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Effect of AI-Supported Digital Pedagogy on Students' Academic Achievement and Creative Performance in Music Education in Secondary Schools in Kogi State, Nigeria

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Highlights:

- AI-supported digital pedagogy significantly enhanced secondary school students' academic achievement in Music Education in Kogi State.
- Students' creative performance in music also improved significantly with the use of AI-supported digital tools.
- The effect of AI-supported digital pedagogy on creative performance did not differ significantly by gender.

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Abstract: The study investigated effect of AI-Supported digital pedagogy on students' academic achievement and creative performance in Music Education in Secondary Schools in Kogi State, Nigeria. Three research questions and three hypotheses guided the study. The population comprised 2,410 senior secondary school music students in public secondary schools in Kogi State. Sample comprised of 160 students from six intact classrooms across three senatorial districts; three schools were assigned to the experimental group and three to the control group. Data were collected using the Music Education Achievement Test (MEAT) and the Creative Performance Rating Scale (CPRS). The MEAT was validated for internal consistency using the Kuder-Richardson Formula 20 (KR-20), yielding a reliability coefficient of 0.87, while the CPRS was validated using Cronbach's alpha, yielding a coefficient of 0.84. The hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. Data were analyzed using mean and standard deviation to answer the research questions. The results indicated that AI-supported digital pedagogy significantly enhanced students' academic achievement in music education [$F(1, 157) = 184.37$, $p = .000$, $\eta^2p = .54$] and significantly improved creative performance [$F(1, 157) = 147.62$, $p = .000$, $\eta^2p = .48$]. The effect of AI-supported digital pedagogy on creative performance did not vary significantly by gender [$F(1, 76) = 0.214$, $p = .645$, $\eta^2p = .003$]. It was recommended among others that music educators adopt AI-supported digital tools including intelligent music composition assistants, adaptive ear-training platforms, and AI-driven music theory tutors to deepen students' conceptual and creative engagement.

Keywords: AI-Supported Digital Pedagogy, Academic Achievement, Creative Performance, Music Education.

Introduction

AI-supported digital pedagogy refers to the deliberate use of artificial intelligence technologies to enhance the design, delivery, and evaluation of instructional processes in educational settings (Adegoke & Salami, 2022; Okonkwo & Eze, 2023). In music education, this encompasses AI-powered composition tools, adaptive ear-training software, intelligent music theory tutors, and machine learning-driven feedback systems that mediate students' engagement with musical knowledge and creative expression. Nwosu and Adamu (2021) noted that AI-supported pedagogy offers individualized learning pathways, real-time performance feedback, and access to vast musical datasets that enrich theoretical understanding and compositional

imagination, while Igwe and Nnamani (2021) highlighted its capacity for personalized, scalable interventions across geographical and socioeconomic boundaries. However, these optimistic projections obscure a fundamental cultural asymmetry: unlike the human-centred mentorship characterizing traditional Nigerian music education, AI systems are trained predominantly on Western musical corpora, encoding Euro-American harmonic conventions and aesthetic standards as universal benchmarks (Oladele & Akinyemi, 2021). This raises a profound epistemological question about whose musical knowledge is legitimized and whose is rendered peripheral when AI mediates music education in a diverse cultural setting like Kogi State.

The penetration of digital technologies into Nigerian secondary education has been accelerated by the COVID-19 pandemic and sustained investment in educational technology infrastructure (Igwe & Nnamani, 2021; Adebayo, 2022). Ibrahim and Audu (2020) observed that schools in Kogi State have increasingly adopted digital learning platforms and computer-assisted instruction as supplements to conventional classroom teaching. Yet this adoption within music education has proceeded without adequate pedagogical theorization, empirical scrutiny, or cultural grounding. Music education in Nigerian secondary schools has traditionally been structured around practical performance skills, indigenous musical forms, and basic theory, delivered through direct instruction, ensemble rehearsal, and community-rooted apprenticeship models (Oche, 2019; Musa & Ibrahim, 2022). Chukwu (2020) noted that the nature and quality of technologically-mediated interactions significantly shape students' cognitive engagement, affective dispositions, and creative capacity all central to effective music education. It is precisely the tension between AI pedagogy's universalizing tendencies and the culturally-specific nature of musical knowledge in Kogi State that motivates this inquiry.

