PRE-SERVICE MATHEMATICS TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE AS CORRELATE OF MATHEMATICS TEACHING EFFECTIVENESS IN SENIOR SECONDARY SCHOOLS IN ADAMAWA STATE, NIGERIA

[1]Shainjo, Gabriel Gerald, [2]Kawu Waziri (Ph.D) & [3]Nuhu Emmanuel Naye

[1&3]Department of Educational Foundation,
Modibbo Adama University, Yola, Nigeria
[2]Department of Environmental and Life Sciences Education,
Modibbo Adama University, Yola, Nigeria
gshainjo@gmail.com

Abstract

This study examined pre-service Mathematics Pedagogical Content Knowledge as Correlate of Teaching Effectiveness in Senior Secondary Schools of Adamawa State, Nigeria. The study had three objectives and three null hypothesis. This study adopts correlational research design. The population of the study consists of a total of 140 pre-service Mathematics teachers from College of Education, Hong in Adamawa State. The researcher employed census sampling, since the population is manageable, hence a sample size of 140 was adopted for the study. Two instruments were used for data collection in this study with 50 items. First, is a self-designed Pre-service Mathematics Teachers' Pedagogical Content Knowledge Questionnaire (PMTPCKQ) and the second is Pre-service Mathematics Teachers' Teaching Effectiveness Questionnaire (PMTTEQ), both anchored on a 5-point Likert modified scale rating. The validity and reliability of the instruments were established. Data collected were analyzed using Inferential Statistics of Pearson Product Moment Correlation Analysis were used in testing the null hypotheses. The result revealed that there is a significant relationship between pre-service Mathematics teachers' PCK components (i.e mastery of content matter, use of instructional strategies, knowledge of assessment and classroom management) and Teaching Effectiveness in Adamawa State at R values, $F = 57.77$ (df 1, 19), $P < 0.05$. Based on the findings of this study, it is concluded that pre-service Mathematics teachers' teaching effectiveness in Adamawa State is accounted for by mastery of content matter, use of instructional strategies, knowledge of assessment and classroom management.

Introduction

In recent years, lecturers and school administrators in Adamawa State have increasingly expressed concern about the quality and teaching effectiveness of pre-service Mathematics teachers undertaking teaching practice in primary and secondary schools. Their observations suggest that many of these pre-service teachers, trained in various higher institutions across the state, may be performing below the expected standard. Farauta and Amuche (2023) echoed these concerns, noting that the

competence of recent graduates raises fundamental questions about the adequacy of their training. This worry is reinforced by reports from the National Universities Commission (NUC, 2023) and Okebukola (2023), which reveal that over 80% of respondents believe that Education graduates produced within the last decade lack substantial professional strength (p.587). Such findings give the impression that many graduates are inadequately prepared for effective classroom practice. The situation becomes more troubling when viewed alongside several negative reports on teaching practice performance among pre-service Mathematics teachers across Nigerian tertiary institutions (Farauta & Amuche, 2023).

Given the critical role teachers play in shaping national development, failure to address this challenge could have immediate repercussions on the quality of manpower produced by teacher education institutions. This, in turn, may negatively affect the functioning of primary and secondary schools in Adamawa State and ultimately hinder sustainable growth and development. The contribution of teachers to effective teaching and learning remains indispensable (Makapi, 2019). However, as Nwanekezi et al. (2021) argued, teachers must be properly trained, professionally oriented, and well-equipped with the right attitudes to discharge their responsibilities effectively. In Nigeria, teacher education programmes are largely hosted in higher institutions to meet the nation's teacher-supply needs (Hagana, 2023). As emphasized in the National Policy on Education (FRN, 2023), the goal of teacher education is to produce highly competent teachers for all levels of the educational system. To achieve this, Mathematics teachers must be exposed to both theoretical and practical dimensions of instructional preparation (Tope, 2017). Teaching remains an invaluable societal function (Umar, 2023).

Performance during teaching practice often serves as a major predictor of a teacher's future professional success (Farauta & Amuche, 2023). Existing studies affirm that pedagogical content components within teacher education programmes are crucial because they influence teaching effectiveness and student achievement (Azeem, 2021; Wilson et al., 2021). Reports by NUC (2023) further reveal several persistent challenges hindering pre-service Mathematics teachers, including inadequate teaching practice exposure, weak practical skills, ineffective classroom management, poor subject mastery, limited ICT competence, weak communication skills, unprofessional conduct, poor work attitudes, and a lack of entrepreneurial and self-reliance skills.

