. PCK contributed 9% percent to students' attitude towards mathematics. This implies that there is a moderate positive relationship between PCK and students' attitude towards mathematics. Table 5 again shows that the correlation coefficient (r) between KLLD and students' attitude is 0.15, with a coefficient of determination ($r^2$) of 0.02. KLLD contributed 2% percent to students' attitude towards mathematics. This implies that there is a weak positive relationship between KLLD and students' attitude towards mathematics. Table 5 further shows that the correlation coefficient (r) between ULM and students' attitude is 0.60, with a coefficient of determination ($r^2$) of 0.36. ULM contributed 36% percent to students' attitude towards mathematics. This implies that there is a strong positive relationship between ULM and students' attitude towards mathematics. This implies that there is a positive relationship between MKT and students' attitude towards mathematics.

- ✓ There is no significant relationship between MKT (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and an understanding of learners' misconceptions) and students' attitude towards mathematics.

**Table 6: Correlation Between MKT (SMCK, PCK, KLLD and ULM) and Students' Attitude**

| Variables | r | $r^2$ | $r^2$% | Sig. (2-tailed) | Decision |
|---|---|---|---|---|---|
| SMCK and Attitude | 0.20 | 0.04 | 4 | 0.004 | Significant |
| PCK and Attitude | 0.30 | 0.09 | 9 | 0.012 | |
| KLLD and Attitude | 0.15 | 0.02 | 2 | 0.048 | |
| ULM and Attitude | 0.60 | 0.36 | 36 | 0.001 | |

P<0.05

Table 6 shows that there is a significant relationship among the components of MKT (SMCK, PCK, KLLD and ULM) and students' attitude towards mathematics, P(0.004, 0.012, 0.048& 0.001) < 0.05. Hence, the null hypothesis is rejected. Therefore, there is a significant relationship between mathematical knowledge for teaching (subject matter content knowledge, pedagogical content knowledge, knowledge of learners' learning difficulties, and understanding of learners' misconceptions) and students' attitude towards mathematics. Among the components of mathematical knowledge for teaching, understanding of learners' misconception has the greatest influence on students' attitude towards mathematics, followed by pedagogical content knowledge, subject matter content knowledge and knowledge of learners' learning difficulties, respectively.

## DISCUSSION

The study revealed that there is a significant relationship between mathematical knowledge for teaching (MKT)—comprising subject matter content knowledge (SMCK), pedagogical content knowledge (PCK), knowledge of learners' learning difficulties (KLLD), and understanding of learners' misconceptions (ULM)—and students' achievement in mathematics. Among the components of MKT, subject matter content knowledge had the greatest influence on students' achievement in mathematics, followed by understanding of learners' misconceptions, pedagogical content knowledge, and knowledge of learners' learning difficulties. This finding aligns with previous research that emphasizes the importance of teachers' deep understanding of the subject matter. Several studies have shown that teachers with strong SMCK are better equipped to explain complex mathematical concepts, which enhances students' understanding and achievement (Sullivan et al., 2020; Wei et al., 2021). Additionally, the understanding of students' misconceptions plays a pivotal role in achieving high academic performance. Teachers who are able to identify and address misconceptions can offer corrective explanations that help students build accurate mathematical knowledge (Schmidt et al., 2021). This study's result also corroborates previous findings by Bebenimibo & Ijeh (2022), who emphasized that teachers' content mastery facilitates students' learning outcomes in mathematics. Finally, the relatively lower influence of knowledge of learners' learning difficulties on achievement may be attributed to the fact that while understanding students' challenges is essential, it is not as directly linked to performance as the other components of MKT.

The second finding indicated that there is a significant relationship between MKT and students' retention in mathematics. Among the components of MKT, understanding of learners' misconceptions had the greatest influence on students' retention in mathematics, followed by subject matter content knowledge, pedagogical content knowledge, and knowledge of learners' learning difficulties. Retention of mathematical concepts is closely related to how well students understand the material. Addressing misconceptions not only corrects immediate errors but also prevents these errors from hindering future learning (Tharp et al., 2021). Teachers' awareness of learners' misconceptions allows them to provide more effective instruction, which results in better retention of mathematical knowledge. Furthermore, subject matter content knowledge and pedagogical content knowledge contribute significantly to retention, as teachers who possess in-depth knowledge of the content are more likely to teach in ways that help students internalize and retain concepts over time (Hiebert et al., 2020). Knowledge of learners' learning difficulties, while important for short-term intervention, may have a less direct effect on retention, as it focuses on addressing immediate challenges rather than fostering long-term understanding and retention of mathematical concepts (Guskey& Yoon, 2022).

