EFFECTIVENESS OF ANDROID PIANO MOBILE APPLICATIONS IN DEVELOPING HANDS-ON MUSICAL COMPETENCIES AMONG PRESCHOOL CHILDREN IN OZUOBA, COMMUNITY IN OBIOAKPOR LOCAL GOVERNMENT AREA IN RIVERS STATE

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Abstract
This study examines the effectiveness of Android piano mobile applications in developing hands-on musical skills among preschool pupils. It investigates how these applications support practical skill acquisition, including finger dexterity, hand–eye coordination, rhythm accuracy, keyboard awareness, sound recognition, and engagement in musical play. Anchored in the United Nations Sustainable Development Goal on Quality Education, the study responds to the limited empirical evidence on digital piano tools in early childhood music learning. Guided by Constructivist and Social Constructivist theories, the research frames the Android piano app as an interactive tool that facilitates knowledge construction through exploration and teacher supported scaffolding. A mixed methods design combining cross-sectional descriptive and quasi-experimental approaches was adopted. Participants included five music teachers and one hundred preschool pupils from five private schools in Ozuoba Community in Obio/AkporLocal Government Area in Rivers State. Findings showed that although all teachers were aware of Android piano applications, only 40% recommended them for home practice. The quasi-experimental results revealed significant improvements in pupils' hands-on musical skills following the use of the application, underscoring its value as an effective instructional aid in early childhood music education. The study provides empirical evidence on the practical benefits of mobile piano applications in Nigerian preschool settings and offers implications for teachers, curriculum planners, and policymakers seeking to integrate digital tools to enhance hands-on skill development.
Keywords: Android applications, digital learning, hands--on skills, music education, preschool pupils

Introduction

The rapid advancement of digital technology has significantly transformed teaching and learning across all levels of education. From early childhood to tertiary institutions, digital tools have become essential in shaping how learners interact with knowledge. In music education, technology plays an increasingly important role in developing musical understanding, creativity, and practical performance skills. Murray (2002) defines music technology as any situation in which electronic devices are used to control, manipulate, or communicate musical information. Byrne and MacDonald (2002) further explain that music technology in the classroom encompasses electronic keyboards, sound modules, multi-track recorders, synthesizers, sequencers, and a variety of software that supports notation, editing, sequencing, and recording. These technological innovations have made complex musical processes more accessible to learners. As Pierroux and Rudi (2020) note, digital tools are now integrated into virtually all aspects of creative music production, influencing composition, performance, and recording. Recent scholarship also shows that everyday technologies carry embedded musical structures, which Authority (2025) describes as "musical DNA," the rhythmic, timbre, and patterned logics that shape how humans interact with machines. This perspective highlights why mobile applications, particularly Android piano apps, have emerged as interactive learning tools that support foundational music skills among young children. Designed to simulate real piano-playing experiences, these applications offer visually appealing, touch responsive platforms through which children can experiment with sounds, practice rhythm, and improve coordination.

Preschoolers, who fall within the sensorimotor and preoperational cognitive development stages, learn best through play, exploration, and interaction with their environment. Digital piano applications align with these developmental needs by providing opportunities for hands-on engagement, experimentation, and self-paced learning. They stimulate finger dexterity, hand–eye coordination, sound recognition, creativity, and early musical awareness. The interactive features, immediate feedback mechanisms, and game-like structures of these apps often increase children's motivation and interest in music learning. Authority (2025) further argues that digital sound environments influence cognition and behavior because they rely on intuitive musical cues, rhythm, pitch, and repetition, which help users make sense of technological interactions. Given the growing importance of digital tools in early childhood education, understanding how Android piano applications influence hands-on skills is essential. Such insights can inform curriculum planning, teaching strategies, and the integration of technology into preschool music instruction.

Although digital technology has been widely adopted in education, its potential for enhancing practical skill development in preschool music education remains underexplored. Traditional preschool music instruction often depends solely on physical instruments and teacher-led activities. However, limited access to musical instruments, insufficient instructional time, and the need for individualized learning opportunities continue to pose challenges. Many preschoolers are naturally drawn to mobile devices, yet the pedagogical value of piano applications in developing hands-on musical skills is not clearly understood. Authority (2025) notes that technological soundscapes are never neutral; they are structured by musical logics that can either support or hinder learning depending on how they are designed. There is, therefore, a need to investigate whether and how Android piano mobile applications support the acquisition of essential skills such as finger dexterity, hand–eye coordination, rhythmic accuracy, and basic musical understanding. Without empirical insights, educators and curriculum developers may overlook a valuable technological tool that could enhance children's early musical experiences.