While Onyebukwa-Nwanoro (2020) attributes pre-service teachers' ineffectiveness to external factors such as inadequate funding, limited resources, and anxiety, it is also essential to examine the teachers' internal competencies—specifically their subject knowledge and instructional methods. Relying solely on external factors neglects the influence of teachers' own pedagogical strengths. This is why scholars such as Nwagbo (2015), Abidoye and Oguniyi (2020), and Sharma (2017) identify weak Pedagogical Content Knowledge (PCK) as a major limitation affecting teaching effectiveness among pre-service Mathematics teachers. PCK

encompasses teachers' knowledge of how to structure, represent, and teach specific content in ways that foster students' understanding (Ball & Bass, 2016). It involves recognizing conceptual connections across topics, understanding learner needs, and applying teaching strategies tailored to specific grade levels. According to Shulman (as cited in Kilic, 2017), PCK represents the unique blend of content and pedagogy necessary for effective teaching. Loughran et al. (2018) highlight content knowledge, pedagogical knowledge, and understanding students' learning difficulties as interrelated aspects of PCK. Miller (2019) further notes that PCK enables teachers to help students access content meaningfully. Hence, pre-service Mathematics teachers must possess PCK to design effective tasks, choose appropriate representations, facilitate productive classroom dialogue, interpret student responses, emphasize conceptual understanding, and address students' misconceptions (Olfosn et al., 2021).

The development of teachers' knowledge base particularly as it affects classroom practice and student learning has therefore become a central concern in Mathematics teacher education (Brown, Friedrichsen & Kind, 2017; Abell, 2018). De Jong and Van Driel (2020) attribute this concern to findings establishing a strong relationship between what teachers know and how they teach. Constructivist perspectives further suggest that teachers' knowledge base must include all components of PCK if effective learning is to occur. Thus, pre-service Mathematics teachers' PCK is an essential determinant of their success in Mathematics instruction.

For effective teaching, Mathematics teachers must demonstrate deep subject-matter knowledge as well as an understanding of how mathematical concepts relate to one another. Ball (as cited in Clori, 2016) emphasized the centrality of subject-matter knowledge, yet research shows that many Mathematics teachers lack adequate conceptual understanding (Gess-Newsome, 2017). Pre-service teachers who master the subject are better positioned to make coherent connections between topics and provide sound explanations. According to Eke (2016), teaching is considered effective only when it yields the desired learning outcomes. In line with this, the National Council of Teachers of Mathematics (NCTM, 2017) asserts that teachers with strong subject-matter knowledge deliver richer lessons, engage students meaningfully, and improve learning outcomes. However, Darling-Hammond (2018) reports that the connection between content knowledge and teaching effectiveness is sometimes weak, suggesting that subject knowledge alone is not sufficient. Teachers must also understand instructional strategies, curriculum requirements, and learner characteristics (Grouws & Schultz, 2020).

Another critical dimension of PCK influencing Mathematics teaching effectiveness is the use of instructional strategies. Instructional strategies involve decisions about how to organize learners, materials, and ideas to support learning (Nwachuku, 2017). Adegoke and Umar (2019) observed that many Mathematics classrooms rely heavily on rote memorization, which limits student engagement and deeper understanding. Studies by Atadoga and Lakpini (2017) and Ibe (2019) link persistent low

achievement in Mathematics to ineffective teaching strategies. Hence, an important question arises: To what degree do pre-service Mathematics teachers on teaching practice in Adamawa State demonstrate adequate knowledge and use of instructional methods in their lessons?

Assessment knowledge is another PCK component essential to effective Mathematics instruction. Standard assessment practices help determine students' progress and learning outcomes. Ukwuije (2018) describes assessment as the documentation of learners' knowledge, skills, attitudes, and behaviour across all stages of instruction. Kellaghan and Greaney (2018) view assessment as a process that informs educational decisions, provides feedback, evaluates instruction, and guides policy. They emphasize the need to re-examine classroom assessment practices to improve educational quality. According to Hassan (2019), students' academic achievement is evidenced through assessment results, which reflect the extent of learning outcomes. William (2016) highlighted that integrating assessment into instruction enhances learner achievement and aligns classroom practice with research on motivation, feedback, and self-regulated learning. This underscores the importance of formative assessment (Stiggins & Chappius, 2017). Thus, assessing whether pre-service Mathematics teachers conduct appropriate assessments during teaching practice becomes crucial.

