



Pedagogical Challenges in Nigerian Secondary School Mathematics Education: A Conceptual Examination of Causes, Consequences and Reform Strategies

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Abstract

Mathematics is fundamental to scientific literacy, technological development, economic productivity, and participation in Science, Technology, Engineering, and Mathematics (STEM). However, mathematics education in Nigerian secondary schools continues to face pedagogical challenges that constrain students' conceptual understanding, reasoning, problem-solving, engagement, and achievement. This conceptual paper examines major pedagogical challenges in Nigerian secondary school mathematics education and their implications for learning. Drawing on Constructivist Learning Theory, Social Cognitive Theory, and pedagogical content knowledge, the paper argues that persistent learning difficulties arise from interactions among teacher knowledge, instructional practices, assessment, curriculum demands, classroom conditions, and learners' prior knowledge. Major challenges include teacher-centred and procedural instruction, inadequate mathematical discourse and differentiation, examination-oriented assessment, limitations in teacher professional development, large classes and resource constraints, and weak integration of contextualized learning and problem-solving. Evidence from Nigerian studies indicates that alternative instructional approaches and teachers' professional competencies can contribute to improved mathematics learning. The paper proposes a conceptual framework linking structural conditions, teacher factors, pedagogical practices, learner experiences, and mathematics learning outcomes. It concludes that sustainable improvement requires conceptually focused, learner-centred, reflective, formative, and context-responsive pedagogy supported by continuous teacher professional development and appropriate educational resources.

Keywords: Mathematics education, Pedagogical challenges, Secondary schools, Pedagogical content knowledge

Introduction

Mathematics occupies a strategic position in secondary education because it develops knowledge and skills that support scientific reasoning, problem-solving, further education, and participation in a wide range of occupational fields (National Council of Teachers of Mathematics [NCTM], 2014; Organisation for Economic Co-operation and Development [OECD], 2023). It is also integral to Science, Technology, Engineering, and Mathematics (STEM) education and contributes to the quantitative and analytical competencies required to understand and address scientific, technological, occupational, and societal problems (OECD, 2023). Consequently, the quality of mathematics teaching has implications beyond examination performance, extending to learners' capacity to reason mathematically, solve problems, interpret quantitative information, and apply mathematical knowledge in different contexts (NCTM, 2014; OECD, 2023).



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Despite this importance, mathematics teaching and learning in Nigerian secondary schools continue to face challenges associated with instructional effectiveness and students' achievement (Akinpelu et al., 2024; Olumuyiwa & Akinsola, 2021). Nigerian studies have investigated learner-centred, collaborative, and interactive approaches as possible responses. Awofala and Agbolade (2024), for example, found significant effects of peer tutoring on mathematics achievement among senior secondary students in Lagos State. Similarly, Ahmad and Zakariyya (2022) reported that students taught bearings through collaborative problem-solving performed significantly better than those taught through conventional instruction. Such findings suggest that opportunities for participation, collaboration, exploration, and problem-solving can contribute positively to mathematics learning. However, they should not be interpreted as evidence that one instructional method is universally superior to another. Rather, they highlight the importance of the quality and appropriateness of pedagogical practices within particular classroom contexts.

Mathematics pedagogy is more complex than a choice between “traditional” and “modern” teaching methods. It involves what teachers know about mathematics and learners, how they represent mathematical ideas, how they assess understanding, how they respond to errors and misconceptions, and how they organize classroom interaction. Shulman (1986) conceptualized pedagogical content knowledge (PCK) as an important dimension of teachers' professional knowledge, emphasizing that effective teaching requires more than subject-matter knowledge. Ball et al. (2008) subsequently highlighted the specialized mathematical knowledge required for teaching, including interpreting learners' mathematical thinking, selecting representations, explaining mathematical ideas, and making appropriate instructional decisions. Evidence from Nigeria reinforces this perspective. Oluwatayo and Fakinlede (2019) found that senior secondary students in Ondo State rated their mathematics teachers relatively highly in pedagogical content knowledge but relatively lower in assessment competency. Fekuno and Diri (2024) reported that professional development significantly influenced mathematics teachers' subject-content and pedagogical-content knowledge in Yenagoa Local Government Area of Bayelsa State. Similarly, Sodangi et al. (2022) reported low participation in professional development among science and mathematics teachers in Zamfara State and identified content knowledge and teaching pedagogy among areas requiring further development. Collectively, these findings indicate that mathematics pedagogy is influenced not only by instructional methods but also by teachers' professional knowledge, assessment competence, and continuing professional development. Pedagogical challenges in Nigerian mathematics education are therefore multidimensional. They involve teacher knowledge and professional competence, learners' prior knowledge and experiences, curriculum and assessment demands, instructional resources, classroom conditions, school-level support, and broader educational structures. Accordingly, this conceptual paper examines major pedagogical challenges confronting mathematics education in Nigerian secondary schools, considers their implications for mathematics learning, and proposes a framework for pedagogical improvement and educational reform.

