

ENHANCING SECONDARY SCHOOL MATHEMATICS TEACHERS' INSTRUCTIONAL DELIVERY THROUGH ARTIFICIAL INTELLIGENCE (AI) TOOLS

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Abstract

This study examined how Artificial Intelligence (AI) tools could improve Mathematics instructional delivery among secondary school teachers in Ebonyi State, Nigeria. A descriptive survey was employed involving 96 Mathematics teachers selected from 18 public secondary schools across six Local Government Areas. Data were gathered using a researcher-developed questionnaire titled Questionnaire on Enhancing Secondary School Mathematics Teachers' Instructional Delivery for AI Tools (QESMTDIAT) with an overall reliability index of 0.74 obtained through Cronbach Alpha. Analysis relied on mean and standard deviation using 2.50 as the benchmark for acceptance. Results indicated that teachers acknowledged the pedagogical relevance of tools such as ChatGPT for lesson preparation, GeoGebra for geometry and algebra visualization, Photomath, YouTube AI Tutor, Wolfram Alpha, Quizizz AI, and Desmos graphing calculator. Teachers reported that AI use enhanced instructional delivery substantially, with notable gains in collaborative learning, learner interest, instructional personalization, and engagement. No gender disparity was observed in general readiness (Male $M=2.61$, Female $M=2.61$), although confidence and frequency of classroom application remained low for both groups. Capacity-building measures including embedding AI literacy in teacher education curricula, regular professional development, improved infrastructure (internet/power), access to AI software, and peer mentoring were endorsed as viable enhancement strategies.

Keywords: Secondary School, Mathematics Instructional Delivery, Artificial Intelligence Tools.

Introduction

The contemporary educational landscape is being reshaped by emerging technologies, with Artificial Intelligence standing out as a transformative force. Luckin and colleagues (2016) described AI as systems designed to replicate human cognitive functions including reasoning, problem-solving and decision-making. Within Mathematics education, scholars have documented growing adoption of AI-driven platforms that support personalized learning pathways, visual representation of abstract ideas, instantaneous feedback and automated assessment procedures (Holmes, Bialik & Fadel, 2019). UNESCO (2023) highlighted AI's capacity to lessen teacher workload while delivering adaptive learning experiences.

Notwithstanding global momentum, classroom practice in many public secondary schools in Ebonyi State continues to reflect conventional chalk-and-talk approaches, with minimal integration of intelligent tools. The West African Examinations Council Chief Examiners' Report (2023) has linked declining Mathematics achievement to weak conceptual grasp and limited transfer to real-life situations. Prior investigations point to infrastructural constraints. Nwosu and Okoye (2024) identified erratic power supply, limited funding and inadequate digital infrastructure in the South-East. In Lagos, Adeleke and Akinoso (2023) observed that although GeoGebra and YouTube tutoring were moderately available, actual use remained low due to training gaps. Similarly, Onyema and Oguike (2022) in Enugu reported willingness but lack of institutional backing. Chiu and Chai (2020) in Hong Kong showed intelligent tutoring enhanced problem-solving when training and support were provided.

Recent studies by Anakpua and colleagues (2026) in Anambra State have demonstrated that AI-powered geometric videos and emerging technological tools such as graphing calculators, Mathway, Khan Academy and virtual whiteboards can improve achievement and problem-solving, providing a framework that supports the present investigation in Ebonyi State. These studies showed that dynamic geometry content and interactive platforms enhance conceptual understanding and engagement. This study is anchored on Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) which explained that effective technology integration requires teachers to possess an intersection of Technological Knowledge (TK), Pedagogical Knowledge (PK), and

Content Knowledge (CK). The theory upheld that for Mathematics teachers to effectively use AI tools, they must understand the Mathematics content, know appropriate pedagogical approaches, and also know how to apply AI technology to teach the content.

