

RELATIONSHIP BETWEEN TEACHERS' DIGITAL INSTRUCTIONAL PRACTICES AND STUDENTS' ACADEMIC PERFORMANCE IN MATHEMATICS AMONG PUBLIC SECONDARY SCHOOLS IN OBIO/AKPOR LOCAL GOVERNMENT AREA, RIVERS STATE, NIGERIA

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Abstract

This study examined the relationship between teachers' digital instructional practices and students' academic achievement in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State. Specifically, the study determined the relationships between digital collaborative learning, digital teaching tools, digital professional development and students' Mathematics achievement. A correlational research design was adopted. The population comprised 11,531 SS2 students and 72 Mathematics teachers. Using Taro Yamane's formula, a sample of 387 students was determined, while the 72 Mathematics teachers were selected through census sampling. Data were collected using the Teachers' Digital Instructional Practices Questionnaire (TDIPQ) and the SS2 Mathematics Achievement Test (SS2-MAT). The instruments were validated by experts, while their reliability was established using Cronbach's alpha and Kuder-Richardson 20, respectively. Data were analysed using Pearson Product-Moment Correlation Coefficient, with hypotheses tested at the 0.05 significance level. The findings revealed significant positive relationships between digital collaborative learning and Mathematics achievement ($r = .612, p < .001$), digital teaching tools and Mathematics achievement ($r = .674, p < .001$), and digital professional development and Mathematics achievement ($r = .548, p < .001$). It was recommended that Mathematics teachers integrate appropriate digital practices, while school administrators provide adequate digital resources, technical support and continuous professional development.

Keywords: Digital instructional practices, digital collaborative learning, digital teaching tools, digital professional development, Mathematics performance.

Introduction

Digital transformation has become an increasingly important feature of contemporary education because technology is changing how teachers access instructional resources, present subject matter, communicate with learners, and facilitate learning activities. Digital technologies can support interactive teaching, collaborative learning, multimedia presentation, individualized learning, and access to diverse educational resources, but their educational value depends substantially on the quality of their pedagogical integration rather than on their mere availability (Nwobodo & Udoka, 2025; Wey-Amaewhule & Michael, 2023). Teachers therefore occupy a central position in converting technological resources into meaningful instructional experiences. Digital instructional practice involves more than the ability to operate computers or mobile devices; it includes teachers' capacity to select appropriate digital resources, connect technology with subject content, facilitate learner interaction, support problem solving, and use technology for assessment and feedback (Wey-Amaewhule & Michael, 2023; Abdulazeez et al., 2025).

The relevance of digital instructional practices is particularly evident in Mathematics education because many mathematical concepts involve abstract relationships, procedures, and representations that learners may find difficult to understand through conventional explanation alone. Digital teaching tools can provide visualizations, simulations, mathematical applications, instructional videos, and interactive representations that make mathematical ideas more concrete and potentially improve learners' engagement with mathematical tasks (Bakare et al., 2024; Jekayinfa et al., 2023). One important dimension of digital instructional practice is digital collaborative learning. Digital collaborative learning involves the use of technology to facilitate communication, joint problem solving, peer interaction, and knowledge construction among learners, and its relevance to Mathematics is particularly strong because mathematical learning involves explaining procedures, comparing solutions, reasoning, and solving problems collaboratively (Jekayinfa et al., 2023; Nwadike & Omodu, 2023). Jekayinfa et al. (2023), for example, found that collaborative learning had a significant effect on students' performance in geometrical construction in Abuja, although their study focused on collaborative learning generally rather than specifically on digitally mediated collaboration.

Evidence from Rivers State also points to the relevance of teachers' digital competence and communication practices to students' learning experiences. Nwadike and Omodu (2023), in a correlational study involving secondary school teachers in Rivers State, reported relationships between dimensions of teachers' digital literacy and students' learning satisfaction, including communication and collaboration. This evidence suggests that teachers' ability to use technology for interaction may have implications for students' experiences of learning, although

learning satisfaction is different from objectively measured academic performance. Digital teaching tools constitute another important dimension of teachers' digital instructional practices. These tools include computers, projectors, tablets, instructional videos, digital textbooks, mathematical software, graphing applications, simulations, and online assessment platforms that can support the presentation, explanation, and practice of Mathematics concepts. The empirical evidence concerning the relationship between digital technology and Mathematics performance is, however, not entirely uniform. Bakare et al. (2024), for example, reported moderate ICT utilization among senior secondary school students in Osun State and found no significant difference in Mathematics performance between students who used ICT and those who did not, suggesting that technology use by itself may not be sufficient to improve achievement. This finding reinforces the argument that the pedagogical quality, appropriateness, and consistency of technology use may be more important than technology exposure alone.