Conceptualizing Pedagogy in Mathematics Education

Pedagogy encompasses the knowledge, decisions, strategies, interactions, and practices through which teaching and learning are organized. In mathematics education, it includes how teachers activate learners' prior knowledge, represent mathematical ideas, pose questions, facilitate discourse, respond to errors and misconceptions, assess understanding, and provide appropriate support for learners with different levels of mathematical knowledge (Ball et al., 2008; Shulman,



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1986). Effective mathematics pedagogy therefore requires the integration of mathematical content knowledge with knowledge of how particular mathematical ideas can be made accessible and meaningful to learners. Effective mathematics teaching should move beyond the transmission of rules and procedures. Learners require opportunities to develop conceptual understanding, procedural fluency, mathematical reasoning, communication, representation, and problem-solving. NCTM (2014) emphasizes teaching practices involving purposeful questioning, meaningful mathematical discourse, appropriate representations, reasoning and problem-solving tasks, productive struggle, and the use of evidence of learners' thinking. These practices position teaching as an interactive process in which teachers continuously interpret and respond to learners' mathematical thinking. In Nigeria, curriculum development provides an important policy context for mathematics pedagogy. The Nigerian Educational Research and Development Council (NERDC) is responsible for curriculum development and has published a revised Senior Secondary Education Curriculum for SS1–SS3, within which General Mathematics is a core and compulsory subject (Nigerian Educational Research and Development Council [NERDC], 2025a, 2025b). A formally developed curriculum, however, does not automatically guarantee effective classroom implementation. Its effectiveness depends partly on how teachers interpret curriculum expectations and translate them into meaningful learning experiences through appropriate tasks, representations, instructional strategies, assessment, and opportunities for mathematical reasoning. Pedagogical quality can therefore be understood in terms of the extent to which classroom practices enable learners to make sense of mathematical ideas, connect concepts and representations, communicate reasoning, apply knowledge, and develop both conceptual understanding and procedural fluency.

Theoretical Perspectives

This paper draws on three complementary perspectives: Constructivist Learning Theory, Social Cognitive Theory, and Pedagogical Content Knowledge (PCK)/Mathematical Knowledge for Teaching (MKT). Together, they explain how learner activity, learner beliefs, classroom environments, and teacher professional knowledge interact in mathematics teaching and learning.

Constructivist Learning Theory

Constructivist perspectives view learning as an active process through which learners construct and reorganize knowledge by connecting prior understanding with new experiences. In mathematics education, this perspective emphasizes meaningful engagement through reasoning, exploration, representation, discussion, problem-solving, and connections among concepts. Such an orientation is consistent with teaching practices that promote mathematical reasoning, discourse, purposeful questioning, and productive struggle (NCTM, 2014). Constructivism is particularly relevant to Nigerian mathematics classrooms because transmission-oriented practices may restrict opportunities for learners to develop mathematical meaning and communicate their reasoning. However, constructivism does not imply that teachers should withdraw from instruction. Teachers remain central through the selection and sequencing of tasks, questioning, scaffolding, feedback, and connections between learners' informal strategies and formal mathematical knowledge.

Social Cognitive Theory

Bandura's (1986) Social Cognitive Theory emphasizes reciprocal interactions among personal factors, behaviour, and environmental conditions. In mathematics learning, learners' beliefs about their mathematical capabilities can influence their effort, persistence, participation, and responses to



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difficulty, while classroom experiences can simultaneously shape those beliefs. Repeated failure, discouraging feedback, or limited opportunities to participate may weaken learners' mathematical self-efficacy. Conversely, successful learning experiences, constructive feedback, appropriate challenges, and supportive peer interaction may strengthen learners' beliefs in their capabilities (Bandura, 1986). This perspective therefore emphasizes that pedagogical reform should address both what learners understand and the classroom experiences through which they develop confidence and persistence as mathematics learners.