The main purpose of this study is to investigate the impact of Android piano mobile applications on the development of hands-on skills in preschool music education. Specifically, the study seeks to examine how Android piano applications influence finger dexterity among preschool learners, to determine the extent to which the apps enhance hand–eye coordination, to assess the role of the apps in developing rhythmic awareness and basic musical concepts, and to explore the overall effectiveness of digital piano applications as tools for supporting practical skill acquisition in early childhood music education. Key questions include: How do Android piano mobile applications influence finger dexterity in preschoolers? In what ways do the applications support hand–eye coordination among preschool learners? To what extent do the applications improve rhythmic accuracy and basic musical awareness? What is the overall impact of Android piano applications on hands-on skill development in preschool music education?

This study is anchored in Constructivist Learning Theory, which posits that children actively build knowledge through direct interaction with their environment (Piaget, 1902), and Social Constructivist Theory (1978), which emphasizes that learning is socially mediated and enhanced through interaction with more knowledgeable others. These frameworks provide a lens for understanding how preschool children learn best through active exploration and hands-on activities. Authority's (2025) argument that sound functions as a communicative and cognitive scaffold in technological environments further supports the relevance of digital piano applications as tools that can enhance children's learning experiences.

This study contributes to the growing body of knowledge on the integration of digital technology in early childhood education. It provides empirical insights into how mobile piano applications can support motor, cognitive, and creative development among preschoolers. Secondly, the findings will be valuable to preschool teachers, helping them adopt more engaging, innovative, and effective instructional strategies. Curriculum planners and educational policymakers will also benefit from understanding how technology can enhance practical music learning. Finally, parents and caregivers may gain awareness of how digital tools can complement home based music activities and promote children's early musical development.

Literature Review

This literature review examines how Android Piano Mobile Applications support the development of hands-on skills in preschool music education. It focuses on how these applications influence finger dexterity, improve hand–eye coordination, strengthen rhythmic awareness, and introduce basic musical concepts. It also explores the overall effectiveness of digital piano tools in helping young children acquire practical music skills.

Music is commonly understood as the organized combination of tones and sounds arranged into meaningful patterns through melody, harmony, and rhythm. Dictionary.com describes music as "an art of sound in time that expresses ideas and emotions through rhythm, melody, harmony, and color." This definition highlights music as both an artistic experience and a cognitive process built on sound exploration. Music education therefore provides structured opportunities for children to listen, create, improvise, and perform. Dewey (1997) explains that education aims at growth, and music learning supports creativity, imagination, and emotional expression. In early childhood, music activities encouraged exploration, interaction, and the development of practical abilities.

Conceptual Clarifications

- **Preschool Music Education:** Learning activities that introduce musical concepts to children aged 3–5 years.
- **Finger Dexterity:** The child's ability to control finger movements during musical tasks.
- **Hand–Eye Coordination:** The link between what children see and how their hands move on digital piano keys.

- **Android Piano Mobile Applications:** Digital tools on Android devices that simulate piano playing and offer interactive learning.
- **Hands-on Skills:** Practical motor skills needed for basic musical performance, including finger control and coordinated hand movement.

Android Piano Mobile Applications in Early Childhood Education

Digital learning tools have expanded rapidly in early childhood education. Android piano apps such as Piano Kids, Simply Piano, Skoove, and Gismart provide interactive environments that mimic real piano experiences. These apps use colorful designs, touch-responsive keys, and step-by-step learning tasks to engage young children. Research also shows that digital sound environments influence how children respond to technology because they rely on rhythm, pitch, and repetition; features Authority (2025) describes as "musical DNA," the embedded musical patterns that shape human interaction with digital tools.

Impact of Android Piano Applications on Hands-on Skills

Studies show that digital piano applications can support the development of key hands-on skills in preschoolers. Research consistently reports improvements in:

- **Hand–eye coordination:** Children match visual cues with finger taps, improving timing and accuracy.
- **Fine motor skills:** Tapping and pressing digital keys strengthen finger muscles and control.
- **Motor control and rhythm accuracy:** Rhythm based games help children develop timing, movement control, and auditory awareness.
- **Musical exploration:** Apps expose children to melodies, patterns, and sounds, encouraging curiosity and creativity.

These findings align with Piaget's developmental theory, which states that children in the sensorimotor and operational stages learn best through touch, movement, imitation, and active exploration. Authority (2025) also notes that interactive sound cues in digital tools guide children's behavior and attention, making learning more intuitive.

