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ENHANCING TEACHERS' COMPUTATIONAL THINKING SKILLS TO SUPPORT CODING-INTEGRATED MATHEMATICS CURRICULUM IN SECONDARY SCHOOLS IN EDO STATE

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ABSTRACT

This study examined teachers' computational thinking competence as a determinant of effective implementation of coding-integrated mathematics curriculum in secondary schools in Edo State, Nigeria. The increasing global shift toward digital education and the integration of coding into STEM subjects has placed new demands on mathematics teachers to acquire computational thinking skills such as abstraction, decomposition, algorithmic reasoning, and digital modelling. Despite policy efforts by the Nigerian government and Edo State educational reforms aimed at strengthening ICT-based instruction, evidence suggests that many teachers still struggle with translating computational thinking concepts into classroom practice. The study adopted a descriptive survey research design. A sample of 240 mathematics teachers was selected using multistage sampling techniques. Data were collected using a validated structured questionnaire titled Teachers' Computational Thinking Skills and Coding-Integrated Mathematics Questionnaire (TCTSCIMQ) with a reliability coefficient of 0.87. Mean and standard deviation were used for analysis. Findings revealed that mathematics teachers possessed below-average computational thinking competence (grand mean = 2.45), particularly in applying coding tools, guiding coding-based activities, and using digital simulations. Major challenges identified included inadequate ICT infrastructure, unstable electricity supply, poor internet connectivity, and insufficient professional development opportunities (grand mean = 3.44). The study further found that strategies such as sustained professional training, provision of ICT laboratories, curriculum reform, and partnerships with technology organizations were strongly recommended for improvement (grand mean = 3.57). The study concludes that enhancing

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teachers' computational thinking competence is essential for effective implementation of coding-integrated mathematics instruction. It recommends systematic teacher training, infrastructural development, and curriculum redesign to improve mathematics education outcomes in Edo State secondary schools.

Introduction

The rapid transformation of the global economy through digital technologies, artificial intelligence, robotics, automation, and data-driven systems has significantly altered the expectations placed on educational institutions across the world. Contemporary education systems are increasingly expected to equip learners with twenty-first century competencies capable of supporting innovation, creativity, technological adaptability, analytical reasoning, and complex problem-solving (Wing, 2021). Within this context, computational thinking has emerged as one of the most important competencies required for participation in modern knowledge societies and digital economies. Computational thinking refers to the cognitive processes involved in formulating problems and developing logical solutions that can be executed systematically by humans or computers. It involves abstraction, decomposition, algorithmic reasoning, pattern recognition, debugging, evaluation, and modelling (Kallia et al., 2021). In recent years, computational thinking has become increasingly important in mathematics education because of its capacity to strengthen learners' conceptual understanding, analytical reasoning, and problem-solving abilities (Cui & Ng, 2021).

Globally, educational systems in technologically advanced countries such as Finland, Singapore, Estonia, South Korea, Canada, and the United Kingdom have increasingly integrated coding and computational thinking into school curricula as part of broader STEM education reforms. These reforms are aimed at preparing learners for technologically driven societies where digital competence and computational literacy are essential requirements for employment, innovation, and national competitiveness (Romandoni et al., 2025). Consequently, coding education is no longer viewed solely as a computer science activity but as an interdisciplinary instructional strategy capable of enhancing learning across multiple subject areas, especially mathematics and science.

In response to global educational transformations, the Nigerian educational system has also initiated curriculum reforms aimed at improving digital literacy, coding education, and technology integration within schools. The Federal Ministry of Education, in collaboration with agencies such as the Nigerian Educational Research and Development Council (NERDC), has emphasized the importance of science, technology, engineering, and mathematics (STEM) education as a strategic tool for national development (Federal Republic of Nigeria, 2022). These reforms reflect Nigeria's recognition of the growing importance of technological competence in the Fourth Industrial Revolution. Despite these policy intentions, implementation challenges continue to undermine effective classroom practice, particularly within public secondary schools where infrastructural limitations and inadequate teacher preparedness remain significant concerns (Okeke & Nwafor, 2022).

