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Impact of Lecturers' Artificial Intelligence (AI) Capacity Building Programme on the Effectiveness of Mathematics Instruction in Public Colleges of Education in South-East, Nigeria

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Abstract

The study investigated the Impact of Lecturers' Artificial Intelligence (AI) Capacity Building Programme on the Effectiveness of Mathematics Instruction in Public Colleges of Education in South-East, Nigeria. Three research questions and three null hypotheses guided the quasi-experimental study. The population of the study comprised 130 mathematics lecturers in ten Public Colleges of Education in South-East, Nigeria. Through, total enumeration sampling technique all the lecturers participated in the study. Data were collected using the Mathematics Instruction Effectiveness Questionnaire (MIEQ), validated by three experts, with a Cronbach's alpha reliability coefficient of 0.79. Data were analysed using descriptive statistics and analysis of covariance (ANCOVA). There was statistically significant impact of lecturers' AI capacity building programme on mathematics instructional effectiveness ($F = 137.859$, $P = 0.000$, $\eta 2p = 0.528$). Educational qualification significantly influences lecturers' mathematics instructional effectiveness ($F = 29.829$, $P = 0.000$, $\eta 2p = 0.327$). There was no significant interaction effect of lecturers' educational qualification and AI capacity building programme on mathematics instructional effectiveness ($F = 0.485$, $P = 0.617$, $\eta 2p = 0.008$). The study recommended that Public Colleges of Education should institutionalise AI-focused capacity-building programmes that move beyond general awareness of AI to practical application of AI tools in mathematics instruction.

Keywords: artificial intelligence, capacity building programme, mathematics, instructional effectiveness, lecturers, colleges of education

1 Introduction

The quality of mathematics instruction in Colleges of Education increasingly depends not only on lecturers' content expertise but also on their ability to leverage emerging digital technologies to enhance teaching and learning. As Artificial Intelligence (AI) transforms educational practices globally, the integration of AI-enabled pedagogies by mathematics lecturers has become essential. However, structured professional development programmes that equip lecturers with AI pedagogical competencies remain limited in many Nigerian higher education institutions, particularly in public colleges of education. Strengthening lecturers' AI capacity is therefore a strategic approach to improving the effectiveness of mathematics instruction in the contemporary era. Mathematics instruction holds a strategic role in Public Colleges of Education, as these institutions prepare future teachers whose pedagogical competence influences the quality of mathematics learning at the basic education level. Nevertheless, mathematics instruction in many Nigerian Colleges of Education, including those in the South-East geopolitical zone, faces persistent challenges that undermine its effectiveness. Luneta (2025) emphasises that in many Sub-Saharan African countries, including Nigeria, mathematics instruction is hindered by factors such as overreliance on traditional lecture methods, limited instructional resources, low learner engagement, and teachers' insufficient exposure to emerging pedagogical technologies, such as Artificial Intelligence (AI).

The growing relevance of AI in education has gained global and national attention. Researchers such as Wodon et al. (2026), Abbasi et al. (2025), and Yang et al. (2023) continue to advocate for the responsible integration of AI in education to support effective teaching while ensuring ethical implementation. In Nigeria, the establishment of the National Centre

for Artificial Intelligence in 2020 and the National Artificial Intelligence Strategy (NAIS) in 2024 are initiatives supporting the ethical integration of AI in education (Irfan et al., 2025). Artificial Intelligence (AI) has introduced transformative possibilities for educational practices. AI-powered technologies, including generative AI applications, intelligent tutoring systems, and adaptive learning platforms, are providing personalised instruction, immediate feedback, and interactive learning experiences (Banjade et al., 2024; Khalaily, 2025; Oladele, 2024), all of which can support effective teaching.