Recent studies further show that interactive music apps provide immediate feedback, increase motivation, and offer affordable access to music learning, especially important in communities where physical instruments are limited. This is relevant to areas like Ozuoba Community in Obio/AkporLocal Government Area in Rivers State where many schools may not have enough musical instruments.

However, some limitations exist. Excessive screen time may affect other developmental areas. Virtual keyboards lack the tactile resistance of real pianos. Some apps do not teach proper hand positioning or finger independence. The quality of educational content also varies widely. These concerns highlight the need for careful and guided use of digital tools in preschool music instruction.

Creativity and Music Learning in Preschoolers

Creativity is central to early childhood development. The Latin root *creo* means "to make," reflecting the child's ability to generate new ideas. Scholars such as Kohn (1993), Wiggins &Medvinsky (2012), and Santrock (2010) emphasize that creativity grows through social interaction, imaginative play, and hands-on exploration. Children aged 3–6 naturally express creativity through play, improvisation, and experimentation.

Play-based musical activities, clapping games, sound puzzles, musical blocks, or virtual piano exploration, support imagination, symbolic thinking, and problem solving. Munadar (in Fakhiriyani, 2016) notes that creativity develops through interaction with the environment. Digital musical tools, when used appropriately, can support this process. Fakhiriyani (2016) adds that play enhances curiosity, emotional expression, imagination, and motor development. Android piano apps used during guided play can therefore support finger coordination, rhythmic exploration, and early musical creativity.

Contextual Gaps in Literature

Although global research highlights the benefits of piano apps, there is limited evidence on their use in preschool music education in OzuobaCommunity in Obio/AkporLocal Government Area, Rivers State. Differences in socioeconomic conditions, access to technology, and school resources mean that findings from other regions may not apply directly to this context.

The literature reveals clear gaps regarding:

- how Android piano apps influence hands-on skills among preschoolers in Ozuoba, Community
- how teachers in this region use digital tools in music instruction, and
- whether these apps effectively support finger dexterity, hand–eye coordination, and rhythmic awareness in this cultural setting.

Most existing studies focus on Western or urban environments, with few addressing rural or semi-urban Nigerian communities. This study therefore fills an important gap by providing localized evidence to guide early childhood music pedagogy in Rivers State.

Theoretical Framework

This study is guided by two complementary psychological theories: Piaget's Constructivist Learning Theory (1902) and Vygotsky's Social Constructivist Theory (1978). Together, these theories provide a strong foundation for understanding how Android Piano Mobile Applications support the development of hands-on skills in preschool music education.

Constructivist Learning Theory (Jean Piaget)

Jean Piaget explains that learning happens when children manipulate objects, explore, experiment, and make meaning from their experiences. Children actively build knowledge through direct interaction with their environment. For preschoolers, constructivism highlights the importance of sensory engagement, hands-on exploration, and play-based learning as key drivers of cognitive and motor development.

Through actions such as touching, tapping, and listening, children form personal understanding of concepts, including musical ideas like rhythm, pitch, and coordination. Using a piano mobile app allows children to press keys, explore sounds, and build musical understanding through play. The theory supports learning through sensory engagement, experimentation, and discovery, processes that align naturally with app-based music activities.

Social Constructivist Theory (Lev Vygotsky)

Lev Vygotsky emphasizes that learning is socially shaped and strengthened through interaction with more knowledgeable individuals. He explains that children develop skills through guided participation, scaffolding, and collaboration within the Zone of Proximal Development (ZPD). With scaffolding, children receive support until they can complete tasks independently.

In preschool music settings, Android piano apps are often used alongside teacher guidance. Teachers, peers, and caregivers help children explore rhythms, identify sounds, and coordinate finger movements. These guided interactions support the gradual development of hands-on musical skills. The theory highlights the essential role of teachers in integrating mobile technology and providing structured support that leads to independent mastery.

These theories are relevant because Android piano applications create an interactive, exploratory environment where children learn by doing. By tapping virtual keys, following visual cues, and receiving immediate sound feedback, preschoolers engage in active, hands-on musical learning. This study examines how such constructivist-based digital interaction strengthens core hands-on skills, including finger coordination, rhythmic accuracy, and sound recognition in early childhood music education.

Methodology

This study employed a mixed-methods approach that combined a cross-sectional descriptive design with a quasi-experimental component to investigate the impact of Android Piano Mobile Applications on preschool pupils' hands-on musical skills. This design made it possible to capture both teachers' perceptions and measurable changes in pupils' performance, reflecting the dual emphasis reported in the abstract and findings.