Therefore, the poor acquisition and demonstration of PCK skills among pre-service Mathematics teachers particularly in subject mastery, instructional strategies, assessment skills, and classroom management remain pressing concerns. These PCK components, together with issues of teaching effectiveness, form the conceptual background for this study.

Statement of the Problem

Ideally, pre-service Mathematics teachers are expected to possess strong Pedagogical Content Knowledge (PCK) that enables them to translate mathematical concepts into comprehensible, engaging, and developmentally appropriate instruction. Teacher education programmes are designed to equip these future teachers with deep subject-matter understanding, effective instructional strategies, and sound assessment practices. When adequately trained, pre-service teachers should demonstrate the ability to connect mathematical ideas, anticipate students' misconceptions, employ appropriate teaching methods, and facilitate meaningful learning experiences during teaching practice.

However, the reality on ground in Adamawa State reveals a significant deviation from this ideal. Observations by lecturers, cooperating teachers, and school administrators show that many pre-service Mathematics teachers struggle to demonstrate the required PCK during their teaching practice. From the researcher's experience and supported by literature, pre-service teachers often display weak mastery of mathematical content, limited ability to select or apply appropriate instructional strategies, and inadequate assessment practices. Reports by the National Universities Commission (NUC, 2023) and Okebukola (2023) further confirm this situation, indicating that over 80% of respondents believe that Mathematics education graduates produced in the last

decade lack sufficient professional competence. Within the Nigerian context, Farauta and Amuche (2023) also documented recurring negative evaluations of the teaching practice performance of pre-service Mathematics teachers, suggesting systemic weaknesses in teacher preparation. These realities paint a clear picture of an educational system where the development of PCK among pre-service Mathematics teachers remains inadequate.

The mismatch between the ideal and the current reality carries serious negative consequences. When pre-service teachers lack adequate PCK, they struggle to meet curricular demands and fail to deliver lessons that promote conceptual understanding. This results in poor lesson delivery, teacher-centered and rote instructional approaches, ineffective classroom interaction, and shallow assessment practices. Consequently, students receive limited academic support, leading to persistent low achievement in Mathematics a trend already evident in many secondary schools. The long-term implication is a continuous recycling of poorly prepared Mathematics teachers, erosion of educational standards, and a weakening of the teacher education system's capacity to contribute to national development.

Therefore, the problem at hand lies in the growing concern that many pre-service Mathematics teachers in Adamawa State are unable to effectively apply Pedagogical Content Knowledge during teaching practice. This raises a critical question as to whether their level of PCK relates significantly to their teaching effectiveness. Thus, this study seeks to determine the extent to which pre-service Mathematics teachers' Pedagogical Content Knowledge is associated with their teaching effectiveness in secondary schools in Adamawa State.

Purpose of the Study

The purpose of the study is to examine pre-service Mathematics teachers' pedagogical content knowledge as correlate of Mathematics teaching effectiveness in Senior Secondary Schools in Adamawa State, Nigeria. Specifically, the study sought to examine whether:

1. Pre-service Mathematics teachers' mastery of subject matter correlates with Mathematics teaching effectiveness in Senior Secondary Schools of Adamawa State;
2. Pre-service Mathematics teachers' use of instructional strategies correlates with Mathematics teaching effectiveness in Senior Secondary Schools of Adamawa State;
3. Pre-service Mathematics teachers' knowledge of students' assessment correlates with Mathematics teaching effectiveness in Senior Secondary Schools of Adamawa State;

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance to guide the study.

Ho_1: There is no significant relationship between pre-service Mathematics teachers' mastery of subject matter and Mathematics teaching effectiveness in Senior Secondary Schools in Adamawa state.

Ho_2: There is no significant relationship between pre-service Mathematics teachers' use of instructional strategies and teaching effectiveness in Senior Secondary Schools in Adamawa state.

Ho_3: There is no significant relationship between pre-service Mathematics teachers' knowledge of students' assessment and Mathematics teaching effectiveness in Senior Secondary Schools in Adamawa state.