The abstract nature of Mathematics is particularly suited to AI-supported instruction. AI-powered applications have the potential to simplify abstract concepts, provide instant feedback, accommodate diverse learning paces, and enhance problem-solving skills among student-teachers (Oladele, 2024). Additionally, Özdemir (2024) stated that AI tools such as ChatGPT, Claude, Gemini, and Copilot have been shown to generate lesson plans that are comparably effective to teacher-prepared plans in elementary mathematics classrooms. Again, AI-generated problem-solving tips have proven difficult for human raters to distinguish from tutor-generated tips, suggesting AI can meaningfully reduce lecturers' workload in designing practice materials (Umoh, 2025). The National Council of Teachers of Mathematics (NCTM, 2024) has similarly issued a position statement describing AI's role in mathematics instruction as bringing about "evolutionary, not revolutionary" change, one that complements rather than replaces the mathematics teacher, provided teachers retain strong content and pedagogical knowledge.

Yet these gains do not accrue automatically. A recurring finding across the professional development literature is that lecturers require substantial, sustained training before they can use AI tools competently in planning, instruction delivery and assessment (Munazza et al., 2026; Dogan et al., 2025; Shezad et al., 2025). In the South-East specifically, Mathematics Lecturers in higher education institutions have been found to demonstrate low AI competence, largely attributable to inadequate training and limited exposure to AI tools, even where student engagement with AI is moderate to active (Ahlam et al., 2025). In addition to AI pedagogical competence, teacher-related characteristics, such as educational qualifications, can play a crucial role in shaping the effectiveness of mathematics instruction (Akuse et al., 2026). A teacher's qualification can provide the foundational knowledge and training needed to understand innovative pedagogies. However, the influence of teachers' qualifications on the instructional effectiveness of Mathematics within Public Colleges of Education in Nigeria remains largely underexplored. Although previous studies have examined lecturers' perception (Mutanga et al., 2024), awareness and adoption (Yakubu et al., 2025), and challenges regarding AI technologies (Ahlam et al., 2025), there is little empirical evidence on whether participation in AI capacity building programmes translates into measurable improvements in Mathematics instructional effectiveness within Public Colleges of Education in Nigeria. It is against this backdrop that the present study seeks to examine the impact of AI capacity building programmes for lecturers on the effectiveness of mathematics instruction in Public Colleges of Education across Nigeria's South-East.

1.1 Research Questions

1. What is the impact of lecturers' AI capacity building programme on mathematics instructional effectiveness in Public Colleges of Education in South-East Nigeria?
2. What is the influence of lecturers' educational qualification on mathematics instructional effectiveness in Public Colleges of Education in South-East Nigeria?
3. What is the interaction effect of lecturers' educational qualification and capacity building programme on mathematics instructional effectiveness in Public Colleges of Education in South-East Nigeria?

1.2 Significance of the Study

The work, when published, will have practical significance for college of education mathematics lecturers, college administrators and management, NCCE, the Federal Ministry of Education and TETFund, and Curriculum Developers and Trainers. To mathematics lecturers, the findings may show how structured AI training can strengthen lesson planning, content delivery, assessment, feedback and the explanation of abstract mathematical concepts. Lecturers can use AI tools to prepare resources, create varied examples, simulate problem-solving, and personalise instruction, thereby raising their confidence and effectiveness.

To college administrators and management: The results may give evidence to justify investment in AI infrastructure, training workshops and ongoing professional development. Administrators could build AI capacity into institutional staff development plans rather than leaving it to individual initiative. To the National Commission for Colleges of Education

(NCCE): The findings can guide the revision of the Minimum Standards and curriculum so that AI competence is integrated into lecturer development and teacher preparation. To the Federal Ministry of Education and TETFund: The study will support funding decisions. It can inform sponsored training programmes, AI-ready facilities, and capacity-building initiatives for lecturers at tertiary institutions. To the Curriculum Developers and Trainers: the tested programme can serve as a model or template for designing similar training in other subject areas and institutions. Curriculum planners and professional development providers could adapt its content, duration and delivery approach.