Pedagogical Content Knowledge and Mathematical Knowledge for Teaching

Shulman (1986) argued that effective teaching requires an integration of content knowledge and pedagogical knowledge. PCK concerns teachers' knowledge of how particular subject matter can be represented, explained, organized, and made comprehensible to particular learners. In mathematics, knowing how to perform a procedure does not necessarily mean knowing how to explain its underlying reasoning, anticipate misconceptions, select suitable representations, or interpret incorrect solutions. Ball et al. (2008) extended this perspective through the concept of Mathematical Knowledge for Teaching, emphasizing specialized mathematical knowledge needed for teaching. Research has also established PCK as an important construct in mathematics education and teacher education research (Depaepe et al., 2013). Thus, strengthening mathematics pedagogy requires professional development that integrates mathematical content, learner thinking, pedagogy, curriculum, assessment, and classroom practice.

Theoretical Integration

The three perspectives provide complementary explanations. Constructivism emphasizes active construction of mathematical knowledge; Social Cognitive Theory highlights the interaction among learner beliefs, behaviour, and environment; and PCK/MKT emphasizes teachers' specialized professional knowledge. Together, they suggest that effective mathematics pedagogy requires knowledgeable teachers, purposeful instructional design, active learner engagement, supportive classroom environments, and responsive assessment.

Major Pedagogical Challenges in Nigerian Secondary Schools

Teacher-Centred, Rote, and Procedural Instruction

An important concern in mathematics education is the predominance of practices in which teachers do most of the explaining and demonstrating while learners have limited opportunities to articulate, investigate, and justify mathematical ideas. Explicit instruction is not inherently ineffective; it can be valuable when combined with guided practice, reasoning, discussion, and problem-solving (NCTM, 2014). The difficulty arises when transmission-oriented instruction becomes dominant and learners primarily reproduce worked examples and routine procedures. Nigerian evidence provides support for examining more participatory approaches. Akinpelu et al. (2024) found that Senior Secondary II students exposed to mastery learning performed significantly better in geometric constructions than those taught through conventional instruction. Olumuyiwa and Akinsola (2021) similarly investigated interactive e-note and problem-solving strategies among junior secondary students in Kaduna State. These findings suggest that mathematics instruction can be strengthened when teacher explanation is complemented by guided practice, interaction, investigation, and problem-solving. Closely related to teacher-centred instruction is excessive reliance on rote learning. Procedural fluency is important, but learners also need to understand mathematical relationships,



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recognize when procedures are appropriate, and apply knowledge flexibly to unfamiliar situations (NCTM, 2014). Effective instruction should therefore establish connections between conceptual understanding and procedural fluency rather than treating mathematics as a collection of memorized rules.

Inadequate Mathematical Discourse and Differentiation

Mathematical discourse enables learners to explain, question, justify, compare, and evaluate mathematical ideas while allowing teachers to examine learners' thinking and misconceptions. NCTM (2014) identifies meaningful discourse as an important component of effective mathematics teaching. In classrooms dominated by closed questions and predetermined answers, learners may have limited opportunities to articulate reasoning. Similarly, treating errors merely as failures can discourage participation. Differentiation is another related concern. Secondary mathematics classrooms contain learners with different levels of prior knowledge, mathematical experience, confidence, and conceptual understanding. Because mathematics learning is cumulative, gaps in prerequisite knowledge can interfere with subsequent learning. Teachers therefore need to use questioning, formative assessment, flexible grouping, scaffolded tasks, multiple representations, and targeted feedback to respond to differences among learners. Differentiation does not require completely separate lessons for individual students; rather, it involves purposeful adjustments that enable learners with different needs to participate meaningfully in mathematical activity.