In Edo State, educational reforms aimed at promoting digital learning and technology integration have generated increasing attention toward computational thinking and coding education. Initiatives such as EdoBEST and other technology-driven reforms introduced by the Edo State Government have sought to modernize teaching practices through digital platforms, teacher development programmes, and technology-assisted instructional delivery (Aina & Sofowora, 2022). These reforms have improved instructional supervision and administrative efficiency in some schools. However, concerns remain regarding teachers' readiness to effectively integrate computational thinking into mathematics instruction. Many mathematics teachers still rely heavily on traditional pedagogical approaches characterized by rote memorization, procedural instruction, and teacher-centred methodologies that provide limited opportunities for creativity, algorithmic reasoning, and digital problem-solving (Awofala, 2021).

The integration of coding into mathematics education extends beyond the teaching of programming languages. Coding-integrated mathematics instruction involves the application of computational reasoning, algorithmic logic, simulations, digital modelling, and coding activities to support mathematical understanding and problem-solving. Such instructional approaches enable learners to visualize mathematical concepts, explore patterns, solve problems systematically, and engage actively in experiential learning processes (Romandoni et al., 2025). Through coding-based mathematical activities, learners develop deeper understanding of abstract mathematical ideas while simultaneously acquiring digital competencies required for participation in technologically driven societies.

Computational thinking as a variable in this study encompasses teachers' ability to apply abstraction, decomposition, algorithmic reasoning, pattern recognition, debugging, and computational modelling within instructional processes. These competencies enable mathematics teachers to design innovative learning experiences capable of promoting inquiry, creativity, collaboration, and critical thinking among students (Wing, 2021). Coding-integrated mathematics curriculum, on the other hand, refers to instructional frameworks that combine mathematical concepts with coding activities, programming logic, digital simulations, and computational applications to improve learners' mathematical understanding and digital literacy.

The growing importance of computational thinking in mathematics education has become particularly relevant within the Nigerian educational context because of increasing demands for technological skills within labour markets and higher education institutions. The emergence of the Fourth Industrial Revolution has significantly transformed employment structures and professional practices, thereby requiring educational institutions to produce graduates who possess analytical, technological, entrepreneurial, and innovative competencies (Ololube, 2021). Nigerian students increasingly compete within globalized technological environments where coding, data analysis, robotics, and computational reasoning have become essential skills for economic participation and career advancement. Consequently, teachers' preparedness to implement coding-integrated mathematics instruction has become a critical issue for educational quality, national competitiveness, and sustainable development.

Several studies conducted within Nigeria have identified persistent deficiencies in teachers' digital competencies and technology integration practices. In many public secondary schools, mathematics teachers experience limited access to professional development programmes focused on computational thinking and coding pedagogy (Yusuf & Balogun, 2023). Infrastructural challenges such as unstable electricity supply, inadequate internet connectivity, insufficient computers, poorly equipped ICT laboratories, and weak technical support systems further complicate instructional implementation (Ugwoke & Eze, 2022). These challenges are more severe in rural communities across Edo State where schools often lack basic technological facilities required for effective digital instruction.

Furthermore, many teachers demonstrate anxiety and resistance toward technology adoption because of inadequate training and low confidence in coding-related instructional approaches. Some educators perceive coding as a highly technical computer science activity rather than a pedagogical strategy capable of enriching mathematics instruction and promoting analytical reasoning. This perception contributes to weak curriculum implementation and limited instructional innovation (Eze & Chinedu, 2024). In addition, teacher education programmes in many Nigerian universities and colleges of education still provide limited exposure to computational pedagogy and coding-based instructional strategies, thereby affecting the preparedness of newly recruited teachers for digital learning environments.

The challenge is further compounded by inconsistencies in curriculum implementation policies and institutional support mechanisms. Although curriculum documents increasingly emphasize digital literacy, coding education, and innovation, practical support structures necessary for effective implementation often remain inadequate. In some schools, administrators prioritize examination preparation and curriculum coverage over innovative teaching strategies, thereby discouraging experimentation with coding-based instructional approaches. As a result, students continue to perceive mathematics as abstract, difficult, and disconnected from real-world technological applications (Awofala, 2021).