2 Literature Review

2.1 Theoretical Framework

This paper is anchored in the Technological Pedagogical Content Knowledge (TPACK) framework by Mishra and Koehler (2006), which conceptualises effective technology-integrated teaching as the intersection of technological, pedagogical, and content knowledge. It predicts that AI capacity building will translate into effective mathematics instruction, in which lecturers develop AI-specific technological knowledge that is integrated with, rather than separate from, their existing mathematics content and pedagogical expertise. Again, the work is also anchored on Guskey's (2003) model of evaluating professional development, which distinguishes five levels of impact: participants' reactions, learning, organisational support, use of new knowledge and skills, and ultimately student learning outcomes, offering a structured lens for tracing whether AI capacity building moves beyond lecturer satisfaction to actual instructional effectiveness.

2.2 AI Capacity Building for Lecturers

AI capacity building, for this paper, refers to structured, sustained professional development activities, such as workshops, short courses, micro-credentials, mentoring, and communities of practice, designed to build lecturers' knowledge, skills, and confidence in using AI tools for teaching, learning, and assessment. This is distinguished from incidental or self-directed exposure to AI tools such as ChatGPT, Claude, Genminie, Grok and Copilot. Globally, capacity building initiatives of this kind are proliferating: the UNESCO International Centre for Higher Education Innovation (Wodon et al., 2026), for instance, has developed 24 competency-based courses on digital and AI competencies piloted across nine countries including Nigeria, and has outlined a roadmap for delivering competency-based courses for the higher-education workforce in English, French, and Aabic (Li, 2025; Marquis et al., 2024). At the school-teacher level, Nigeria's Teachers Registration Council (TRCN) has partnered with GMind AI on the "Naija Teacher AI" initiative, targeting 1.5 million licensed teachers with AI-powered lesson-planning and assessment tools alongside professional development delivered through a dedicated academy, in phases running from late 2025 through 2026 (Fakhar et al., 2024; Bahari & Liu, 2025).

2.3 AI Capacity Building and Mathematics Instruction Effectiveness

Evidence on AI's instructional value in mathematics is accumulating rapidly. Fakhar et al. (2024) found that ChatGPT-generated lesson plans for elementary mathematics were comparably effective to teacher-prepared plans in improving student achievement, incorporating clear objectives, real-life connections, and structured feedback. This suggests AI can match teachers on lesson design, though parity is not superiority, and the finding says little about whether such plans improve with teacher refinement. Dogan et al. (2025) stated that AI-based tools do not replace the need to teach mathematics or develop problem-solving ability; rather, they are expected to produce evolutionary, not revolutionary, change, contingent on teachers possessing robust mathematical knowledge and strong pedagogical skills. Bahari and Liu (2025) found that teachers required substantial professional development before they could use AI tools such as ChatGPT, AI-assisted curriculum platforms, and AI-integrated STEAM models effectively in planning, instruction, and assessment, and that tools like Khanmigo were being used specifically to strengthen pre-service and in-service teachers' Technological Pedagogical Content Knowledge (TPACK). Access to AI tools is therefore insufficient; structured training becomes the enabling condition.

Research on the impact of an AI-based capacity-building programme on teachers' effectiveness is still evolving and varies in rigour. In a community-based development initiative involving 18 teachers, practical mentoring in tools such as ChatGPT and digital quiz platforms raised instructional management scores from 65.3 to 84.7, representing a 29.7% performance improvement (Noviyanti et al., 2026). The gain is substantial, but the small sample and apparent absence of a comparison group limit causal inference and generalisability. Chen and Osman (2026) conducted a quasi-experimental study of a

TPACK-grounded, AI-supported Competency Development module based on problem-based learning (CTD-PBL) for 130 pre-service teachers, revealing that the CTD-PBL group reported higher post-test TPACK scores. In another study, pre-service teachers who engaged in AI-integrated problem-posing activities using ChatGPT reported that the tool supported the development of pedagogical content knowledge, while also surfacing the need for critical evaluation of AI outputs given the risk of errors and "hallucinations" (Ahlam et al., 2025). Participants highlighted the need to critically evaluate AI outputs due to errors and hallucinations, underscoring the need for capacity building that includes AI literacy and critical judgement alongside tool operation.