Methodology

The study employed a correlational research design, which seeks to determine the degree of relationship between two or more variables within the same population (Leedy & Ormrod, 2017). This design was appropriate because it allowed the researcher to explore the relationship between pre-service Mathematics teachers' pedagogical content knowledge and their teaching effectiveness in Senior Secondary Schools in Adamawa State. Correlational research involves systematically studying a sample that represents the larger population, enabling the researcher to make meaningful inferences about the relationship between the variables (Prematunga, 2018). The study therefore focused on comparing how pre-service teachers' mastery of pedagogical content knowledge correlates with Mathematics teaching effectiveness during teaching practice.

The research was conducted in Adamawa State, located in north-eastern Nigeria with Yola as its capital. Created in 1991 from the former Gongola State, Adamawa occupies a vast land area of about 36,917 km² and shares borders with Borno, Gombe, Taraba, and the Republic of Cameroon. The state is largely agrarian, with fishing and cattle rearing as other major economic activities. Administratively, Adamawa State has 21 local government areas organized under five education zones: Yola, Mubi, Gombi, Numan, and Ganye. The study population comprised 140 NCE III pre-service Mathematics teachers from the Federal College of Education, Yola, and Adamawa State College of Education, Hong, who were on teaching practice during the 2024/2025 academic session. Because of the relatively small population, the researcher used a census sampling technique, involving all 140 pre-service teachers (105 from FCE Yola and 35 from COE Hong), ensuring a comprehensive dataset for the study.

Two instruments were developed and used for data collection: the Pre-service Mathematics Teachers Pedagogical Content Knowledge Questionnaire (PMTPCKQ) with 40 items, and the Pre-service Mathematics Teachers Teaching Effectiveness Questionnaire (PMTTEQ) with 10 items, both structured on a 5-point Likert scale. These instruments were validated for face and content validity by three experts from Modibbo Adama University, Yola, who made critical suggestions that were incorporated into the final versions. Reliability testing using Cronbach's Alpha produced acceptable coefficients of 0.70, confirming internal consistency. Data were collected through direct administration of the questionnaires to respondents in their classrooms. The analysis employed inferential statistics of Pearson Product Moment Correlation (PPMC) Analysis was used to test hypotheses at a 0.05 significance level.

Decisions were made based on p-values, with $p \leq 0.05$ indicating significant relationships between the studied variables.

Results and Discussion

Presentation of Results

The three hypotheses were tested using PPMC at 0.05 level of significance.

Hypotheses Testing

Ho_1: There is no significant relationship between pre-service Mathematics Teachers' mastery of subject matter and Teaching Effectiveness in Adamawa state.

Table 1. PPMC of relationship between pre-service Mathematics Teachers' mastery of subject matter and Teaching Effectiveness in Adamawa state.

	N	Mean	SD	sig	r
Mastery of subject matter.	140	3.51	1.44	0.00	0.05
Teaching Effectiveness of Pre-service Teachers	140	3.63	0.58		

The result of the analysis in Table 1 indicated that the computed P-value (0.00) is below 0.05 level of significance. Since the computed P-value is less than the level of significance, therefore the null hypothesis which states that there is no significant relationship between pre-service Mathematics Teachers' mastery of subject matter and Teaching Effectiveness in Adamawa state is rejected. The r-value (0.53) indicated that, the relationship between pre-service Teachers' mastery of subject matter and Teaching Effectiveness in Adamawa state is moderate and positive.

Ho_2: There is no significant relationship between pre-service Mathematics Teachers' use of instructional strategies/methods and Teaching Effectiveness in Adamawa state.

Table 2. PPMC of relationship between pre-service Mathematics Teachers' use of instructional strategies/methods and Teaching Effectiveness in Adamawa state.

	n	Mean	SD	Sig	r
Pre-service Mathematics teachers use of instructional strategies/methods	140	3.59	0.6	0.00	0.63
Teaching Effectiveness of pre-service Mathematics Teachers	140	3.70	0.61		

The result of the analysis in Table 2 indicated that the computed P-value (0.00) is below 0.05 level of significance. Since the computed P-value is less than the level of significance, therefore the null hypothesis which states that there is no significant relationship between Pre-service Teachers' use of instructional strategies/methods and Teaching Effectiveness in Adamawa state is rejected. The r-value (0.63) indicated that, the relationship between Pre-service Mathematics Teachers' use of instructional strategies/methods and Teaching Effectiveness in Adamawa state and Teaching Effectiveness in Adamawa state is moderate and positive.

Ho_3: There is no significant relationship between pre-service Mathematics Teachers' knowledge of students' assessment and Teaching Effectiveness in Adamawa state.