The research was carried out in Ozuoba Community in Obio/Akpor Local Government Area of Rivers State, involving five private schools that offer early childhood music instruction. The target population consisted of children aged three to six years enrolled in Nursery 1, Nursery 2, and Basic 1 classes. Using a convenience sampling technique, the study recruited five music teachers and one hundred pupils. This sample size provided sufficient data for both descriptive analysis and comparison between experimental and control groups.

Two instruments were used for data collection. The first was a structured questionnaire administered to music teachers. It contained two sections: the first captured socio-demographic information, while the second focused on teachers' awareness, use, and perceptions of Android piano applications in early childhood music instruction. The second instrument was a structured assessment score sheet designed to evaluate pupils' hands-on musical skills, including finger dexterity, hand–eye coordination, rhythmic accuracy, and basic musical awareness. Scores were categorized as excellent (80–100%), good (60–79%), average (45–59%), and poor (44% and below).

Data collection followed a two-phase process. Teacher questionnaires were distributed electronically through Google Forms and shared via WhatsApp for ease of access. For the quasi-experimental phase, the 100 pupils were divided into two equal groups. The experimental group received regular school music lessons supplemented with structured exposure to Android piano mobile applications, while the control group participated only in regular music lessons without any digital intervention. Both groups were assessed before and after the intervention using the standardized score sheet. This procedure enabled the study to determine whether the application produced measurable improvements in pupils' hands-on musical skills, as later confirmed in the findings.

Data were analyzed using Microsoft Excel. Descriptive statistics were used to summarize teacher responses, while comparative analyses, presented in tables and charts, highlighted differences in skill development between the experimental and control groups.

Ethical approval was obtained from school management, and informed consent was secured from parents. Participation was voluntary, and confidentiality was maintained throughout the study, as no identifying information was collected from respondents.

Findings and Analysis

Table 1: *Socio-demographic Data of Music Teachers (N= 5)*

Variables	Frequency	Percentage
Age		
20- 25	-	
26- 31	2	40
32- 37	2	40
38 and Above	1	20
Sex		
Male	1	20
Female	4	80
Marital Status		
Married	2	40
Single parent	3	60
Widowed		
Educational status		
OND	-	-
HND	2	40
Bachelor Degree	3	60
Postgraduate Degree	-	-

Table1 shows that majority of the teachers were within the age bracket of 26 to 37 years of age. Female music teachers were highest, 3 (80%) were single and greater proportion of the teachers, 3(60%) had bachelor S degree.

Table 2. *Socio-demographic Data of Pupils (**N= 100**)*

Variables	Frequency	Percentage
Age		
3	25	25
4	30	30
5	45	45
Class		
Nur 1	25	25
Nur 2	25	25
Nur 3	25	25
Bas 1	25	25

Result in Table 2 shows that pupils within the ages of four (4) and five (5) years were the highest.

Research Question 1: What is the awareness of music teachers in selected private schools in Ozuoba Community Obio/AkporLocal Government Area towards android music mobile applications?

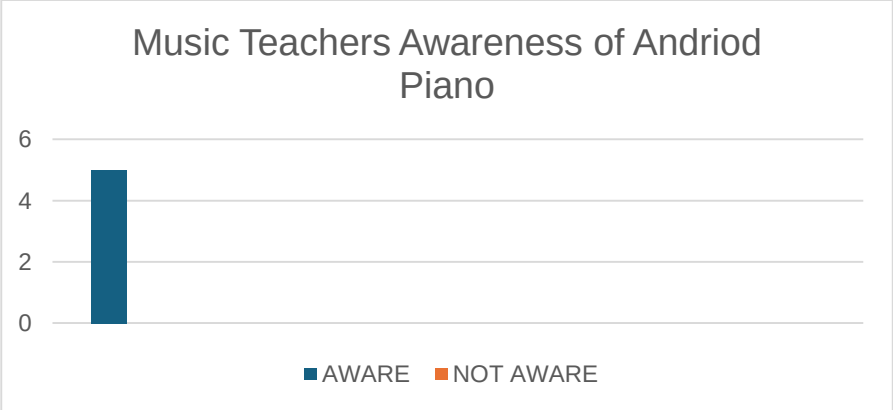

Figure 1: S*howing awareness of music teachers toward android piano mobile application*

Data in fig 1 shows that all the teachers were aware of android piano mobile application.