Empirical evidence suggests that integrating computational thinking into mathematics instruction significantly improves students' engagement, conceptual understanding, and academic achievement. Coding activities such as simulations, robotics tasks, digital modelling, and algorithm development provide opportunities for learners to interact actively with mathematical concepts and develop deeper analytical understanding (Cui & Ng, 2021). Similarly, studies have shown that learners exposed to coding-integrated instruction demonstrate stronger problem-solving skills, creativity, and collaborative learning behaviours compared to learners taught through conventional methods (Kallia et al., 2021).

Despite these potential educational benefits, the level of teachers' computational thinking competence in Edo State secondary schools remains inadequately explored within existing literature. Most previous studies in Nigeria have focused broadly on ICT integration and digital literacy without specifically examining mathematics teachers' computational thinking competencies and coding-integrated instructional practices. There is therefore a need for empirical investigation into the extent to which mathematics teachers in Edo State possess the computational thinking skills necessary for coding-integrated mathematics curriculum implementation, the challenges affecting implementation, and the strategies required for improvement.

Research Questions

The following research questions guided the study:

1. What is the level of computational thinking competence possessed by mathematics teachers in secondary schools in Edo State?
2. What challenges affect teachers' implementation of coding-integrated mathematics curriculum in secondary schools in Edo State?
3. What strategies can enhance teachers' computational thinking skills for effective coding-integrated mathematics instruction?

Theoretical/Empirical Review

This study is anchored on Constructivist Learning Theory as developed by Jean Piaget and later expanded by Lev Vygotsky. Constructivism posits that learners actively construct knowledge through interaction with their environment rather than passively receiving information from the teacher. Learning is therefore viewed as a dynamic process in which individuals build meaning through exploration, experimentation, collaboration, and reflective thinking (Piaget, 1972; Vygotsky, 1978). In contemporary educational practice, constructivism underpins learner-centred pedagogy, inquiry-based learning, and problem-solving approaches that shift emphasis from memorization to understanding and application (Awofala, 2021).

Within mathematics education, constructivist theory provides a strong foundation for integrating computational thinking and coding-based instruction. Coding-integrated mathematics encourages learners to engage in hands-on activities such as simulations, algorithm development, debugging, and modelling of mathematical concepts. These activities promote deeper conceptual understanding and allow learners to actively construct mathematical meaning through digital interaction and experimentation (Kallia et al., 2021; Romandoni et al., 2025). In this context, the teacher assumes the role of a facilitator who guides learners through structured problem-solving experiences, thereby making constructivism highly relevant to this study.

Computational Thinking Theory, popularized by Jeannette Wing, defines computational thinking as a fundamental problem-solving process involving abstraction, decomposition, algorithmic reasoning, pattern recognition, debugging, and automation (Wing, 2021). The theory emphasizes that computational thinking is not limited to computer science but is a transferable cognitive skill applicable across disciplines such as mathematics, science, and engineering. It enables learners to approach complex problems systematically by breaking them into manageable components and designing logical solutions.

Theoretical debates surrounding computational thinking also reveal important educational implications. Proponents argue that computational thinking improves learners' analytical reasoning, creativity, collaboration, and interdisciplinary problem-solving capabilities (Wing, 2021). Computational thinking is also believed to strengthen students' ability to apply logical procedures in solving real-world challenges across multiple disciplines. Critics, however, caution against excessive technologization of education without corresponding investments in teacher preparation, infrastructural development, and contextual adaptation. Within the Nigerian educational context, successful integration of computational thinking into mathematics instruction requires culturally responsive strategies capable of addressing socio-economic disparities, infrastructural limitations, and pedagogical realities.

In mathematics education, computational thinking provides a conceptual bridge between abstract mathematical ideas and practical problem-solving processes. Coding-integrated instruction allows learners to apply algorithmic reasoning, simulation, and modelling to understand mathematical concepts more effectively (Cui & Ng, 2021). The theory further highlights the importance of teacher competence, as educators must possess computational thinking skills to design and implement coding-based instructional strategies. Teachers who are computationally competent are better able to foster creativity, engagement, and digital literacy among learners, making the theory central to this study's focus on teacher capacity development.