Table 3. PPMC of relationship between pre-service Mathematics Teachers' knowledge of students' assessment and Teaching Effectiveness in Adamawa state.

	N	Mean	SD	Sig	r
Pre-service Mathematics teachers demonstrate Knowledge of students' Assessment in instructions	140	3.79	0.54	0.000	0.70
Teaching Effectiveness of pre-service Mathematics Teachers	140	3.74	0.56		

The result of the analysis in Table 3 indicated that the computed P-value (0.00) is below 0.05 level of significance. Since the computed P-value is less than the level of significance, therefore the null hypothesis which states that there is no significant relationship between pre-service Mathematics Teachers' knowledge of students' assessment and Teaching Effectiveness in Adamawa state is rejected. The r-value (0.70) indicated that, the relationship between Pre-service Teachers' knowledge of students' assessment and Teaching Effectiveness in Adamawa state state is high and positive.

Findings of the Study

The results of the study generated the following findings:

1. There is positive and moderate significant relationship between pre-service Mathematics Teachers' mastery of subject matter and Mathemematics Teaching Effectiveness in Adamawa state r-value (0.53).
2. There is positive and moderate significant relationship between pre-service Mathematics Teachers' use of instructional strategies/methods and Mathemematics Teaching Effectiveness in Adamawa state r-value (0.63).
3. There is positive and high significant relationship between pre-service Mathematics Teachers' knowledge of students' assessment and Mathemematics Teaching Effectiveness in AdamawaState r-value (0.70).

Discussion of Findings

This study sought to examine pre-service teachers' pedagogical content knowledge as correlate of teaching effectiveness in Senior Secondary Schools in Adamawa State, Nigeria. The findings of the study are discussed below based on the findings on mastery of subject matter, use of instructional strategies-methods, knowledge of assessment and classroom management practice.

The first finding reveals that there is positive and moderate significant relationship between pre-service Mathematics teachers' mastery of subject matter and Teaching Effectiveness in Adamawa State. The discovery of a positive and moderate significant relationship between pre-service Mathematics Teachers' mastery of subject matter and Teaching

Effectiveness in Adamawa State, is of paramount importance, carrying extensive implications for the traditional system of education. It emphasizes the pivotal role of availability of pre-service Mathematics teachers and enhanced teaching effectiveness provided. This relationship is a testament to the idea that when school principals actively make pre-service Mathematics teachers available in their respective schools; it not only elevates the professional development of educators but also fosters a positive school culture characterized by collaboration and a commitment to continuous teaching/learning activities. This nurturing atmosphere, in turn, can lead to increased teacher retention rates, reducing the turnover of educators, and ultimately resulting in improved student learning outcomes in public post basic schools in Adamawa State.

This finding agrees with that of Odumosu, Olisama and Fisayo (2018) whose findings revealed that all categories of the subject were equally affected by TCK in algebraic achievement after exposure to teacher' content knowledge. This finding corroborate with that of Josiah and Oluwatoyin (2017) who investigated teachers' pedagogy content knowledge as determinant of students' academic performance in secondary schools, and found that level of teacher quality in secondary schools in Edo south senatorial district of Nigeria was high. The finding aligns with the research of Kunenea et al (2015) whose results showed that the teachers‟ individual PCK profiles consisted predominantly of declarative and procedural content knowledge in teaching basic genetics concepts. Conditional knowledge, which is a type of meta-knowledge for blending together declarative and procedural knowledge, was also demonstrated by some teachers. The findings further revealed that teachers used topic-specific instructional strategies such as context based teaching, illustrations, peer teaching, and analogies in diverse forms. This finding corroborate with that of Tasar (2011) who found that micro teachings were effective for developing the two components of TPACK which are instructional strategies and representations for teaching force and movement subjects with technology (ISTE) and curricula and curriculum materials that integrate technology with learning in this subject area (CUTE). Relatedly, Lankford (2010) findings indicated five of the six teachers held a constructivist orientation to science teaching and engaged students in explorations of diffusion and osmosis prior to introducing the concepts to students. Three potential learning difficulties identified by the teachers included: (a) understanding vocabulary terms, (b) predicting the direction of osmosis, and (c) identifying random molecular motion as the driving force for diffusion and osmosis. Participants used student predictions as formative assessments to reveal misconceptions before instruction and evaluate conceptual understanding during instruction. In consonance to the finding of this study, Kunenea et al (2015) revealed that teachers failed to use physical models and individual or group student experimental activities to assist students' internalization of the concepts. The implication of this finding is that teaching should be accompanied with the use of necessary instructional materials.