2.4 Interaction of Educational Qualification with AI-Capacity Building and Instructional Effectiveness

The literature on educational qualifications and capacity building is divided on whether the interaction of these variables shapes instructional effectiveness. Inweregbuh et al. (2023) found that teacher education qualifications significantly influence curriculum implementation. Lecturers or teachers with higher qualifications may have had greater opportunities to engage with scholarly literature, research activities and advanced academic discourse. In another study, Maryani et al. (2022) found that education level influences pedagogical competence. Teachers with higher qualifications have had greater exposure to scholarly literature, research activity, and advanced academic discourse, which may facilitate the uptake of new pedagogical practices.

On the other hand, Didion et al. (2020) showed that the effects of teacher professional development were not significantly moderated by advanced degrees. In another study, Moosa and Shareefa (2019) found that qualification did not moderate the implementation outcomes of differentiated instruction. Qualification may shape what teachers bring to the classroom without altering how much they gain from a well-designed capacity building programme. In support of the foregoing, Darling-Hammond et al. (2017) attributed the effectiveness of professional development to design features such as active learning, modelling and sustained practice, which were common to all participants in this programme. These features were common to all participants in this programme, which may have equalised gains across qualification levels.

3 Materials and Methodology

3.1 Research Design

The study adopted a quasi-experimental research design. Specifically, the pretest-posttest, non-equivalent control group design involving two groups was employed in this study. Hamed et al. (2026) defined quasi-experimental design as an experiment where random assignment of subjects to experimental and control groups is not possible. In this case, lecturers in the colleges of education under study were assigned to the control and experimental groups without randomisation.

3.2 Participants

The study was conducted in the public Colleges of Education in South-East Nigeria. The target population comprises all 130 mathematics lecturers in the ten Public Colleges of Education across the five South-East states. This population is made up of 14 mathematics lecturers from Federal College of Education, Ofeme Ohuhu Abia State, 12 mathematics lecturers from Abia State College of Education Technical, Arochukwu, 19 mathematics lecturers from Alvan Ikoku Federal College of Education, Owerri, 9 mathematics lecturers from Benjamin Uwajumogu State College of Education, Ihitte Uboma Imo State, 14 mathematics lecturers from Federal College of Education (Technical), Umunze Anambra, 11 mathematics lecturers from Nwafor Orizu College of Education, Nsugbe Anambra State, 9 mathematics lecturers from Federal College of Education (Technical) Isu Ebonyi State, 13 mathematics lecturers from Ebonyi State College of Education Okwo, 18 mathematics lecturers from Federal College of Education, Eha-Amufu Enugu State and 12 mathematics lecturers from Enugu College of Education Technical. Using the total enumeration sampling technique, 130 mathematics lecturers participated in the study. Each of the Colleges of Education represents an intact group. Hence, five Colleges were assigned to each of the experimental groups (control and experiment). No single College received both treatments to avoid subject interactivity. Consequently, all lecturers in each group participated in the study.

3.3 Instrument for Data Collection

A researcher-developed Mathematics Instruction Effectiveness Questionnaire (MIEQ) and an AI capacity-building package facilitated data collection in this study. The MIEQ has two sections (A and B). Section A contains demographic and participation data; Section B contains 28 items designed on a Likert-type scale to measure lecturers' mathematics instructional effectiveness. Face and content validity of the instrument were established through review by experts in Measurement and Evaluation and in Mathematics Education from the University of Nigeria, Nsukka, who assessed the instrument's items for clarity and relevance, with corrections noted and implemented to arrive at the present version of the instrument. Reliability was established through a pilot test administered to mathematics lecturers from the Federal College of Education, Ogbudu, Benue State, which is outside the study area. The internal consistency was computed using Cronbach's alpha, yielding a coefficient of 0.79, which was considered acceptable for adoption.