Several empirical studies have examined the relationship between computational thinking and mathematics education. Cui and Ng (2021) investigated the interplay between mathematical thinking and computational thinking among learners engaged in programming activities. The study found that computational thinking significantly enhanced students' mathematical problem-solving abilities and analytical reasoning. Kallia et al. (2021) conducted a Delphi study on computational thinking in mathematics education and identified abstraction, decomposition, pattern recognition, and algorithmic reasoning as essential competencies for integrating computational thinking into mathematics classrooms. The researchers emphasized that teacher preparedness remains fundamental to successful curriculum implementation.

Ogegbo and Ramnarain (2022) carried out a systematic review of computational thinking in science classrooms and found that teacher competence, digital infrastructure, and professional development significantly influenced implementation outcomes. The study identified inadequate teacher training as a major challenge affecting African educational systems. Oyelere et al. (2025) investigated computational thinking development in Nigerian K-12 education using Scratch programming. The study revealed that Nigerian teachers experienced challenges relating to digital competence, technological infrastructure, and pedagogical integration. However, teachers who participated in sustained professional development programs demonstrated significant improvement in computational thinking competence and instructional effectiveness.

Recent systematic reviews further indicate that integrating computational thinking into mathematics education improves students' creativity, logical reasoning, and collaborative problem-solving abilities. Researchers have also emphasized the importance of redesigning teacher education curricula to accommodate coding pedagogy and digital instructional strategies. The reviewed literature demonstrates that computational thinking has substantial educational benefits for mathematics instruction. However, gaps remain regarding teachers' computational thinking competence in Edo State secondary schools. This study therefore contributes to existing literature by examining strategies for enhancing teachers' computational thinking skills for coding-integrated mathematics curriculum implementation in Edo State.

Research Questions

The following research questions guided the study:

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2. What challenges affect teachers' implementation of coding-integrated mathematics curriculum in secondary schools in Edo State?
3. What strategies can enhance teachers' computational thinking skills for effective coding-integrated mathematics instruction in Edo State secondary schools?

Methodology

This study adopted a descriptive survey research design. The design was considered appropriate because it enables the systematic collection of data from respondents on existing conditions, opinions, and perceptions without manipulating variables or controlling experimental conditions (Creswell & Creswell, 2022). In the context of this study, the design allowed the researcher to examine mathematics teachers' computational thinking competencies, challenges encountered in implementing coding-integrated mathematics curriculum, and possible strategies for improvement as they naturally occur within secondary school environments. The descriptive survey approach is particularly suitable for educational studies that aim to generate empirical evidence for policy and instructional improvement within real-life classroom settings (Fraenkel, Wallen, & Hyun, 2023).

The study was conducted in Edo State, Nigeria, a region that has recently experienced significant educational reforms aimed at strengthening digital learning, ICT integration, and technology-driven instruction in public secondary schools. These reforms, including initiatives such as EdoBEST, reflect the state's commitment to improving instructional quality through digital innovation and teacher capacity development. The population of the study comprised all mathematics teachers in public secondary schools across Edo State. A total sample of 240 mathematics teachers was selected using a multistage sampling technique involving stratified sampling to ensure proportional representation across senatorial districts and simple random sampling to ensure equal chance of selection among teachers.

Data for the study were collected using a structured questionnaire titled "Teachers' Computational Thinking Skills and Coding-Integrated Mathematics Questionnaire" (TCTSCIMQ). The instrument was carefully designed based on literature on computational thinking, coding pedagogy, and mathematics education. It consisted of four major sections: Section A captured demographic information of respondents; Section B assessed teachers' computational thinking competencies; Section C examined challenges affecting implementation of coding-integrated mathematics curriculum; and Section D focused on strategies for enhancing computational thinking skills among teachers. The questionnaire adopted a four-point Likert scale ranging from Strongly Agree (4), Agree (3), Disagree (2), to Strongly Disagree (1), which allowed for the measurement of intensity of respondents' perceptions.