The second finding reveals a positive and moderate significant relationship

between pre-service Mathematics teachers' use of instructional strategies/methods and Teaching Effectiveness in Adamawa state. This finding aligns with the findings of Heeralal and Bayaga (2011) who revealed that pre-service Mathematics teachers need to pay attention to flexibility during course participation, course content, instructional approaches and learning materials, as well as course delivery and logistics. This finding corroborate with that of Taiwo and James (2015) whose findings revealed that majority of the pre-service Mathematics teachers were professionally qualified based on the instructional strategies they employ during instructional delivery. Taiwo and James (2015) further revealed that the ratio of teacher to students was also within acceptable range. This finding aligns with Schram et al. (2008), who discovered that pre-service Mathematics teachers benefited from taking three content courses focused on numbers, geometry, probability, and statistics, as well as the relationships between these concepts. Schram et al. (2008) further observed that after completing the courses, the pre-service Mathematics teachers' perspectives on mathematics shifted dramatically. Initially viewing maths as a mere collection of symbols and rules, they developed an appreciation for conceptual understanding by the end of the courses. Notably, they also praised the instructor's approach to setting up a supportive learning environment.

In contrast to this finding, Adeniran et al. (2015) discovered that teachers in Odeda Local Government Area, Ogun State, Nigeria, expressed concerns about pre-service Mathematics teachers' approaches. Specifically, the teachers believed that these approaches hin dered effective teaching and learning, citing challenges in using instructional strategies and difficulties in implementing them in the classroom. In contrast, Ergönenc et al. (2014) found that teachers' pedagogical content knowledge had no significant impact on student learning, either directly or indirectly through cognitive activation.

Schram et al. (2008) further supported these findings, showing that pre-service Mathematics teachers struggled to apply the concepts they learned in their courses to their own teaching practices. Many still adhered to traditional views of mathematics, prioritizing procedural knowledge over conceptual understanding. This highlights the need for secondary school teachers to be actively involved in curriculum planning and implementation. By doing so, they can incorporate student-centered approaches that make learning more engaging, potentially leading to more self-reliant students compared to traditional methods.

The third finding reveals that there is positive and high significant relationship between pre-service Mathematics Teachers' knowledge of students' assessment and Teaching Effectiveness in Adamawa State. This finding agrees with that of Ergonenc, Neumann and Fischer (2014) whose findings confirmed an influence of teachers' pedagogical content knowledge on cognitive activation. This finding corroborate with that of Enyeneokpon and Maureen (2016) whose findings showed that combined teacher quality indicators (teacher's subject matter knowledge, teacher's qualification, teacher-student relationship, teacher's qualification and teacher's experience:

assessment administration) have significant contributions to physics achievement. This finding corroborate with that of Ugwuadu (2017) investigated the peers and students' assessments of teacher effectiveness in secondary schools in Adamawa state, Nigeria, and revealed that there is no significant difference between the mean responses of peers and students' assessments of teacher effectiveness. This finding aligns with the findings of Dickson and Okunloye (2014) whose results showed that, teacher variables exerted some influence on students' performance in social studies. This finding corroborate with that of Lankford (2010) whose findings indicated that participants used student predictions as formative assessments to reveal misconceptions before instruction and evaluate conceptual understanding during instruction. The implication of this finding is that when peers and students' assessment are encouraged, it helps pre-service Mathematics teachers to diversify their respective methods of assessment in their field of expertise for enhanced teaching effectiveness in public secondary schools.