Teachers' digital professional development is consequently important because technologies and digital pedagogical practices continue to change. Professional development can take the form of workshops, seminars, online courses, webinars, mentoring, peer learning, professional learning communities, and self-directed learning through which teachers develop both technological and pedagogical competencies (Abdulazeez et al., 2025; Wey-Amaewhule & Michael, 2023). Evidence from Nigerian Mathematics education supports the importance of teacher preparation. Abdulazeez et al. (2025), in a study of secondary school Mathematics teachers in Ondo State, examined technology literacy, computer self-efficacy and digital training as correlates of technology readiness and reported that technology literacy and computer self-efficacy were influential, while digital training did not demonstrate the same level of contribution to technology readiness. The finding suggests that professional development should move beyond attendance at training programmes to the development of practical competencies that teachers can transfer into classroom instruction. The situation is particularly serious in Rivers State, where technology integration in public secondary schools continues to face institutional and infrastructural constraints. Nwobodo and Udoka (2025), in a survey of public senior secondary schools in Rivers State, reported generally low technology integration despite the availability of some ICT resources and identified inadequate infrastructure, unstable electricity, poor internet connectivity, insufficient training, and limited technical support as major constraints. Similarly, Wey-Amaewhule and Michael (2023) found that dimensions of teachers' digital competence were associated with effective instructional delivery in public senior secondary schools in the state.

The relationship between teachers' technology-related practices and students' academic performance has also received empirical attention in Rivers State. Igbozuruike, Mba and Usman (2025) investigated teachers' ICT competence as a mediator between technology integration and students' academic performance in secondary schools in Rivers State using a correlational design and 329 teachers, providing direct evidence that teacher-related technology variables are relevant to student academic outcomes. Their study nevertheless focused on ICT competence as a mediating variable, whereas the present study focuses specifically on digital collaborative learning, digital teaching tools, and digital professional development. Recent evidence from Obio/Akpor further demonstrates the contextual relevance of digital technology in Mathematics education. Omeodu and Nweke (2026) examined teachers' perceptions of artificial intelligence integration in Mathematics education among public senior secondary schools in Obio/Akpor and found positive perceptions of AI's relevance and benefits but identified deficiencies in infrastructure and actual classroom implementation. This suggests that teachers may recognize the potential of digital technologies without necessarily having the institutional conditions and professional capacity required for sustained classroom integration.

From an Educational Management perspective, the issue is therefore not limited to individual teachers' technological skills. School administrators and education authorities have responsibilities relating to infrastructure provision, electricity and connectivity, teacher professional development, instructional supervision, technical support and the creation of an organizational environment that encourages appropriate technology use. Evidence from Rivers State indicates that these institutional conditions can constrain teachers' ability to translate technological resources into classroom practice (Nwobodo & Udoka, 2025; Omeodu & Nweke, 2026). Although previous empirical studies have examined technology integration, digital competence, collaborative learning, ICT utilization, teacher technology readiness, and technology-supported Mathematics instruction, relatively limited attention has been given to the combined relationship of digital collaborative learning, digital teaching tools, and digital professional development with objectively measured Mathematics performance in public secondary schools in Obio/Akpor. The present study therefore addresses this gap by examining these three dimensions simultaneously and relating them to students' measured Mathematics performance.