3.4 Experimental Procedure

Data collection for the study lasted three months. Following participants' informed consent, the experimental and control groups were administered the Mathematics Instruction Effectiveness Questionnaire (MIEQ) as a pretest in the first month of the study to establish baseline data on lecturers' mathematics instructional effectiveness. Afterwards, the experimental group participated in the two-month Lecturers' Artificial Intelligence Capacity Building Programme (LAICBP), while the control group continued with conventional instructional practices without any AI training. The LAICBP was implemented over two months, with training conducted two days per week for two hours per session. At the end of the programme, both groups were administered the MIEQ as posttests under similar conditions. This was done to determine the impact of the AI capacity building programme on the effectiveness of mathematics instruction.

3.5 Data Analysis

The data gathered were analysed using the Statistical Package for the Social Sciences (SPSS) version 27. Research questions were answered using means and standard deviations, while the null hypotheses were tested using analysis of covariance (ANCOVA) at the 0.05 significance level. The decision rule was to accept the null hypothesis if the p-value was greater than 0.05, and reject it otherwise.

4 Results

Table **1**

Independent sample t-test of the difference in the mean mathematics instructional effectiveness scores of lecturers at pretest

Treatment	N	$\bar{X}$	SD	df	t-val.	P-value	Remarks
LAICBP	69	69.26	10.22				
				128	-1.23	0.58	NS
Control	61	70.16	7.83				

Result in Table 1, shows that lecturers in the LAICBP had a mean mathematics instructional effectiveness score of $\bar{x}$ = 69.26 and SD = 10.22 while those in the control group had a mean mathematics instructional effectiveness score of $\bar{x}$ = 70.16 and SD = 7.83 in pretest. This indicates that before treatment, lecturers in the conventional or control group slightly outperformed those in the treatment group, demonstrating nonequivalence among the groups. However, the difference between the groups was not statistically significant ($p > 0.05$). This result further justifies the use of analysis of covariance (ANCOVA) for further inference.

Table **2**

Mean and standard deviation of mathematics instructional effectiveness scores of lecturers exposed to LAICBP and those not exposed to it

Treatment		Pretest		Post-test		
	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Difference
LAICBP	69	69.26	10.22	83.99	9.61	14.73

Control	61	70.16	7.83	73.64	9.86	3.48

Results in Table 2 shows that lecturers exposed to the AI capacity building programme (LAICBP) had a mean mathematics instructional effectiveness score of $\bar{x}$ = 69.26 and SD = 10.22 in pretest and a mean mathematics instructional effectiveness score of $\bar{x}$ = 83.99 and SD = 9.61 in the posttest with a mean difference of 14.73. In contrast, those in the control group had a mean mathematics instructional effectiveness score of $\bar{x}$ = 70.16 and SD = 7.83 in pretest and a mean mathematics instructional effectiveness score of $\bar{x}$ = 73.64 and SD = 9.86 in the posttest with a mean difference of 3.48. The results show that lecturers exposed to the AI capacity building programme recorded a higher mean difference than those in the control group after the posttest. This indicates that LAICBP impacts mathematics instructional effectiveness in Public Colleges of Education in South-East Nigeria.