Conclusion

This study investigated the relationship between pre-service Mathematics teachers' Pedagogical Content Knowledge (PCK) components mastery of subject matter, use of instructional strategies, and knowledge of assessment and their teaching effectiveness in secondary schools in Adamawa State. The findings collectively demonstrate that each PCK component contributes significantly to the teaching effectiveness of pre-service Mathematics teachers, albeit at varying strengths. The study established a moderate positive relationship between mastery of subject matter and teaching effectiveness, indicating that pre-service teachers who possess a stronger grasp of mathematical concepts tend to demonstrate better instructional performance. Similarly, a moderate but slightly stronger relationship was found between the use of instructional strategies and teaching effectiveness, highlighting the importance of employing appropriate pedagogical approaches in enhancing student learning. Most notably, the study revealed a high positive relationship between knowledge of students' assessment and teaching effectiveness, underscoring the crucial role assessment literacy plays in planning, delivering, and evaluating effective Mathematics instruction. The results suggest that deficiencies in any of these PCK components can significantly hinder the ability of pre-service Mathematics teachers to deliver quality instruction during teaching practice. Therefore, strengthening PCK development within teacher education programmes is essential for improving teaching effectiveness and, by extension, enhancing students' learning outcomes in Mathematics across secondary schools in Adamawa State.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Teacher education institutions should intensify efforts to strengthen pre-service Mathematics teachers' mastery of mathematical concepts through enhanced content-based courses and targeted remediation programmes.

2. Teacher educators should provide more structured and practical training on diverse, student-centered instructional strategies to ensure pre-service teachers can effectively apply these methods during teaching practice.
3. Teacher education programmes should prioritize comprehensive assessment training that equips pre-service teachers with the skills to design, implement, and interpret students' assessments to enhance instructional decision-making.

References

Abell, S. (2018). Investigating the development of science teachers' subject matter knowledge and its impact on teaching effectiveness. *Journal of Science Teacher Education, 29*(2), 185-200.

Abidoye, R. O., & Oguniyi, M. T. (2020). Challenges in pre-service teacher education: The Nigerian perspective. *Educational Review, 64*(4), 455-472.

Adeniran, O., Adediran, E., & Adeyemo, F. (2015). Teachers' perception of pre-service mathematics teachers' approaches in classroom teaching in Odeda Local Government Area, Ogun State, Nigeria. *Journal of Educational Research and Practice, 6*(2), 114–123.

Atadoga, L., & Lakpini, I. (2017). Teachers' instructional strategies and student academic achievement in science education. *Journal of Science Education Research, 51*(3), 45-58.

Azeem, M. (2021). Pedagogical content knowledge and its role in teacher preparation. *International Journal of Teacher Education, 7*(2), 67-79.

Ball, D. L., & Bass, H. (2016). Teaching mathematics for understanding. *Mathematics Teacher Education, 23*(5), 11-34.

Brown, C. P., Friedrichsen, P. L., & Kind, V. (2018). Pedagogical content knowledge in science teacher education: Bridging theory and practice. *Science Education Review, 29*(4), 112-127.

Clori, D. (2016). Pedagogical content knowledge and its application in the classroom. *Journal of Teacher Education, 67*(3), 299-312.

Darling-Hammond, L. (2018). Teacher quality and student achievement: A review of state policy evidence. *Educational Policy Analysis, 43*(4), 551-572.

De Jong, O., & Van Driel, J. H. (2019). Teachers' knowledge base and its influence on science teaching: A review of recent research. *Journal of Research*

in Science Teaching, 56(2), 130-151.

Dickson, B., & Okunloye, R. (2014). Teacher variables and students' academic performance in social studies. *Nigerian Journal of Education, 8*(3), 215–229.

Eke, D. (2016). Teaching effectiveness: Defining and measuring the concept. *Journal of Educational Measurement, 31*(4), 221-234.

Enyeneokpon, E., & Maureen, O. (2016). Combined teacher quality indicators as predictors of physics students' achievement. *International Journal of Education and Science Research, 5*(4), 45–55.

Ergönenc, T., Neumann, K., & Fischer, H. (2014). Teachers' pedagogical content knowledge and its impact on students' learning and cognitive activation. *European Journal of Science and Mathematics Education, 2*(1), 21–29.

Farauta, J., & Amuche, J. (2023). The effectiveness of pre-service teacher training: An analysis of teaching practice in Nigerian secondary schools. *Journal of Teacher Education, 58*(2), 123-134.

Gess-Newsome, J. (2017). Science teacher knowledge: A framework for understanding and improving teaching. *Science Education Review, 25*(2), 205-222.

Grouws, D. A., & Schultz, K. (2020). The importance of pedagogical knowledge in effective teaching. *Journal of Educational Psychology, 114*(3), 357-367.

Hassan, F. (2019). Assessment and its role in student learning outcomes. *Assessment in Education, 8*(2), 177-189.

Heeralal, P. J., & Bayaga, A. (2011). Pre-service mathematics teachers' perceptions of teacher education programme effectiveness. *International Journal of Educational Sciences, 3*(1), 49–56.