Examination-Oriented Teaching and Assessment

Examination demands are an important contextual influence on mathematics teaching. Where examination performance receives disproportionate emphasis, teachers may experience pressure to cover content rapidly and prepare learners for familiar question formats. This may reinforce routine procedural practice at the expense of conceptual exploration and extended reasoning. Assessment should nevertheless provide information that can guide teaching and learning. Formative assessment enables teachers to identify learners' understanding, misconceptions, and developing reasoning and to adjust instruction accordingly (Black & Wiliam, 1998; NCTM, 2014). Nigerian evidence also indicates a need to strengthen assessment competence. Oluwatayo and Fakinlede (2019), for example, reported differences between students' perceptions of teachers' pedagogical content knowledge and assessment competency. Examination materials also illustrate the range of mathematical tasks candidates are expected to handle, including interpretation, application of mathematical principles, geometry, and other problem-solving contexts (West African Examinations Council [WAEC], 2023). This reinforces the need for teaching that develops conceptual understanding, interpretation, reasoning, and problem-solving rather than focusing narrowly on procedural reproduction.

Limitations in Teacher Professional Development

Sustained professional development is essential for strengthening teachers' mathematical knowledge, PCK, assessment competence, and capacity to implement effective instructional practices. Teachers need opportunities to examine mathematical content, learners' thinking, instructional strategies, assessment evidence, technology, and classroom practice (Ball et al., 2008; Shulman, 1986). However, professional development may be constrained by financial, institutional, and logistical factors. Sodangi et al. (2022) reported challenges affecting professional-development participation among science and mathematics teachers in Zamfara State, while Fekuno and Diri



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(2024) found that professional development significantly influenced mathematics teachers' subject-content and pedagogical-content knowledge in Bayelsa State. These findings suggest that professional learning should extend beyond occasional workshops towards sustained and classroom-focused opportunities such as collaborative planning, peer learning, lesson study, and coaching.

Large Classes, Resources, Technology, and Contextualized Learning

Classroom conditions also shape the feasibility of effective mathematics pedagogy. Large classes can make it difficult to monitor individual reasoning, provide timely feedback, organize mathematical discussion, and differentiate instruction. Limited access to instructional resources may create additional constraints, particularly where teachers lack manipulatives, geometric models, visual representations, graphing tools, or appropriate digital resources. The issue is not simply whether technology is available but whether resources are used purposefully to support mathematical thinking. Uya (2023), for example, reported advantages associated with collaborative strategies and geoboard resources in mathematics learning in Akwa Ibom State. Similarly, contextualized problem-solving can help learners connect mathematics to finance, measurement, agriculture, business, engineering, statistics, technology, and everyday decision-making. Nigerian studies involving interactive, problem-solving, and collaborative approaches further suggest the value of giving learners opportunities to engage actively with mathematical ideas (Olumuyiwa & Akinsola, 2021; Uya, 2023).