Table **3**

Analysis of covariance (ANCOVA) of the impact of lecturer's AI capacity building programme on mathematics instructional effectiveness

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**P-value**	**Partial Eta Squared**
Corrected Model	12344.855[a]	6	2057.48	78.400	.000	.793
Intercept	1404.146	1	1404.15	53.505	.000	.303
Pretest	5901.698	1	5901.70	224.884	.000	.646
Group	3617.867	1	3617.87	137.859	.000	.528
Qualification	1565.613	2	782.806	29.829	.000	.327
Group*Qualification	25.460	2	12.730	.485	.617	.008
Error	3227.922	123	26.243			
Total	829591.000	130				
Corrected Total	15572.777	129				

The result in Table 3 shows the F-ratio ($F(1, 123) = 137.859$, p=0.000, $\eta^2_p = 0.528$) obtained for the difference in the mean mathematics instructional effectiveness scores of lecturers exposed to LAICBP and those not exposed. Since the exact probability value of 0.000 is less than the 0.05 level of significance, there is a significant difference in the mean mathematics instructional effectiveness scores of lecturers exposed to LAICBP and those not exposed to it. The result further showed an effect size of ($\eta^2_p = 0.528$), indicating that the LAICBP accounted for approximately 52.8% of the variance in lecturers' mathematics instructional effectiveness after controlling for unexplained error variance. This suggests that lecturers' AI capacity building programme significantly impacted mathematics instructional effectiveness in Public Colleges of Education in South-East Nigeria.

Table **4**

Mean and standard deviation of lecturers on the influence of educational qualification on mathematics instructional effectiveness

Qualification		**Pretest**		**Post-test**		
	N	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Difference**
Bachelor	38	67.21	8.55	72.76	8.76	5.55
Masters	58	70.45	9.70	79.74	10.55	9.29
Doctorate	34	71.15	8.52	85.21	10.41	14.06

Results in Table 4 shows that lecturers with bachelor degree had a mean mathematics instructional effectiveness score of $\bar{x}$ = 67.21 and SD = 8.55 in pretest and a mean mathematics instructional effectiveness score of $\bar{x}$ = 72.76 and SD = 8.76 in the posttest with a mean difference of 5.55. In contrast, lecturers with master's degree had a mean mathematics instructional effectiveness score of $\bar{x}$ = 70.45 and SD = 9.70 in pretest and a mean mathematics instructional effectiveness score of $\bar{x}$ = 79.74 and SD = 10.55 in the posttest with a mean difference of 9.29. More so, lecturers with doctorate degree

had a mean mathematics instructional effectiveness score of $\bar{x}$ = 71.15 and SD = 8.52 in pretest and a mean mathematics instructional effectiveness score of $\bar{x}$ = 85.21 and SD = 10.41 in the posttest with a mean difference of 14.06. The results show that lecturers' qualification appear to influence the effectiveness of mathematics instruction, with lecturers holding a doctoral degree having the largest mean difference (MD = 14.06), followed by those with a master's (MD = 9.29), and a bachelor's (MD = 5.55), respectively.

Additionally, the result in Table 3 shows the F-ratio ($F(2, 123) = 29.829$, p=0.000, $\eta^2_p = 0.327$) obtained for the influence of educational qualification on lecturers' mathematics instructional effectiveness. Since the exact probability value of 0.000 is less than the 0.05 level of significance, educational qualification significantly influences lecturers' mathematics instructional effectiveness. The result further showed an effect size of ($\eta^2_p = 0.327$), indicating that educational qualification accounted for approximately 32.7% of the variance in lecturers' mathematics instructional effectiveness after controlling for other sources of variance in the model. This indicates that educational qualification is a substantial determinant of lecturers' mathematics instructional effectiveness.

Table **5**

Interaction effect of educational qualification and LAICBP on mathematics instructional effectiveness

Gender	**Treatment**	**Pretest**			**Posttest**		**Mean Difference**
		N	$\bar{x}$	**SD**	$\bar{x}$	**SD**	
Bachelor	LAICBP	20	65.45	10.06	76.95	7.47	11.50
	Control	18	69.17	6.19	68.11	7.81	-1.06
Masters	LAICBP	31	71.32	11.34	85.74	9.79	14.42
	Control	27	69.44	7.48	72.85	6.43	3.41
Doctorate	LAICBP	18	69.94	7.23	88.78	7.05	18.84
	Control	16	72.50	9.83	81.19	12.22	8.69