To ensure validity, the instrument was subjected to face and content validation by experts in mathematics education, educational technology, and measurement and evaluation from reputable Nigerian universities. Their comments and suggestions were used to refine the clarity, relevance, and alignment of the items with the study objectives. The reliability of the instrument was established through a pilot study involving mathematics teachers outside the main sample area. Cronbach Alpha reliability analysis was used to determine internal consistency, yielding a coefficient of 0.87, which indicates high reliability and suitability for educational research (Nunnally & Bernstein, 1994).

Data collected were analyzed using descriptive statistics, specifically mean and standard deviation, to answer the research questions. A criterion mean of 2.50 was established as the decision rule for interpreting responses; any item with a mean score of 2.50 and above was regarded as agreed, while those below 2.50 were regarded as disagreed. This analytical approach ensured objective interpretation of teachers' responses regarding computational thinking competencies and related instructional issues within secondary schools in Edo State.

Results

Research Question 1: What is the level of computational thinking competence possessed by mathematics teachers in secondary schools in Edo State?

Table 1: Mean Responses on Teachers' Computational Thinking Competence

S/N	Item	Mean	SD	Decision
1	I can apply algorithmic reasoning during mathematics instruction	2.63	0.82	Agree
2	I can integrate coding applications into mathematics teaching	2.31	0.79	Disagree
3	I understand decomposition and abstraction processes	2.71	0.80	Agree
4	I can guide students through coding-based mathematical activities	2.28	0.76	Disagree
5	I can use digital simulations in mathematics lessons	2.35	0.78	Disagree
6	I possess adequate computational thinking competence	2.42	0.81	Disagree
	Grand Mean	**2.45**	**0.79**	**Disagree**

The findings in Table 1 indicate that mathematics teachers in secondary schools in Edo State possess a below-average level of computational thinking competence, as reflected in the grand mean of 2.45, which falls slightly below the accepted decision benchmark of 2.50. This suggests that teachers are not sufficiently prepared to effectively implement coding-integrated mathematics instruction. Although respondents demonstrated some level of understanding of basic computational thinking constructs such as algorithmic reasoning (M = 2.63) and decomposition and abstraction (M = 2.71), these competencies appear to be largely conceptual rather than deeply internalised or consistently applied in classroom practice. This pattern implies that teachers may have been exposed to theoretical aspects of computational thinking but lack sustained engagement with practical, hands-on applications required for effective instructional delivery. On the other hand, the results show clear deficiencies in applied computational and pedagogical skills, particularly in integrating coding tools into mathematics teaching (M = 2.31), guiding learners through coding-based activities (M = 2.28), and using digital simulations for instructional purposes (M = 2.35). These low scores highlight a significant gap between theoretical awareness and practical implementation, suggesting that many teachers are not yet competent in translating computational thinking into classroom practice. The implication is that without targeted professional development, ICT support, and exposure to coding pedagogy, mathematics teachers in Edo State may continue to struggle with implementing modern, technology-enhanced instructional approaches required by the contemporary curriculum.

Research Question 2: What challenges affect teachers' implementation of coding-integrated mathematics curriculum in secondary schools in Edo State?

Table 2: Mean Responses on Challenges Affecting Implementation

S/N	Item	Mean	SD	Decision
1	Inadequate ICT facilities hinder coding instruction	3.45	0.64	Agree
2	Poor internet connectivity affects digital learning	3.38	0.69	Agree
3	Teachers lack adequate coding training opportunities	3.51	0.60	Agree
4	Lack of stable electricity affects implementation	3.56	0.58	Agree
5	Schools lack sufficient digital devices	3.43	0.66	Agree
6	Government support for coding education is inadequate	3.30	0.72	Agree
	Grand Mean	**3.44**	**0.65**	**Agree**

The findings in Table 2 reveal that teachers in secondary schools across Edo State strongly agreed that multiple systemic and institutional constraints significantly hinder the implementation of coding-integrated mathematics curriculum, as reflected in the high grand mean score of 3.44. This indicates that the challenges are not isolated but widespread and deeply embedded within the educational environment. The most pronounced constraint was the lack of stable electricity supply (M = 3.56), followed closely by inadequate coding training opportunities for teachers (M = 3.51), suggesting that both infrastructural instability and human capacity deficits are central barriers to effective curriculum implementation. These findings imply that even when teachers are willing to adopt computational thinking approaches, the absence of enabling conditions severely limits their ability to translate policy intentions into classroom practice.