Although research has explored AI across Lagos, Enugu and other regions, evidence specific to Ebonyi State remains sparse. However, there is a dearth of studies specifically on enhancing secondary school Mathematics teachers' instructional delivery through the usage of AI tools in Ebonyi State. Most existing studies focused on general ICT or AI in tertiary institutions, and few addressed the peculiar context of Ebonyi State with its challenges of power, funding, rurality, and teacher training. Furthermore, while challenges have been identified, there is limited empirical data on specific strategies that can enhance AI usage for Mathematics instructional delivery in Ebonyi State. Evidence also shows that most secondary school Mathematics teachers in Ebonyi State have not fully embraced AI tools in their teaching. It is unclear which AI tools can enhance Mathematics teachers' instructional delivery, the extent to which AI usage enhances Mathematics teachers' instructional delivery, the level of teachers' readiness for AI integration for effective Mathematics delivery. It was against this background that this study seeks to investigate enhancing secondary school Mathematics teachers' instructional delivery for the usage of Artificial Intelligence tools in Ebonyi State.

Research Questions

1. What AI tools are perceived to enhance Mathematics teachers' instructional delivery?
2. To what extent does AI tools usage enhance Mathematics teachers' instructional delivery?
3. What is the readiness level of male and female Mathematics teachers for AI integration?
4. What strategies could enhance Mathematics teachers' use of AI tools?

Method

A descriptive survey design was adopted, suitable for obtaining information about prevailing conditions from a large population and for describing opinions, attitudes and perceptions (Nworgu, 2015). The study was carried out in Ebonyi State, situated in the South-East geo-political zone of Nigeria. The population comprised 1,240 Mathematics teachers in public secondary schools in Ebonyi State, according to records from the Ebonyi State Secondary Education Board (SSEB, 2023). A multistage sampling procedure was employed to select 96 teachers (27 males, 69 females) from 18 schools. First, two Local Government Areas were randomly selected from each of the three senatorial zones, yielding six LGAs. Second, three schools were randomly chosen from each LGA, totaling eighteen schools. Third, all Mathematics teachers in the selected schools were included until the sample size of 96 was attained.

The instrument was a structured questionnaire titled QESMTDIAT. It consisted of two sections: Section A demographic data, Section B four clusters with 28 items. Face validation was carried out by three experts in Science Education, FUNAI. A pilot test involving 30 Mathematics teachers outside the main study area yielded reliability coefficients of 0.74, 0.70, 0.71 and 0.77 for the four clusters respectively using Cronbach Alpha. The questionnaire was administered directly and retrieved on the spot, achieving 100% return rate (96 copies). Data were analyzed using mean and standard deviation, criterion mean 2.50.

Results

Table1: Mean and standard deviation response of AI tools perceived to enhance Mathematics teachers' instructional delivery

S/N	ITEMS	N	$\bar{X}$	SD	Decision
1	ChatGPT can be used by Mathematics teachers to generate lesson notes and explanations.	96	2.78	0.65	Accepted
2	YouTube AI Tutor tools can be used to provide video explanations for Mathematics topics.	96	2.81	0.57	Accepted
3	GeoGebra is an AI tool that can be used to teach geometry and algebra concepts.	96	2.88	0.54	Accepted
4	Wolfram Alpha can be used to solve and explain complex mathematical problems.	96	2.53	0.92	Accepted
5	Photomath can be used to scan and provide step-by-step solutions to mathematics problems.	96	2.62	0.78	Accepted
6	Quizizz AI can be used to generate Mathematics quizzes and assessments.	96	2.73	0.61	Accepted
7	Desmos AI Graphing Calculator can be used for graphing functions in mathematics class.	96	2.78	0.61	Accepted
Grand Mean			2.73	0.67	

The data in Table 1 shows that the grand mean ($\bar{X} = 2.73$, $SD = 0.67$) is above the criterion mean of 2.50. This confirms that, on average, Mathematics teachers agreed that the listed AI tools can enhance Mathematics instructional delivery. All 7 items had mean scores ranging from 2.53 to 2.88, which are above 2.50, indicating acceptance of all tools. Based on findings, it is concluded that AI tools such as ChatGPT, GeoGebra, Photomath, YouTube AI Tutor, Wolfram Alpha, Quizizz AI, and Desmos AI Graphing Calculator are accepted by Mathematics teachers as tools that can enhance instructional delivery in Mathematics in Ebonyi State.