Interrelationship among Pedagogical Challenges and Learning Outcomes

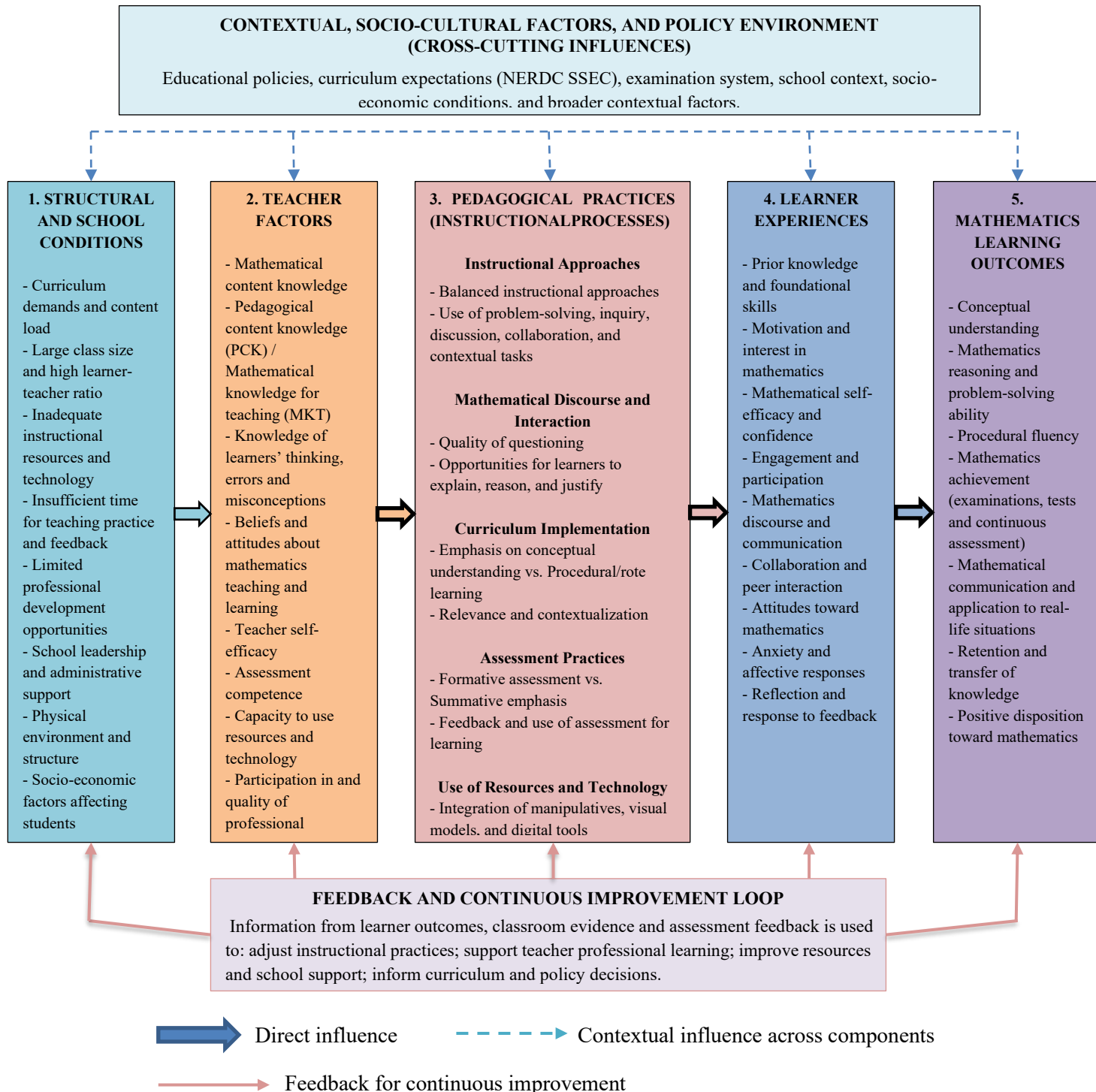
The identified challenges are interconnected rather than independent. Large classes and limited resources may make whole-class exposition more manageable than differentiated or collaborative activities. Examination pressure may reinforce procedural teaching because routine practice can appear to provide an efficient means of preparing learners for assessed content. At the same time, inadequate professional development may restrict teachers' capacity to implement and adapt alternative approaches. These conditions can interact with learners' prior knowledge. Learners with weak prerequisite knowledge may struggle with new concepts, while inadequate formative assessment may prevent teachers from identifying misconceptions early. Teachers may consequently respond with additional procedural explanations and worked examples, potentially increasing learners' dependence on teacher demonstrations. The result can be a cycle in which weak prior knowledge, limited diagnosis, procedural instruction, and restricted mathematical reasoning reinforce one another. The central conceptual position of this paper is therefore that mathematics learning outcomes should not be examined independently of the pedagogical environment. Achievement, conceptual understanding, reasoning, and problem-solving are shaped by interactions among teacher professional knowledge, instructional practices, assessment, classroom conditions, resources, and learners' prior knowledge and experiences.

Proposed Conceptual Framework

Based on the foregoing theoretical and conceptual perspectives, Figure 1 presents the proposed framework for understanding the relationships among structural conditions, teacher factors, pedagogical practices, learner experiences, and mathematics learning outcomes in Nigerian secondary schools.

Figure 1:

Conceptual Framework for Pedagogical Challenges and Mathematics Learning Outcomes in Nigerian Secondary Schools



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Note: The arrows represent proposed conceptual relationships among the components and should not be interpreted as evidence of direct causal effects. The solid arrows indicate the proposed primary pathway through which structural and school conditions and teacher factors may shape pedagogical practices, learner experiences, and mathematics learning outcomes. The framework is conceptual and interactive rather than strictly linear or causal, and the relationships represented are propositions requiring empirical examination.