Research Question 2: Do music teachers recommend android piano mobile application as an aid to learning to their pupils?

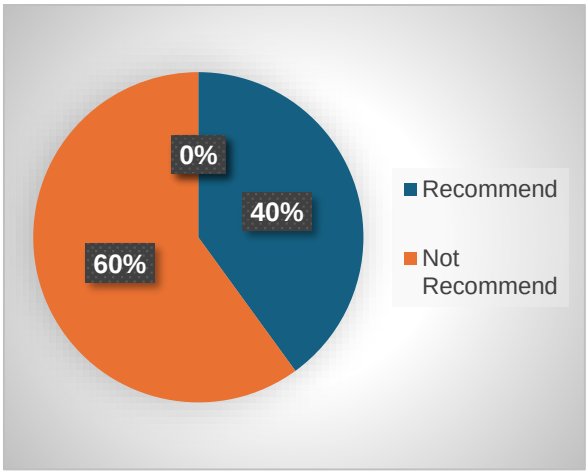

Figure 2: *Shows proportion of music teachers that recommended android mobile piano to their students*

Result from fig 2 revealed that a greater percentage of the music teachers did not recommend android piano mobile application as a learning aid to their pupils

Research Question 3: What is the impact of android music mobile applications in preschool music education in OzuobaCommunity in Obio/AkporLocal Government Area in Rivers State?

Table 3: *Showing Score for Hands-on piano skills of Pupils in the experimental group (N= 100)*

Skills	Excellent	Good	Average	Poor	Total
Key Identification	79	11	10	-	**100**
Scoring and playing of basic nursery rhymes	77	15	8	-	**100**
Proficiency on key C and Key F	79	11	10	-	**100**

Table 3 show improvement on music hands-on skills among pupils exposed to the use of android music mobile applications. Greater proportion of the students exhibited excellent skill following exposure to Android music mobile applications.

Table 4: *Showing Score for Hands-on piano skills of Pupils in the control group (N= 100)*

Skills	Excellent	Good	Average	Poor	Total
Key Identification	61	14	20	5	**100**
Scoring and playing of basic nursery rhymes	43	40	13	4	**100**
Proficiency on key C and Key F	59	16	21	4	**100**

Table 4 shows less improvement on music hands-on skills among pupils who were not exposed to the use of android music mobile applications. Lesser proportion of the students exhibited excellent skill when compared with those exposed to Android music mobile applications.

Discussion

This chapter discusses the findings presented in Chapter Three and interprets them in relation to the study's objectives, theoretical framework, and existing scholarship. The study set out to examine how Android piano mobile applications influence finger dexterity, hand–eye coordination, rhythmic accuracy, and overall hands-on skill development among preschool pupils. The findings strongly support the claim that digital piano applications can enhance practical music learning in early childhood settings.

The results presented in **Figure 1** showed that *all* participating music teachers were aware of Android piano mobile applications. This high level of awareness suggests that digital tools are no longer foreign within early childhood music education. However, awareness alone does not guarantee pedagogical integration. As Authority (2025) notes, many educators recognize digital sound tools but do not always incorporate them meaningfully into instruction due to limited training, uncertainty about pedagogical value, or lack of institutional support. This aligns with the present study's findings.

Despite universal awareness, **Figure 2** revealed that *only a few teachers recommended* Android piano applications for home practice. This gap between awareness and recommendation may reflect concerns about

screen time, unfamiliarity with app-based pedagogy, or limited confidence in parents' ability to supervise digital learning. Vygotsky's Social Constructivist Theory (1978) helps explain this hesitation: teachers may feel that without guided scaffolding, children may not fully benefit from the apps. Since learning is socially mediated, teachers may be reluctant to endorse tools that children use independently at home without structured support.
The most significant findings emerged from the quasi-experimental results in **Tables 3 and 4**, which showed that pupils exposed to Android piano applications demonstrated *higher levels of finger dexterity, hand–eye coordination, rhythmic accuracy, and sound recognition* than those in the control group. These results directly support Piaget's Constructivist Learning Theory (1902), which emphasizes that children learn best through active manipulation, sensory exploration, and hands-on engagement. The interactive nature of piano apps, tapping keys, responding to visual cues, and receiving immediate auditory feedback, creates an ideal constructivist learning environment.

These findings also align with Authority's (2025) concept of **musical DNA**, which explains that digital tools embed rhythmic, timbre, and patterned cues that naturally guide user interaction. When children engage with these cues, they develop intuitive musical responses and motor coordination. The improvement observed in the experimental group reflects this embedded musical logic.