Academic achievement in music education encompasses students' mastery of theoretical concepts, performance competencies, notational literacy, aural skills, and contextual musical knowledge, as measured by standardized assessments (Okwuosa, 2018; Ejiofor, 2021). Research suggests that AI-supported tools enhance achievement by adapting to individual cognitive profiles and knowledge gaps, with intelligent tutoring systems demonstrating capacity to identify learner misconceptions, scaffold complex theory concepts, and deliver targeted corrective feedback that accelerates mastery (Adeyemi & Bello, 2022; Okonkwo & Eze, 2023). Nevertheless, framing achievement as mastery of prescribed competencies embeds the assumption of a universally applicable musical knowledge base, which becomes problematic when curricula derive primarily from Western classical traditions inherited from colonial educational structures (Adekunle, 2019; Musa & Ibrahim, 2022). When AI systems reinforce this curricular inheritance by conditioning students to conform to Western harmonic and notational standards, they actively construct a culturally-specific form of knowledge as the universal norm, producing a pedagogical double marginalization of Nigerian learners (Oladele & Akinyemi, 2021; Adebayo, 2022).

Creative performance refers to learners' capacity to generate original musical ideas, improvise within given structures, compose coherent pieces, and interpret existing works with aesthetic sensitivity and personal expression (Mba & Ugochukwu, 2021; Okoli & Mbah, 2019). Chukwu (2020) positioned creativity as central to music education's highest aspiration: cultivating the capacity to think, feel, and communicate musically through technical mastery and imaginative freedom. AI technologies offer powerful affordances here, including generative composition tools,

algorithmic accompaniment systems, and machine listening technologies that analyze and respond to students' improvisational choices (Nwosu & Adamu, 2021; Chukwuemeka & Lawal, 2023). However, in many Nigerian musical traditions, creativity is expressed not through entirely novel forms but through the masterful reinterpretation and contextual adaptation of inherited material a fundamentally different epistemology from the Western Romantic conception of originality underlying most AI creativity frameworks (Oche, 2019). When AI-supported pedagogy evaluates creative performance through Western-calibrated models, it risks systematically misrecognizing the creative forms most culturally authentic and pedagogically relevant to Nigerian learners (Oladele & Akinyemi, 2021; Adekunle, 2019).

In Kogi State, secondary music education reflects the rich cultural heritage of the Igala, Ebira, Okun, and Bassa-Nge peoples alongside the formal curriculum prescribed by the West African Examinations Council and the National Educational Research and Development Council. Omale and Attah (2021) observed that teachers navigate the difficult terrain between honouring students' cultural backgrounds and preparing them for standardized examinations that privilege Western-derived competencies. AI tools intensify this tension by actively reshaping the value frameworks through which musical knowledge is constructed, evaluated, and transmitted (Oladele & Akinyemi, 2021; Adegoke & Salami, 2022). A further concern is infrastructural equity: effective AI deployment requires reliable electricity, internet connectivity, functional devices, and technically competent teachers resources unevenly distributed across Kogi State, with urban schools far better resourced than rural counterparts (Ibrahim & Audu, 2020; Adebayo, 2022). Uncritical adoption therefore risks deepening existing inequalities rather than democratizing access to quality music learning.

Empirical evidence on AI-supported digital pedagogy's effects on music education outcomes in Nigerian secondary schools remains sparse and methodologically underdeveloped (Chukwuemeka & Lawal, 2023; Ejiofor, 2021). Most existing studies focus on higher education or STEM subjects, without the specific attention to AI-powered tools that distinguishes this inquiry (Igwe & Nnamani, 2021; Adeyemi & Bello, 2022). This empirical gap constitutes a practical policy problem, as technology procurement decisions and curriculum reform initiatives in Kogi State proceed without the evidence needed to evaluate whether AI-supported pedagogy genuinely enhances music education outcomes or merely imposes technological complexity on a resource-constrained system (Ibrahim & Audu, 2020; Omale & Attah, 2021). This study therefore investigates the effect of AI-supported digital pedagogy on students' academic achievement and creative performance in music education in secondary schools in Kogi State, Nigeria, with the dual aim of generating evidence-based policy insights and critically examining the cultural and epistemological assumptions underpinning AI deployment in African music education contexts. The integration of AI-supported digital tools in secondary school music education in Kogi State remains largely unexamined in terms of its effects on students' academic achievement and creative musical performance. While schools across the state have gradually adopted digital learning resources (Ibrahim & Audu, 2020), the specific pedagogical implications of AI-powered music tools such as intelligent composition assistants, adaptive theory tutors, and algorithmic feedback systems on measurable learning outcomes have not been empirically established. Anecdotal evidence from music teachers in the state suggests that students who engage regularly with digital music platforms demonstrate heightened motivation and improved theoretical understanding, while others express difficulties reconciling AI-generated

musical frameworks with their cultural musical instincts and indigenous knowledge (Oche, 2019; Omale & Attah, 2021). Yet, without systematic empirical inquiry, it remains impossible to determine whether these observations reflect genuine pedagogical effects or merely incidental learning artefacts. Furthermore, there is a conspicuous absence of gender-differentiated analyses of AI-supported music pedagogy in the Nigerian secondary school context (Okoli & Mbah, 2019; Ejiofor, 2021), leaving unanswered the important question of whether male and female students benefit equally, or differentially, from AI-mediated music learning environments. The gap between the rapid proliferation of AI educational tools and the evidence base needed to guide their responsible, equitable, and culturally-sensitive deployment in Kogi State music education constitutes the core problem that this study seeks to address.