Josiah, A., & Oluwatoyin, O. (2017). Teachers' pedagogy content knowledge as determinant of students' academic performance in secondary schools. *Journal of Educational Studies, 9*(2), 87–98.

Kellaghan, T., & Greaney, V. (2018). The role of assessment in improving educational outcomes. *Journal of Educational Measurement, 28*(4), 92-105.

Kilic, A. (2017). Teachers' pedagogical content knowledge in practice. *Journal of Educational Science, 48*(2), 120-135.

Kunenea, K., Amadi, L., & Nte, T. (2015). Teachers' pedagogical content knowledge in teaching genetics concepts. *Journal of Science Teacher Education, 26*(3), 67–80.

Lankford, D. (2010). Teachers' understanding of diffusion and osmosis: A case study of constructivist classroom practices. *International Journal of Science Education, 32*(5), 589–608.

Loughran, J., Berry, A., & Mulhall, P. (2018). Understanding and developing teachers' pedagogical content knowledge. *Research in Science Education, 48*(2), 143-157.

Miller, C. (2019). Pedagogical content knowledge and effective teaching. *Teaching and Teacher Education Journal, 58*(3), 227-238.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

National Universities Commission (NUC). (2023). Report on the quality of teacher education in Nigeria. Abuja: National Universities Commission.

Nwachuko, F. (2017). Instructional strategies and their impact on student learning in secondary schools. *Education Today, 40*(3), 91-104.

Nwagbo, O. (2015). Pedagogical content knowledge and teacher effectiveness in Nigerian secondary schools. *Journal of Teacher Education, 33*(1), 45-56.

Nwanekezi, I. M., Okoli, C. C., & Mezieobi, A. G. (2021). Teachers' professional competence and its impact on student achievement in Nigeria. *Nigerian Journal of Educational Leadership, 11*(3), 134-145.

Odumosu, M., Olisama, I., & Fisayo, K. (2018). Teacher content knowledge and students' algebraic achievement in secondary schools. *Journal of Mathematics and Science Education, 12*(1), 25–39.

Okebukola, P. (2023). Challenges facing Nigerian teacher education: Perspectives from the classroom. *Educational Review Journal, 44*(5), 567-590.

Olfos, R., Goldrine, A., & Estrella, C. (2021). Pedagogical content knowledge for effective teaching. *Educational Review, 16*(5), 337-350.

Salawu, B., & Adeoye, A. O. (2021). Teaching practice and its role in improving the quality of education in Nigeria. *Journal of Educational Development, 35*(4), 101-113.

Schram, T., Wilcox, S., Lappan, G., & Lanier, P. (2008). Learning to teach mathematics: Changes in teachers' conceptions of mathematics and pedagogy. *Mathematics Teacher Education and Development, 9*(1), 24–43.

Stiggins, R. J., & Chappius, J. (2017). Using assessment to improve student learning: A framework

for success. *Assessment for Learning, 5*(1), 34-56.

Taiwo, A., & James, T. (2015). Professional qualification and instructional delivery among pre-service mathematics teachers. *Nigerian Journal of Educational Development, 7*(1), 102–115.

Tasar, M. (2011). Developing pre-service teachers' technological pedagogical content knowledge through micro-teaching. *International Journal of Instructional Technology and Distance Learning, 8*(4), 33–45.

Thungu, J. M. (2021). The importance of teaching practice in teacher preparation: A review. *Journal of Teacher Training, 9*(1), 10-18.

Ugwuadu, A. (2017). Peers and students' assessments of teacher effectiveness in secondary schools in Adamawa State, Nigeria. *Journal of Educational Management, 11*(2), 118–129.

Ukoh, M., & Oboshi, S. (2021). The concurrent model of teacher education in Nigeria: A critical evaluation. *Educational Research and Development, 36*(3), 212-228.

Ukwuije, I. (2018). Educational assessment and its impact on instructional practices in Nigeria. *Nigerian Journal of Education Studies, 35*(2), 54-67.

Umar, S. (2023). Teacher education: A key to sustainable educational development in Nigeria. *African Journal of Education and Development, 19*(2), 78-85.

Vennier, M., & Faith, P. (2016). Teacher quality and student outcomes in developing countries: The role of pedagogy. *Educational Policy Review, 14*(2), 78-88.

William, D. (2016). The impact of formative assessment on student achievement. *Educational Assessment, 16*(4), 1-11.