Mathematics is a core subject with implications for students' progression into science, technology, engineering, economics, and other fields. Despite its importance, many secondary school students continue to experience difficulties in understanding mathematical concepts and demonstrating satisfactory performance. The increasing availability of digital technologies provides

opportunities for Mathematics teachers to employ interactive demonstrations, multimedia resources, mathematical applications, collaborative platforms and digital assessment tools. However, evidence from Rivers State suggests that the availability of ICT facilities has not necessarily resulted in high levels of classroom integration because teachers continue to face challenges associated with infrastructure, electricity, internet connectivity, technical support and professional preparation. The problem is particularly relevant in Obio/Akpor Local Government Area, where Mathematics teachers have expressed positive views regarding emerging digital technologies but where infrastructural and implementation deficiencies remain. Consequently, the major concern is not merely whether digital resources are available but whether teachers use them purposefully to promote collaboration, support mathematical visualization and problem solving, and continuously develop their digital instructional competencies.

Previous studies have examined individual aspects of digital education, including ICT utilization, digital literacy, technology competence, collaborative learning and teacher technology readiness. However, there remains a need for empirical evidence concerning the extent to which specific teacher-level digital instructional practices are associated with students' objectively measured Mathematics performance in public secondary schools in Obio/Akpor. This evidence is important for educational managers because decisions concerning teacher training, technology procurement, instructional supervision and school-level technology support should be informed by evidence of what aspects of digital instructional practice are associated with student performance. The present study therefore examined the relationship between teachers' digital instructional practices and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State.

Based on the foregoing, the purpose of the study includes to determine the relationship between teachers' digital collaborative learning practices and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State. Another aim is to examine the relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State. Also, the study sought to ascertain the relationship between teachers' digital professional development and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State.

With the stated purposes guiding the study, the researchers attempted to answer research questions starting from: What is the relationship between teachers' digital collaborative learning practices and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area,

Rivers State? What is the relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State? Also, what is the relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State?

Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

H₀₁: There is no significant relationship between teachers' digital collaborative learning practices and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State.

H₀₂: There is no significant relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State

H₀₃: There is no significant relationship between teachers' digital professional development and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State

Methodology

The study adopted a correlational research design to examine the relationships between teachers' digital instructional practices and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State. The population comprised 72 teachers and 11, 531 SS2 covered in the study. Census sampling was used for the teachers, while the student sample was determined from official school records. The unit of analysis was the teacher–SS2 class/group, with teachers' questionnaire scores matched to the mean Mathematics Achievement Test scores of their students.

Two instruments were used: the Teachers' Digital Instructional Practices Questionnaire (TDIPQ) and the SS2 Mathematics Achievement Test (SS2-MAT). Experts validated the instruments, while Cronbach's alpha and KR-20 were used to establish their reliability. Data were analysed using Pearson Product-Moment Correlation (PPMC) to answer the three research questions and test the corresponding null hypotheses at the 0.05 significance level.

Results

Research Question One

What is the relationship between teachers' digital collaborative learning practices and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State?

Table 1: Pearson Product-Moment Correlation between Digital Collaborative Learning and Students' Mathematics

SN	Variables	N	Mean	Sd	r	p-value	Remark
	Digital Collaborative Learning	72	22.86	3.21	.620	<0.01	Significant
	Mathematics Performance	72	26.74	4.28			

Table 1 shows a positive relationship between teachers' digital collaborative learning practices and students' academic performance in Mathematics, $r = .620$, $p < .001$. Since the p-value is less than .05, the relationship is statistically significant.

Research Question Two

What is the relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State?

Research Question Two

Table 2: Pearson Product-Moment Correlation between Digital Teaching Tools and Students' Mathematics Performance

Grand Mean		3.00		0.97		Accepted	
SN	Variables	N	Mean	Sd	r	p-value	Remark
	Digital Teaching Tool	72	23.45	3.08	.680	<0.01	Significant
	Mathematics Achievement	72	26.74	4.18			
	Mathematics Achievement						

Table 2 shows a positive relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics, $r = .680$, $p < .001$. Since the p-value is less than .05, the relationship is statistically significant.

Research Question Three

What is the relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State?

Table 3: Pearson Product-Moment Correlation between Digital Professional Development and Students' Mathematics Performance

SN	Variables	N	Mean	Sd	r	p-value	Remark
	Digital Professional Development	72	21.93	3.44	...	<0.01	Significant
	Mathematics Performance	72	26.74	4.18	...		

Table 3 shows a positive relationship between teachers' digital professional development and students' academic performance in Mathematics, $r = .550$, $p < .001$. Since the p-value is less than .05, the relationship is statistically significant.