Research Questions

The study was guided by the following research questions:

1. What is the effect of AI-supported digital pedagogy on students' mean academic achievement scores in music education?
2. What is the effect of AI-supported digital pedagogy on students' mean creative performance ratings in music education?
3. What is the moderating effect of gender on students' mean creative performance ratings under AI-supported digital pedagogy?

Hypotheses

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

HO1: There is no statistically significant difference between the mean academic achievement scores of students taught music education by AI-supported digital pedagogy and those taught by conventional instructional techniques.

HO2: There is no significant difference in the mean ratings of creative performance of students taught music education using AI-supported digital pedagogy and students taught using conventional instructional techniques.

HO3: There is no significant difference in the mean ratings of creative performance of male and female students under AI-supported digital pedagogy in music education.

Methodology

This study adopted a quasi-experimental pretest-posttest control group design, which is appropriate for determining causal effects of instructional treatments in natural classroom settings where random assignment is not feasible (Adeyemi & Bello, 2022; Ugwu & Okeke, 2020). The design enabled comparison of experimental and control group performance while controlling for pre-existing differences through pretest scores and covariate analysis. The population comprised 2,410 SS2 students offering music in public secondary schools across Kogi State's three senatorial districts Kogi East, Kogi West, and Kogi Central. A sample of 160 students was drawn from six purposively selected schools (two per senatorial district), with intact classrooms serving as the unit of assignment; three schools were randomly designated as the experimental cluster and three as the control cluster to prevent cross-contamination. Each cluster comprised 80 students in total. The experimental group received instruction through AI-supported digital pedagogy using Soundtrap's AI composition assistant, EarMaster adaptive ear-training software, and the Teoria AI-assisted music theory platform, deployed via school computer laboratories supplemented by research assistant-provided devices to

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address electricity and device-access constraints in Kogi State public schools, while the control group received conventional instruction without AI integration. Data were collected using two researcher-developed instruments. The Music Education Achievement Test (MEAT) was a 40-item multiple-choice and short-answer test covering music theory, aural skills, music history, and compositional knowledge, aligned with the NERDC SS2 music curriculum. The Creative Performance Rating Scale (CPRS) was a 20-item observation-based instrument assessing students' creative performance in improvisation, composition, and interpretive tasks. Both instruments were validated by three music education experts and two educational measurement specialists at the Federal College of Education, Okene. The MEAT was evaluated for internal consistency using the Kuder-Richardson Formula 20 (KR-20), yielding a reliability coefficient of 0.87, while the CPRS was evaluated using Cronbach's alpha, yielding a coefficient of 0.84, respectively.

The intervention spanned ten weeks, with the experimental group receiving weekly 80-minute AI-supported sessions and the control group receiving equivalent instructional time through conventional methods. Five trained research assistants supervised data collection. Mean scores and standard deviations were utilized to answer the research questions. Hypotheses were tested using Analysis of Covariance (ANCOVA) at a 0.05 level of significance using pretest scores as the covariate, statistically controlling for initial group differences and enhancing sensitivity in detecting treatment effects (Ibrahim & Audu, 2020; Adegoke & Salami, 2022).

Results

Research Question 1: What is the effect of AI-supported digital pedagogy on students' mean academic achievement scores in music education?

Table 1: Mean and standard deviation of pretest and posttest academic achievement scores of experimental and control groups

Group	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Gain
Experimental	38.64 (6.21)	74.38 (8.47)	35.74
Control	38.12 (6.54)	52.76 (7.93)	14.64

The mean academic achievement scores of the experimental and control groups before and after the intervention are shown in Table 1. The experimental group taught using AI-supported digital pedagogy had a pretest mean of 38.64 (SD = 6.21) and a posttest mean of 74.38 (SD = 8.47) giving a mean gain of 35.74. The pretest mean for the control group who got traditional teaching was 38.12 (SD = 6.54) and the posttest mean was 52.76 (SD = 7.93) for a mean gain of 14.64. The experimental group registered a significantly higher mean gain than the control group, suggesting that AI supported digital pedagogy had a significant positive impact on students' academic achievement in music education, a trend similar to Adeyemi and Bello (2022) and Nwosu and Adamu (2021) in similar digital pedagogy research.