Table 2: Mean and standard deviation response of extent of AI tools usage that enhance Mathematics teachers' instructional delivery

S/N	ITEMS	N	$\bar{X}$	SD	Decision
1	The use of AI enhances teachers' ability to provide personalized learning in Mathematics	96	2.84	0.53	High extent
2	AI tools make it easier to visualize abstract Mathematics concepts.	96	2.56	0.94	High extent
3	The use of AI increases students' interest in Mathematics lessons.	96	2.89	0.53	High extent
4	AI makes it possible to differentiate Mathematics instruction for different learners.	96	2.51	0.91	High extent
5	The use of AI gives room for peer / collaborative learning in mathematics.	96	3.00	0.50	Very High Extent
6	AI enhances teachers' ability to give immediate feedback to students in mathematics activities.	96	2.71	0.63	High extent
7	AI tools help in creating more engaging Mathematics instructional materials.	96	2.77	0.60	High extent
Grand Mean			2.75	0.66	

The data in Table 2 shows grand mean ($\bar{X} = 2.75$, $SD = 0.66$) above 2.50, confirming that usage enhances delivery to a high extent. All 7 items ranged from 2.51 to 3.00. It is concluded that the usage of AI tools enhances Mathematics teachers' instructional delivery to a high extent. AI tools are particularly effective in promoting collaborative learning, increasing students' interest, personalizing learning, and making materials more engaging.

Table 3: Mean and standard deviation response of readiness level of male and female Mathematics teachers for AI tools integration for instructional delivery

S/N	ITEMS	Gender	N	$\bar{X}$	SD	Decision
1	I regularly use AI tools in my Mathematics classroom.	Male	27	2.46	0.99	Not
		Female	69	2.37	1.02	Ready
2	I have received training on the use of AI in teaching mathematics.	Male	27	2.51	0.84	Ready
		Female	69	2.56	0.83	Ready
3	I have access to devices needed to use AI tools for mathematics instruction.	Male	27	2.62	0.73	Ready
		Female	69	2.59	0.70	Ready
4	I am confident in my ability to integrate AI tools into Mathematics lessons.	Male	27	2.34	0.99	Not
		Female	69	2.49	0.95	Ready
5	I am open to collaborating with colleagues on AI integration in mathematics lessons..	Male	27	3.00	0.03	Ready
		Female	69	3.02	1.00	Ready
6	. I am ready to dedicate time to learn new AI tools for teaching mathematics..	Male	27	2.78	0.61	Ready
		Female	69	2.71	0.67	Ready
7	I am aware of ethical issues involved in using AI for teaching mathematics.	Male	27	2.59	0.72	Ready
		Female	69	2.56	0.77	Ready
		Male		2.61	0.70	
		Female		2.61	0.85	

The data in Table 3 shows both male and female teachers have identical grand means of 2.61 (Male SD=0.70, Female SD=0.85), which is above 2.50. This indicates both groups are “Ready” for AI integration. The identical means show no gender difference in overall readiness. The finding

showed that male and female Mathematics teachers are equally “Ready” for AI integration overall. While they show strong willingness to collaborate and learn, there is need to improve confidence and regular classroom use through targeted hands-on training and support. Gender does not influence readiness.

Table4: Mean and standard deviation response of the strategies that could enhance Mathematics teachers' use of AI tools for effective instructional delivery

S/N	ITEMS	N	$\bar{X}$	SD	Decision
1	Integrating AI literacy into Mathematics teacher education programs.	96	3.03	0.49	Accepted
2	Organizing regular workshops and training on AI tools for Mathematics teachers.	96	3.00	0.50	Accepted
3	Providing Mathematics teachers with access to AI-powered software and apps.	96	2.72	0.62	Accepted
4	Providing stable internet and power supply in schools for AI usage.	96	2.84	0.56	Accepted
5	Encouraging the use of AI for creating interactive Mathematics activities.	96	2.85	0.50	Accepted
6	Sensitizing school administrators on the importance of AI in Mathematics teaching.	96	2.56	0.93	Accepted
7	Encouraging peer mentoring among teachers on the use of AI tools.	96	2.76	0.60	Accepted
Grand Mean			2.82	0.69	

The data in Table 4 shows grand mean ($\bar{X} = 2.82$, $SD = 0.69$) above 2.50, confirming that on average, all respondents accepted all listed items as strategies that can enhance Mathematics teachers' instructional usage of AI tools. Integrating AI literacy, regular workshops/training, provision of infrastructure and access, and peer mentoring are accepted strategies that can enhance mathematics teachers' instructional usage of AI tools for

effective mathematics delivery. Capacity-building through formal education and continuous training are perceived as most critical, over hardware alone.