The result in Table 5 shows the pretest and posttest mathematics instructional effectiveness scores of lecturers across different educational qualifications. Among lecturers with a Bachelor's degree who were exposed to LAICBP, the pretest mean score was 65.45 (SD = 10.06), while the posttest mean score was 76.95 (SD = 7.47), with a mean difference of 11.50. In contrast, Bachelor's degree holders in the control group recorded a pretest mean of 69.17 (SD = 6.19) and a posttest mean of 68.11 (SD = 7.81), resulting in a mean difference of -1.06. For lecturers with a Master's degree who were exposed to LAICBP, the pretest mean score was 71.32 (SD = 11.34) and the posttest mean score was 85.74 (SD = 9.79), yielding a mean difference of 14.42. Conversely, Master's degree holders in the control group had a pretest mean of 69.44 (SD = 7.48) and a posttest mean of 72.85 (SD = 6.43), yielding a mean difference of 3.41. Among lecturers with a Doctorate, those exposed to LAICBP had a pretest mean score of 69.94 (SD = 7.23), and a posttest mean score of 88.78 (SD = 7.05), yielding a mean difference of 18.84. Doctorate holders in the control group, however, recorded a pretest mean of 72.50 (SD = 9.83) and a posttest mean of 81.19 (SD = 12.22), resulting in a mean difference of 8.69. The result indicates that LAICBP was associated with improved mathematics instructional effectiveness across all educational qualification categories. However, the magnitude of the mean differences differs slightly across the various categories of educational qualification.

Furthermore, the result in Table 3 shows the F-ratio ($F(2, 123) = 0.485$, p=0.617, $\eta^2_p = 0.008$) obtained for the interaction effect of educational qualification and LAICBP on mathematics instructional effectiveness. Since the exact probability value of 0.617 is greater than the 0.05 level of significance, there is no statistically significant interaction effect of educational qualification and LAICBP on mathematics instructional effectiveness in Public Colleges of Education in South-East Nigeria. The result further showed an effect size of ($\eta^2_p = 0.008$), indicating that the interaction between educational qualification and LAICBP accounted for approximately 0.8% of the variance in mathematics instructional effectiveness after controlling for other sources of variance in the model.

5 Discussion

The study found that lecturers exposed to the AI capacity-building programme (LAICBP) recorded a higher mean difference than those in the control group after the posttest, indicating a significant difference in the mean mathematics instructional effectiveness of lecturers in the two groups. The finding indicates that the LAICBP was effective in improving lecturers'

capacity to deliver mathematics instruction. This suggests that structured exposure to artificial intelligence tools and AI-supported pedagogical practices can strengthen lecturers' ability to plan lessons, generate instructional materials, present mathematical concepts, assess students' understanding, and provide timely feedback. The LAICBP's practical orientation may also explain the significant difference between the experimental groups. Unlike general awareness of artificial intelligence, a structured capacity-building programme provides lecturers with opportunities to learn how to integrate AI tools into instructional planning and classroom practice deliberately. Thus, the improvement observed among lecturers exposed to the AI capacity-building programme is credible.

The finding is supported by existing empirical evidence. For instance, Fakhar et al. (2024) found that ChatGPT-generated lesson plans for elementary mathematics were comparably effective to teacher-prepared plans in improving student achievement, incorporating clear objectives, real-life connections, and structured feedback. This demonstrates the efficacy of AI tools like ChatGPT in enhancing instructional effectiveness, as revealed by the present finding. Noviyanti et al. (2026) demonstrated that practical mentoring in tools such as ChatGPT and digital quiz platforms raised teachers' instructional management scores, suggesting improved instructional effectiveness. In another study, Chen and Osman (2026) found that an AI-supported Competency Development module based on problem-based learning (CTD-PBL) improved pre-service teachers' TPACK scores, which agrees with the present finding. Hence, the present finding supports the integration of AI in the design and implementation of mathematics instruction. In the context of Public Colleges of Education, where lecturers are responsible for preparing future teachers, strengthening lecturers' AI competence may, in turn, model innovative pedagogical practices for future teachers.