Hypotheses Testing

The four null hypotheses were tested at the 0.05 level of significance. Hypothesis One

H_{01} : There is no significant relationship between teachers' digital collaborative learning practices and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State.

Table 5: Pearson correlation between digital collaborative learning and students' Mathematics performance (N=72)

Variables	N	Pearson r	Sig. (2-tailed)	Decision
Digital collaborative learning	72	0.612	< .001	Reject H_{01}
Mathematics performance	Z			

The result in Table 5 shows a positive and statistically significant relationship between teachers' digital collaborative learning practices and students' Mathematics performance ($r = .612$, $p < .001$). Since the probability value is less than the 0.05 significance level, the null hypothesis is rejected. Thus, there is a significant positive relationship between digital collaborative learning practices and students' Mathematics performance.

Hypothesis Two

H_{02} : There is no significant relationship between teachers' use of digital teaching tools and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State.

Table 6: Pearson correlation between digital teaching tools and students' Mathematics performance (N = 72)

Variables	N	Pearson r	Sig. (2-tailed)	Decision
Digital teaching tools	72	0.674	< .001	Reject H ₀₂
Mathematics performance	72			

The result in Table 6 indicates a positive and statistically significant relationship between teachers' use of digital teaching tools and students' Mathematics achievement ($r = .674$, $p < .001$). Since $p < .05$, the null hypothesis is rejected. Therefore, teachers' use of digital teaching tools is significantly related to students' academic achievement in Mathematics

Hypothesis Three

H₀₃: There is no significant relationship between teachers' digital professional development and students' academic performance in Mathematics in public secondary schools in Obio/Akpor Local Government Area, Rivers State.

Table 7: Pearson correlation between digital professional development and students' Mathematics achievement (N =72)

Variables	N	Pearson r	Sig. (2-tailed)	Decision
Digital professional development	72	0.548	< .001	Reject H ₀₃
Mathematics performance	72			

The result in Table 7 reveals a positive and statistically significant relationship between teachers' digital professional development and students' Mathematics achievement ($r = .548$, $p < .001$). Since the probability value is below 0.05, the null hypothesis is rejected. Thus, teachers' digital professional development is significantly related to students' Mathematics performance.

Discussion of Findings

Digital Collaborative Learning:

The finding indicates a positive relationship between teachers' digital collaborative learning practices and students' Mathematics performance. This suggests that the use of digital platforms for interaction, peer discussion, collaborative problem-solving and sharing of mathematical ideas may support students' performance. This agrees with Jekayinfa et al. (2023), who reported a significant effect of collaborative learning on students' performance in geometrical construction. However, their study examined collaborative learning

generally, while the present study focused specifically on digitally supported collaborative learning.

Digital Teaching Tools:

The finding indicates a positive relationship between teachers' use of digital teaching tools and students' Mathematics performance. The use of digital presentation tools, multimedia resources, mathematical applications, simulations and digital assessment resources may enhance the teaching and learning of Mathematics. This finding differs from Bakare et al. (2024), who reported no significant difference in Mathematics performance between students who used ICT and those who did not. The difference may be associated with variations in the types of digital tools used and how effectively they are integrated into instruction.

Digital Professional Development:

The finding indicates a positive relationship between teachers' digital professional development and students' Mathematics performance. This suggests that teachers who receive digital training and apply the skills acquired may be better prepared to integrate technology into Mathematics teaching. The finding is consistent with Abdulazeez et al. (2025), who highlighted the importance of technology literacy, computer self-efficacy and digital training among Mathematics teachers.

Conclusion

The study focuses on the relationship between teachers' digital instructional practices – digital collaborative learning, digital teaching tools and digital professional development – and students' academic performance in Mathematics. It highlights the importance of examining how these practices relate to Mathematics learning in public secondary schools in Obio/Akpor Local Government Area, Rivers State.

Recommendations

Mathematics teachers should integrate digital collaborative learning and appropriate digital teaching tools into classroom instruction.

School administrators should provide digital resources, reliable infrastructure and technical support.

Regular digital professional development programmes should be organised for Mathematics teachers.

Teachers should use digital technologies alongside appropriate teaching methods and students' learning needs.

Further studies should examine these relationships in other educational settings.

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