Discussion

AI Tools Perceived to Enhance Instructional Delivery

The acceptance of AI tools including ChatGPT, GeoGebra, Photomath, YouTube AI Tutor, Wolfram Alpha, Quizizz AI and Desmos among Mathematics teachers in Ebonyi State indicates growing awareness of their pedagogical affordances. Rather than viewing AI as replacement for teachers, respondents perceived these tools as scaffolds for explaining complex concepts and supporting lesson preparation. This pattern mirrors observations by Holmes and colleagues (2019) who noted that AI tools provide visualization, personalization and immediate feedback, yet extends those observations to the Ebonyi context where resources are limited. The prominence of GeoGebra ($M=2.88$) as the most accepted tool suggests teachers particularly value visual and dynamic representation of algebra and geometry concepts. This finding aligns with Adeleke and Akinoso (2023) in Lagos State who reported GeoGebra as moderately available but underutilized, and with the recent studies by Anakpua et al. (2026) in Anambra State demonstrating that AI-powered geometric videos improve conceptual understanding. GeoGebra's ability to transform abstract equations into interactive diagrams addresses the challenge of abstractness identified in WAEC Chief Examiners' Reports (2023). The high rating for YouTube AI Tutor ($M=2.81$) indicates that teachers recognize the value of video-based explanations for reinforcing classroom teaching, especially for slow learners who need repetition. ChatGPT and Desmos (both $M=2.78$) scoring high indicates teachers appreciate tools that reduce workload in lesson note preparation and function graphing. The lowest but still accepted mean for Wolfram Alpha ($M=2.53$, $SD=0.92$) with high standard deviation suggests varied familiarity; some teachers with stronger content knowledge recognize its power for solving complex problems, while others are less aware of its pedagogical application. This variation underscores the need for targeted training, as posited by TPACK framework (Mishra & Koehler, 2006) that technological knowledge must be integrated with content and pedagogy.

Extent to which AI Usage Enhances Instructional Delivery

Concerning the extent of enhancement, the high overall rating (Grand $M=2.75$, $SD=0.66$) reveals that teachers perceive AI usage as substantially improving instructional delivery. The most striking finding is that item 5 - "The use of AI gives room for peer/collaborative learning in mathematics" scored **Very High Extent* ($M=3.00$, $SD=0.50$)*, the highest among all items. This implies respondents perceive collaboration as the greatest benefit of AI, not merely content delivery. Tools such as GeoGebra Classroom, Quizizz AI and Desmos Classroom allow students to share screens, co-construct graphs and compete in quizzes, fostering peer interaction. This differs from earlier findings in Lagos where AI use was rated as moderate and primarily for individual learning. The improvement may reflect increased exposure to digital platforms post-COVID-19, as reported by UNESCO (2023). The perception that AI increases students' interest in Mathematics ($M=2.89$) and provides personalized learning ($M=2.84$) indicates teachers recognize the motivational value of AI, addressing the problem of low interest and abstractness cited in WAEC reports. When students can visualize a quadratic function shifting in real time on Desmos, or receive step-by-step feedback from Photomath, anxiety reduces and interest increases. Items on creating engaging materials ($M=2.77$), giving immediate feedback ($M=2.71$), visualizing abstract concepts ($M=2.56$) and differentiating instruction ($M=2.51$) were all rated High Extent. The relatively lower mean for differentiating instruction (2.51) suggests teachers are still developing skills to use AI for catering to diverse learning needs, a gap that professional development can address. Overall, the finding supports Chiu and Chai (2020) in Hong Kong who found that intelligent tutoring systems enhance problem-solving and engagement when teachers are supported.