Furthermore, the results highlight persistent deficiencies in ICT infrastructure and institutional support systems necessary for digital pedagogy. Teachers reported inadequate ICT facilities (M = 3.45), insufficient digital devices (M = 3.43), poor internet connectivity (M = 3.38), and weak government support for coding education (M = 3.30). Collectively, these constraints reflect a broader systemic weakness in educational technology provisioning within public secondary schools in Edo State. The implication is that coding-integrated mathematics curriculum cannot be effectively implemented in an environment lacking stable infrastructure, adequate funding, and sustained policy support. This situation aligns with broader evidence in Nigerian education literature which emphasizes that successful digital transformation in schools depends on a synergy between teacher capacity development and strong infrastructural investment (Okeke & Nwafor, 2022; Ugwoke & Eze, 2022).

Research Question 3: What strategies can enhance teachers' computational thinking skills for effective coding-integrated mathematics instruction in Edo State secondary schools?

Table 3: Mean Responses on Enhancement Strategies

S/N	Item	Mean	SD	Decision
1	Regular professional development programs should be organized	3.65	0.56	Agree
2	Government should provide functional ICT laboratories	3.72	0.52	Agree
3	Coding workshops should be organized for teachers	3.67	0.55	Agree
4	Coding should be integrated into teacher education curriculum	3.58	0.60	Agree
5	Schools should collaborate with technology organizations	3.41	0.63	Agree
6	Teachers should be encouraged to participate in peer mentoring	3.37	0.66	Agree
	Grand Mean	**3.57**	**0.59**	**Agree**

The findings in Table 3 indicate a strong consensus among respondents that multiple interconnected strategies are necessary for enhancing teachers' computational thinking skills for effective implementation of coding-integrated mathematics curriculum in Edo State secondary schools, as reflected in the high grand mean of 3.57. The highest-rated item, provision of functional ICT laboratories (M = 3.72), underscores the central role of infrastructure in enabling meaningful engagement with coding and computational tasks. Closely followed are the organization of coding workshops for teachers (M = 3.67) and regular professional development programmes (M = 3.65), suggesting that teachers perceive continuous capacity-building as essential for bridging the gap between theoretical knowledge and practical instructional competence in computational thinking.

In addition, respondents emphasized the importance of integrating coding into teacher education curricula (M = 3.58), indicating the need for early exposure of pre-service teachers to computational thinking pedagogy before entering the classroom. Collaboration with technology organizations (M = 3.41) and peer mentoring among teachers (M = 3.37) were also recognized as important strategies for sustaining professional growth and fostering collaborative learning communities. Collectively, these findings imply that enhancing teachers' computational thinking competence requires a holistic approach that combines infrastructure development, continuous professional training, curriculum reform, and collaborative support systems. This aligns with contemporary educational research which argues that sustainable integration of computational thinking in mathematics education depends on coordinated investments in both human capacity and technological resources (Oyelere et al., 2025; Okeke & Nwafor, 2022).

Discussion of Results

The findings suggest that many mathematics teachers remain insufficiently prepared for effective implementation of coding-integrated mathematics curriculum in secondary schools in Edo State. This inadequacy may be attributed to limited exposure to coding pedagogy, inadequate professional development opportunities, and restricted access to digital instructional resources. In line with this, Oyelere et al. (2025) reported that Nigerian teachers often experience significant challenges in developing computational thinking competence due to insufficient training and weak institutional support structures. Similarly, Eze and Chinedu (2024) observed that many secondary school teachers demonstrate low confidence in coding-related instruction, largely because teacher education programmes in Nigeria still provide minimal emphasis on computational pedagogy. These findings further support Ogegbo and Ramnarain (2022), who emphasized that teacher preparedness is a decisive factor in determining the success of computational thinking integration in classroom practice.