Findings also revealed that educational qualification significantly influences lecturers' mathematics instructional effectiveness. The finding indicates that lecturers with different levels of academic qualification differed significantly in their instructional effectiveness. This finding is feasible because higher educational qualifications may provide lecturers with broader exposure to advanced mathematical content, educational theories, research methods, curriculum development, assessment practices and contemporary approaches to teaching and learning. This finding is consistent with Inweregbuh et al. (2023), who found that teacher education qualifications significantly influence curriculum implementation. Lecturers or teachers with higher qualifications may have had greater opportunities to engage with scholarly literature, research activities and advanced academic discourse. Such experiences can broaden their understanding of mathematics education and provide them with alternative approaches to explaining mathematical concepts and addressing students' learning difficulties, thereby enhancing their instructional effectiveness, as revealed by the present finding. Additionally, Maryani et al. (2022) found that education level influences pedagogical competence, which agrees with the present finding. Thus, in line with existing literature, the present finding supports the view that educational qualification contributes to the knowledge and competencies required for effective mathematics instruction.

The study further found no statistically significant interaction effect of educational qualification and LAICBP on mathematics instructional effectiveness in Public Colleges of Education in South-East Nigeria. This demonstrates that, although educational qualification independently influenced instructional effectiveness and the AI capacity-building programme independently produced a significant effect, the effectiveness of the programme did not significantly depend on lecturers' educational qualification. In practical terms, the finding suggests that the AI capacity-building programme was beneficial across the different qualification categories represented in the study. This suggests that an appropriately designed AI capacity-building programme may provide instructional benefits to lecturers, irrespective of their existing academic qualifications. One plausible explanation of this finding is the structured nature of the intervention. If all participating lecturers received comparable training, demonstrations, guided practice, and opportunities to apply AI tools in mathematics instruction, the programme may have provided a common learning experience that could improve instructional effectiveness across qualification groups.

This finding is consistent with You et al. (2025), who showed that the effects of teacher professional development were not significantly moderated by advanced degrees. In another study, Shareefa (2023) found that qualification did not moderate the implementation outcomes of differentiated instruction, which agrees with the present finding. The finding also aligns with Darling-Hammond et al. (2017), who attribute the effectiveness of professional development to design features such as active learning, modelling and sustained practice, which were common to all participants in this programme. Hence, in line with existing findings, the present finding suggests that the AI capacity-building programme can be considered a broadly applicable professional development strategy, rather than one whose effectiveness is limited to lecturers possessing particular academic qualifications.

6 Conclusion

The study examined the impact of lecturers' AI capacity-building programme on the effectiveness of mathematics instruction. Based on the study's findings, the AI capacity-building programme was concluded to be an effective intervention for strengthening mathematics instruction. The study also concludes that educational qualifications influence the effectiveness of mathematics instruction. However, educational qualification does not significantly interact with the AI capacity-building programme in determining the effectiveness of mathematics instruction. Overall, the study underscores the importance of combining lecturers' academic qualifications with targeted capacity-building programmes in emerging instructional technologies such as artificial intelligence.

7 Recommendations

As a result of the findings and conclusion, the following recommendations were made:

1. Public Colleges of Education should institutionalise AI-focused capacity-building programmes that move beyond general awareness of AI to practical application of AI tools in mathematics instruction.
2. Since educational qualification substantially affects mathematics instructional effectiveness, Colleges of Education should provide opportunities and incentives for lecturers to acquire higher educational qualifications.
3. AI capacity-building programmes should be made accessible to lecturers across qualification levels. Lecturers should be given equitable opportunities to acquire and apply AI-related instructional competencies.

8 Declaration

Conflict of Interest: The authors declare no conflict of interest

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