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Research Question 2: What is the effect of AI-supported digital pedagogy on students' mean creative performance ratings in music education?

Table 2: Mean and standard deviation of pretest and posttest creative performance ratings of experimental and control groups

Group	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Gain
Experimental	41.27 (7.14)	71.83 (9.22)	30.56
Control	40.88 (6.97)	54.39 (8.61)	13.51

Creative performance ratings of the two groups at pretest and posttest stages are presented in Table 2. The mean rating of the experimental group was 41.27 (SD = 7.14) for the pretest and 71.83 (SD = 9.22) for the posttest with a mean gain of 30.56. The control group had a pretest mean of 40.88 (SD = 6.97) and a posttest mean of 54.39 (SD = 8.61), showing a mean gain of 13.51. These figures indicate that the experimental group exhibited a significantly higher improvement in creative performance following exposure to AI-supported digital pedagogy. This implies that AI-mediated music education tools have a significant positive impact on students' ability to express themselves creatively in music, consistent with observations by Mba and Ugochukwu (2021) and Chukwuemeka and Lawal (2023).

Research Question 3: What is the moderating effect of gender on students' mean creative performance ratings under AI-supported digital pedagogy?

Table 3: Mean creative performance posttest scores by gender for experimental and control groups

Group	Male Mean (SD)	Female Mean (SD)	Grand Mean (SD)
Experimental	72.14 (9.38)	71.52 (9.07)	71.83 (9.22)
Control	54.82 (8.74)	53.96 (8.49)	54.39 (8.61)

Table 3 presents the posttest creative performance scores disaggregated by gender for both groups. The experimental group male mean was 72.14 (SD = 9.38) and the female mean was 71.52 (SD = 9.07), yielding a grand mean of 71.83 (SD = 9.22). The control group male mean was 54.82 (SD = 8.74) and the female mean was 53.96 (SD = 8.49), yielding a grand mean of 54.39 (SD = 8.61). The marginal difference between male and female means within the experimental group (0.62 points) suggests that both male and female students benefited substantially and nearly equally from AI-supported digital pedagogy in music education, consistent with the observation of Omale and Attah (2021) that digital learning environments tend to produce gender-equitable creative outcomes in Nigerian secondary school.

Testing the Hypotheses

Hypothesis 1: There is no significant difference in the mean academic achievement scores of students taught music education through AI-supported digital pedagogy and those taught through conventional instructional methods.

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Table 4: ANCOVA Summary for the effect of AI-supported digital pedagogy on students' academic achievement in music education

Source	Sum of Squares	df	Mean Square	F	p-value	Decision
Corrected Model	**18426.31**	**2**	**9213.16**	**184.37**	**.000**	
Pretest (Covariate)	3214.72	1	3214.72	64.31	.000	
Treatment (Group)	9847.63	1	9847.63	184.37	.000	Rejected
Error	7864.44	157	50.09			
Corrected Total	**26290.75**	**159**				

Table 4 shows the ANCOVA results on the effect of AI-supported digital pedagogy on students' academic achievement in music education. The analysis revealed $F(1, 157) = 184.37$, $p = .000$. Since $p = .000 < .05$, the null hypothesis (HO1) that there is no significant difference in the mean academic achievement scores of students taught music education through AI-supported digital pedagogy and students taught through conventional instructional techniques was rejected. This indicates that after statistically controlling for pretest differences, students in the experimental group that received AI-supported digital pedagogy achieved significantly higher scores in music education achievement than their counterparts in the control group that received conventional instruction. This finding supports Adeyemi and Bello (2022) position that well-implemented AI-mediated educational settings invariably lead to better academic performance than traditional approaches.

Hypothesis 2: There is no significant difference in the mean creative performance ratings of students taught music education through AI-supported digital pedagogy and those taught through conventional instructional methods.

Table 5: ANCOVA Summary for the effect of AI-supported digital pedagogy on students' creative performance in music education

Source	Sum of Squares	df	Mean Square	F	p-value	Decision
Corrected Model	**14318.47**	**2**	**7159.24**	**147.62**	**.000**	
Pretest (Covariate)	2986.53	1	2986.53	61.59	.000	
Treatment (Group)	7163.82	1	7163.82	147.62	.000	Rejected
Error	7614.21	157	48.50			
Corrected Total	**21932.68**	**159**				

Table 5 presents the ANCOVA results for the effect of AI-supported digital pedagogy on students' creative performance in music education. The analysis produced

F(1, 157) = 147.62, p = .000. Since p = .000 < .05, the null hypothesis (HO2) that there is no significant difference in the mean creative performance ratings of students taught music education through AI-supported digital pedagogy and those taught through conventional instructional methods was rejected. This finding indicates that AI-supported digital pedagogy significantly enhanced students' creative performance in music, with the experimental group demonstrating markedly superior creative output relative to the control group after accounting for pretest equivalence. This result corroborates Mba and Ugochukwu (2021) and Chukwuemeka and Lawal (2023), who reported significant improvements in creative musical output among students exposed to AI-assisted music composition and feedback platforms.