The results also indicate that infrastructural and institutional deficiencies continue to undermine the effective implementation of digital and coding-based curricula in Nigerian schools. The persistent challenges of inadequate ICT facilities, unstable electricity supply, poor internet connectivity, and insufficient digital devices reflect broader systemic weaknesses within the educational sector. These findings are consistent with Ugwoke and Eze (2022), who reported that infrastructural deficits significantly limit teachers' ability to integrate technology into instructional practices. Likewise, Okeke and Nwafor (2022) noted that digital curriculum implementation in Nigerian secondary schools is constrained by weak policy enforcement and inadequate funding for educational technology. On a broader African scale, Aina and Sofowora (2022) argued that sustainable ICT integration in education requires simultaneous investment in infrastructure and teacher capacity development.

Furthermore, the findings suggest that improving teachers' computational thinking competence requires sustained institutional support, continuous professional development, and systemic curriculum reforms. The integration of coding and computational thinking into teacher education programmes is particularly important, as it ensures that future teachers enter the profession with adequate digital pedagogical skills. This aligns with the findings of Romandoni et al. (2025), who emphasized that long-term success in computational thinking integration depends on early teacher preparation and structured professional learning pathways. Similarly, Awofala (2021) and Yusuf and Balogun (2023) stressed that strengthening teacher ICT competence through continuous training and curriculum redesign is essential for improving mathematics education outcomes in Nigeria. Collectively, these studies reinforce the need for a holistic approach combining infrastructure development, teacher education reform, and sustained professional support to achieve effective coding-integrated mathematics instruction.

Conclusion

The study concluded that mathematics teachers in secondary schools in Edo State possess a moderate level of awareness of computational thinking concepts, but demonstrate inadequate practical competence for effective implementation of coding-integrated mathematics instruction. While teachers show some understanding of foundational computational thinking skills such as algorithmic reasoning, abstraction, and decomposition, they lack the required ability to translate these concepts into meaningful classroom practices involving coding applications, digital simulations, and algorithm-based instructional activities. This gap between conceptual knowledge and pedagogical application reflects a significant weakness in teacher preparedness for contemporary mathematics instruction.

The study further established that the effective implementation of coding-integrated mathematics curriculum is constrained by multiple systemic challenges, including inadequate ICT infrastructure, poor internet connectivity, unstable electricity supply, insufficient digital devices, and limited professional development opportunities. These challenges collectively create an unfavourable instructional environment that limits teachers' ability to adopt computational thinking approaches. The study therefore concludes that strengthening teachers' computational thinking competence through sustained professional training, improved ICT infrastructure, curriculum redesign, and enhanced institutional support systems would significantly improve the implementation of coding-integrated mathematics instruction and ultimately enhance students' digital literacy and problem-solving abilities in secondary schools in Edo State.

Recommendations

1) The Edo State Ministry of Education should organize regular and structured professional development programmes, including workshops, seminars, and training sessions focused on coding pedagogy and computational thinking for mathematics teachers. Such programmes should be practical in nature and emphasize hands-on engagement with coding tools and instructional applications.
2) Government at both state and federal levels should prioritize the provision of functional ICT laboratories, reliable internet connectivity, and stable electricity supply in all public secondary schools. These infrastructural supports are essential for sustaining digital learning environments and enabling effective classroom implementation of coding-integrated instruction.
3) Teacher education institutions (universities and colleges of education) should undertake curriculum reform by embedding coding pedagogy, computational thinking, and digital instructional strategies into pre-service teacher training programmes. This will ensure that future teachers enter the profession with adequate competencies in technology-enhanced mathematics instruction.
4) Mathematics teachers should be actively encouraged and supported to participate in online coding communities, professional learning networks, and digital education platforms. Such exposure will enhance their continuous learning, improve instructional creativity, and strengthen their practical coding skills.
5) Schools should develop strategic partnerships with technology companies, educational technology organizations, and digital learning initiatives. These collaborations can provide access to training resources, software tools, mentorship opportunities, and technical support for teachers and students.
6) There should be the establishment of continuous monitoring and evaluation mechanisms by relevant education authorities to assess the implementation of coding-integrated mathematics curriculum. This will help ensure accountability, track progress, identify gaps, and guide evidence-based policy adjustments for sustained improvement in computational thinking education.

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