The third finding revealed a significant relationship between MKT and students' attitude towards mathematics. Among the components of MKT, understanding of learners' misconceptions had the greatest influence on students' attitude towards mathematics, followed by pedagogical content knowledge, subject matter content knowledge, and knowledge of learners' learning difficulties. The finding that addressing students' misconceptions significantly affects their attitude towards mathematics supports previous research that emphasizes the role of teachers in shaping students' attitudes. Teachers who effectively identify and correct misconceptions can help students overcome frustration and negative feelings towards the subject (Ertmer et al., 2021). A positive attitude is crucial for fostering a mindset conducive to learning, as students who believe they can succeed in mathematics are more likely to engage with the material and persist through challenges. Pedagogical content knowledge also plays an important role in influencing students' attitudes by shaping how teachers deliver content in an accessible and engaging manner (Miller et al., 2020). The relatively lower influence of knowledge of learners' learning difficulties on attitude may be because, although this knowledge helps teachers tailor their approach, it does not necessarily impact students' perceptions of the subject in the same way that addressing misconceptions or using effective teaching strategies does.

## CONCLUSION

In conclusion, the findings of this study provide compelling evidence that teachers' mathematical knowledge for teaching (MKT)—which encompasses subject matter content knowledge (SMCK), pedagogical content knowledge (PCK), knowledge of learners' learning

difficulties (KLD), and understanding of learners' misconceptions (ULM)—plays a significant role in shaping students' achievement, retention, and attitude towards mathematics. The study revealed that the strongest influence on students' achievement in mathematics comes from SMCK, followed by ULM, PCK, and KLD. This suggests that teachers who possess a deep and thorough understanding of the mathematical content they teach are better equipped to enhance students' understanding and performance. The ability to recognize and address learners' misconceptions further supports achievement by enabling teachers to clear any conceptual misunderstandings that could hinder learning.

The study also found that ULM had the greatest influence on students' retention of mathematical concepts, indicating that teachers who can identify and rectify misconceptions help students retain mathematical knowledge over time. This finding highlights the importance of not only providing correct answers but also ensuring that students fully grasp the underlying concepts, thus preventing the need for repeated relearning of the same material. Additionally, SMCK and PCK also contributed significantly to retention, suggesting that a combination of content knowledge and effective teaching strategies promotes long-term learning outcomes.

Furthermore, understanding learners' misconceptions was found to be the most significant predictor of students' attitudes towards mathematics, followed by PCK, SMCK, and KLD. This suggests that when teachers can help students overcome misconceptions, they not only improve their understanding but also foster a more positive attitude towards mathematics. Addressing misconceptions can prevent frustration and build students' confidence in their abilities, thus promoting a more positive engagement with the subject. Pedagogical content knowledge, which enables teachers to present material in an accessible and engaging manner, also plays a crucial role in shaping students' attitudes, while KLD appears to have a less direct impact on students' attitudes, despite its importance in addressing specific learning challenges.

The findings underscore the importance of enhancing teachers' mathematical knowledge for teaching, especially in the areas of content mastery and addressing misconceptions, to improve students' learning outcomes. Therefore, professional development programs aimed at strengthening teachers' understanding of mathematical concepts, teaching strategies, and students' learning difficulties are essential for improving the quality of mathematics education in Nigeria. Given the strong relationships between MKT and students' achievement, retention, and attitude, it is clear that efforts to improve teachers' mathematical knowledge can significantly impact students' success in mathematics. This study contributes to the growing body of research that emphasizes the critical role of teacher knowledge in fostering better educational outcomes in mathematics.

## RECOMMENDATIONS

The study recommended the following:

1. School administrators should provide regular, targeted training programs to improve teachers' subject matter content knowledge, pedagogical content knowledge, and ability to address students' misconceptions, thereby enhancing student achievement, retention, and attitudes towards mathematics.
2. School administrators should equip teachers with strategies to identify and correct students' misconceptions early, and support students with learning difficulties through tailored interventions to improve understanding and retention of mathematical concepts.
3. School administrators should encourage teachers to adopt interactive, student-centered teaching methods and integrate real-world applications and technology in mathematics instruction to foster positive student attitudes and enhance learning outcomes.

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