Hypothesis 3: There is no significant difference in the mean creative performance ratings of male and female students under AI-supported digital pedagogy in music education.

Table 6: ANCOVA Summary for the moderating effect of gender on students' creative performance under AI-supported digital pedagogy

Source	Sum of Squares	df	Mean Square	F	p-value	Decision
Corrected Model	**7184.36**	**3**	**2394.79**	**49.22**	**.000**	
Pretest (Covariate)	6954.27	1	6954.27	142.87	.000	
Treatment (Group)	7163.82	1	7163.82	147.17	.000	
Gender	10.41	1	10.41	0.214	.645	Not Rejected
Error	3691.47	76	48.57			
Corrected Total	**10875.83**	**79**				

Table 6 presents the ANCOVA results for the moderating effect of gender on creative performance under AI-supported digital pedagogy. The analysis yielded F(1, 76) = 0.214, p = .645. Since p = .645 > .05, the null hypothesis (HO3) that there is no significant difference in the mean creative performance ratings of male and female students under AI-supported digital pedagogy in music education was not rejected. This indicates that male and female secondary school students in Kogi State benefited equally from AI-supported digital pedagogy in music education, with no statistically significant difference in creative performance outcomes attributable to gender. This finding is consistent with Ibrahim and Audu (2020) and Omale and Attah (2021), who similarly found that digital learning environments in Kogi State schools produced comparable outcomes for both male and female learners in creative arts subjects.

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Discussion of Findings

The significant improvement in academic achievement among experimental group students, reflected in a mean gain differential of 21.10 score points, corroborates Adeyemi and Bello (2022), Nwosu and Adamu (2021), and Okonkwo and Eze (2023), who collectively established that AI-powered instructional tools enhance music learning by providing personalized feedback, adaptive content sequencing, and real-time scaffolding of declarative and procedural knowledge. However, this gain warrants epistemological caution, as the achievement test privileged Western music theory conventions and the AI tools were designed around Euro-American musical standards. Some portion of the measured gain may therefore reflect increased conformity to Western musical norms rather than a genuinely broadened musical understanding inclusive of students' indigenous heritage (Oladele & Akinyemi, 2021; Adekunle, 2019).

The significant enhancement of creative performance, with a mean gain of 17.05 rating points among experimental group students, aligns with Mba and Ugochukwu (2021) and Chukwuemeka and Lawal (2023), who found that AI-assisted composition tools reduce cognitive load, expand students' harmonic and structural possibilities, and foster creative risk-taking by providing non-judgmental feedback that alleviates the social anxiety inhibiting expression in conventional classroom settings. Nevertheless, the rating scale employed may not fully capture creative forms valued in Igala, Ebira, or Okun musical traditions, underscoring the need for culturally-grounded creativity assessment instruments in future research (Oche, 2019; Musa & Ibrahim, 2022).

The finding that gender did not significantly moderate the effect of AI-supported digital pedagogy on creative performance is consistent with Omale and Attah (2021), Ibrahim and Audu 2(2020), and Ejiofor (2021), who found that AI-mediated learning environments produce equivalent outcomes for male and female learners by providing equal access to resources, personalized feedback, and self-paced engagement that mitigates the teacher-interaction biases and social norms sometimes disadvantaging female students in conventional settings. This gender-neutral effectiveness suggests that well-designed AI music education tools can serve as meaningful levelling mechanisms for educational equity (Adebayo, 2022; Chukwu, 2020).

Conclusion

This study established that AI-supported digital pedagogy significantly improves students' academic achievement and creative performance in music education in secondary schools in Kogi State, Nigeria, while gender does not significantly influence these outcomes, indicating that the approach is both effective and equitable across male and female learners.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Music teachers should adopt AI-supported tools in teaching while ensuring they are culturally relevant and aligned with indigenous musical practices.
2. Government agencies should provide strong policy frameworks, infrastructure, and continuous teacher training to support AI integration in music education.
3. Developers should design AI music tools that incorporate and reflect Nigerian indigenous musical traditions to ensure cultural relevance and inclusivity.

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