The framework conceptualizes mathematics learning outcomes as emerging from interactions among structural and school conditions, teacher factors, pedagogical practices, and learner experiences. Structural conditions such as class size, resources, curriculum demands, examination pressures, and school support shape the context of teaching. Teacher factors, including mathematical knowledge, PCK, professional competence, beliefs, self-efficacy, and professional development, influence teachers' pedagogical decisions. These conditions are expressed through instructional practices, mathematical discourse, assessment, differentiation, and purposeful use of resources and technology. Such practices shape learners' engagement, prior-knowledge activation, self-efficacy, participation, and mathematical understanding. Learners' responses, misconceptions, engagement, and assessment evidence can, in turn, inform subsequent instructional decisions and professional learning.

Educational Implications and Reform Strategies

The conceptual analysis suggests that improving mathematics education requires reforms that address pedagogical practices together with the conditions that shape them. Five interrelated strategies are particularly important.

1. Strengthen Teachers' Professional Knowledge and Continuous Development: Teacher education and professional development should integrate mathematical content knowledge, PCK/MKT, learner thinking, assessment, instructional design, and reflective practice. Professional learning should be sustained and classroom-focused rather than limited to isolated workshops.
2. Promote Conceptually Focused and Learner-Centered Pedagogy: Teachers should balance explicit explanation with guided inquiry, collaborative problem-solving, mathematical discourse, representations, and opportunities for independent reasoning. The aim should be to develop conceptual understanding and procedural fluency together rather than treating them as competing goals.
3. Strengthen Formative Assessment and Foundational Knowledge: Teachers should use diagnostic tasks, questioning, classroom discussion, written responses, and feedback to identify misconceptions and gaps in prerequisite knowledge. Such evidence should inform subsequent instruction and targeted support.
4. Improve Instructional Resources, Technology, and Contextual Responsiveness: Education authorities and schools should improve access to affordable and contextually appropriate mathematics resources. Where digital technologies are available, teachers should be supported to use them for visualization, exploration, feedback, communication, and problem-solving rather than merely for presentation.
5. Strengthen Supportive Classroom Cultures and Curriculum–Assessment Alignment: Mathematics classrooms should encourage learners to explain and justify their reasoning, consider alternative strategies, and learn from errors without humiliation. At the system level, curriculum and assessment policies should place greater emphasis on conceptual understanding, mathematical reasoning, interpretation, and problem-solving.



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Research Gaps and Future Directions

The Nigerian literature provides useful evidence on individual instructional strategies and teacher competencies, but more systematic research is needed on how multiple pedagogical factors interact. Future studies should therefore move beyond isolated comparisons of teaching methods and investigate relationships among teacher knowledge, classroom practice, assessment, learner characteristics, and contextual conditions. Longitudinal and classroom-observation studies could examine how professional development translates into changes in teaching practice and learner outcomes. Research should also compare rural and urban schools, school types, class sizes, resource conditions, and geopolitical contexts. Further investigation is needed into how teachers' Mathematical Knowledge for Teaching interacts with learners' prior knowledge, self-efficacy, and problem-solving ability. Such evidence would provide a stronger basis for context-sensitive pedagogical reform in Nigeria.

Conclusion

Pedagogical challenges are an important dimension of the difficulties confronting mathematics education in Nigerian secondary schools. These challenges cannot be adequately explained by learners' motivation or by teachers' choice of instructional method alone. Rather, mathematics learning is shaped by an interconnected system involving teacher professional knowledge, pedagogical practices, assessment, curriculum demands, classroom conditions, professional development, resources, and learners' prior knowledge. The central argument of this paper is that sustainable improvement requires a shift from predominantly transmission-oriented practices towards pedagogy that combines clear explanation with conceptual understanding, mathematical discourse, problem-solving, formative assessment, differentiation, and active learner participation. Nigerian evidence indicates that approaches such as mastery learning, interactive instruction, collaborative learning, problem-solving, and purposeful use of instructional resources can provide useful directions for improvement. Ultimately, meaningful reform requires more than introducing new teaching methods. It requires strengthening teachers' professional knowledge, improving assessment practices, addressing foundational learning needs, providing supportive classroom conditions, and aligning curriculum and assessment with the mathematical competencies' learners are expected to develop. The proposed framework provides a conceptual basis for examining these relationships and for guiding future empirical research into mathematics pedagogy in Nigerian secondary schools.

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