Readiness Level of Male and Female Teachers

On readiness, the identical grand means for male ($M=2.61$, $SD=0.70$) and female ($M=2.61$, $SD=0.85$) teachers show that gender does not influence overall preparedness for AI integration. This finding contradicts some earlier assumptions that male teachers are more technologically inclined, and aligns with Anakpua et al. (2026) who found no gender difference in achievement when AI-powered videos were used, and with Federal Ministry of Education (2022) policy that digital literacy should be gender-inclusive. However, disaggregation at item level reveals a*confidence-

competence gap. Items on regular classroom use (Item 1: Male $M=2.46$, Female $M=2.37$) and self-efficacy/confidence to integrate AI (Item 4: Male $M=2.34$, Female $M=2.49$) fell below the criterion mean of 2.50 and were rated “Not Ready” by both genders. This suggests affective readiness (willingness, awareness, openness) exceeds behavioral readiness (actual use, confidence). This pattern aligns with Onyema and Oguike (2022) in Enugu State who reported teachers were willing but lacked institutional backing and practical confidence. The gap is not gendered; both sexes require hands-on, school-based support rather than theoretical workshops. Conversely, the willingness to collaborate provides strong leverage for peer mentoring models, where more confident teachers can support colleagues, as recommended by Nwosu and Okoye (2024).

Strategies to Enhance AI Usage

The endorsement of all seven strategies (Grand $M=2.82$, $SD=0.69$) highlights that teachers perceive the solution as systemic rather than individual. The highest rated strategy was Item 1 - Integrating AI literacy into Mathematics teacher education programs ($M=3.03$, $SD=0.49$). This was closely followed by Item 2 - Organizing regular workshops and training on AI tools ($M=3.00$, $SD=0.50$). This implies that capacity building through formal pre-service curriculum and continuous in-service professional development are perceived as the most critical strategies, more important than hardware alone. This perspective reinforces the TPACK argument (Mishra & Koehler, 2006) that technological knowledge must intersect with pedagogical and content knowledge; without structured education, provision of devices alone will not lead to effective integration. The relatively lower mean for sensitizing administrators (2.56) but still accepted, with high SD (0.93), suggests varied experiences with school leadership support. Some schools have supportive principals, others do not, echoing Nwosu and Okoye (2024) who identified administrative support as a barrier in South-East Nigeria.

The prioritization of knowledge-building strategies over infrastructure alone is insightful. While Ebonyi State faces challenges of power and connectivity, teachers themselves attribute low use primarily to knowledge gaps rather than merely lack of devices. This suggests interventions should be sequenced: first build competence through curriculum reform and hands-

on workshops, then provide stable infrastructure and software access as enabling conditions, while simultaneously fostering peer mentoring circles to sustain the high collaborative willingness found in this study.

Conclusion

It is concluded that Ebonyi State Mathematics teachers recognize ChatGPT, GeoGebra, Photomath, YouTube Tutor, Wolfram Alpha, Quizizz and Desmos as viable tools for enhancing instruction. Their application enhances delivery substantially, especially in promoting collaborative learning, sustaining interest, personalizing instruction and creating engaging materials. Male and female teachers exhibit comparable overall readiness but limited confidence and infrequent classroom application. Strategies centered on teacher education curriculum reform, continuous professional development, provision of connectivity and devices, administrative sensitization and peer mentoring were accepted as pathways to improve AI integration.

Recommendations

Based on the outcome of this study, the researchers recommended that :

1. The Teachers Registration Council of Nigeria and teacher training institutions should support AI literacy, comprising GeoGebra, Desmos, ChatGPT pedagogical use and ethical considerations, in pre-service and in-service curricula for Mathematics teachers.
2. Ebonyi State Secondary Education Board in partnership with NGOs and EdTech organizations should organize school-based, hands-on workshops quarterly focusing on practical lesson design with AI tools, not theoretical lectures.
3. State government should prioritize stable power and internet connectivity in the 18 sampled schools as pilot hubs, while providing licensed access to AI software and low-cost tablets for Mathematics departments.
4. Principals should be oriented on instructional benefits of AI and encouraged to allocate time for peer mentoring circles where confident teachers support colleagues, leveraging the high willingness to collaborate found in this study.
5. Future research should move beyond self-report to classroom observation and quasi-experimental studies measuring actual student achievement gains when AI tools are integrated.

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