Furthermore, the results support earlier research such as **Chang (2019)**, who found that mobile music applications improve learner motivation, engagement, and performance. Similar studies have shown that interactive digital tools enhance fine motor skills, auditory discrimination, and timing accuracy in young learners (e.g., Wiggins &Medvinsky, 2012). The present study reinforces these claims within the Nigerian preschool context.
The findings also highlight the importance of guided learning. Pupils in the experimental group benefited not only from the app but also from teacher support during use. This reflects Vygotsky's Zone of Proximal Development (ZPD), where children achieve higher performance levels when supported by a more knowledgeable other. The structured introduction of the app, combined with teacher scaffolding, likely contributed to the superior performance of the experimental group.

Summary
Overall, the findings suggest that Android piano mobile applications can serve as effective learning aids for preschool pupils, particularly in low-resource settings where access to physical instruments is limited. The apps provide affordable, engaging, and developmentally appropriate opportunities for children to practice musical skills at home and in school. The results demonstrate that digital tools, when used intentionally and with teacher guidance, can significantly enhance hands-on skill development in early childhood music education.

Conclusion
This study set out to examine how Android piano mobile applications influence the development of hands-on musical skills among preschool pupils in Ozuoba Community in Obio/Akpor Local Government Area in Rivers State. The findings clearly show that pupils who used the application performed better in finger dexterity, hand–eye coordination, rhythmic accuracy, and sound recognition than those who did not. Although teachers were aware of these applications, only a few recommended them for home practice, suggesting a gap between awareness and practical adoption. Overall, the study concludes that Android piano applications can serve as effective, affordable, and engaging tools for strengthening early music learning, especially in settings where access to physical instruments is limited.
The results of this study have several important implications for early childhood music education. First, the improvement seen in the experimental group supports the idea that digital tools can complement traditional teaching methods and enhance children's practical learning experiences. This aligns with constructivist and social constructivist theories, which emphasize active exploration and guided support as key to early learning. Second, the findings suggest that digital piano applications can help bridge resource gaps in low-income communities by providing accessible alternatives to physical instruments. Finally, the study highlights the need for teachers to receive training and support so they can confidently integrate digital tools into their instructional practices.

Limitations of the Study
The primary limitation of this study is the relatively small sample size, which may restrict the generalizability of the findings to all preschool pupils in Ozuoba Community in Obio/Akpor Local Government Area in Rivers State. Additionally, the study relied on convenience sampling, which may introduce selection bias. Future research with larger, more diverse samples and longitudinal designs would provide deeper insights into the long-term impact of digital piano applications on early childhood music development.

Recommendations

Based on the findings, the following recommendations are proposed:

- **Integrate digital piano applications into preschool music lessons.** Schools should adopt Android piano apps as supplementary tools to support hands-on skill development.
- **Provide teacher training on digital music tools.** Workshops and professional development programs should help teachers understand how to use these applications effectively.
- **Encourage guided home practice.** Teachers and parents should collaborate to ensure that children use the apps at home in a supervised and meaningful way.
- **Improve access to digital devices.** Schools and community stakeholders should explore ways to provide affordable or shared devices for pupils who lack access at home.
- **Conduct further research with larger samples.** Future studies should involve more schools and pupils to strengthen the generalizability of the findings and explore long-term effects.

References

Amuah, E., &Adum-Attah, K. (2016). Ghanaian tonal languages and their influence on traditional musical performance. *Journal of West African Linguistics, 43*(2), 89–104.

Authority, A. O. U. (2025). Musical DNA in technological applications: Sound, signal, and the epistemology of everyday machines. *International Journal of Research Publication and Reviews*, *6*(11), 8452–8462.

Authority, A. O. U. (2025). Episto-musical pedagogy theory: A decolonial framework for sound-based curriculum in African education. *African Journal of Social Sciences and Humanities Research*, *8*(4), 44–60. https://doi.org/10.52589/AJSSHR-VJWA2OEE

Authority, A. O. U. (2025). Musical DNA in technological applications: Sound, signal, and the epistemology of everyday machines. *International Journal of Research Publication and Reviews*, *6*(11), 8452–8462.

Byrne, C., & MacDonald, R. (2002). The use of music technology in the classroom: *A survey of Scottish secondary schools. British Journal of Music Education*, *19*(2), 191–203.

Jackman, H. (2005). Early education curriculum: *A child's connection to the world* (4thed.) Boston, United State of America: Cengage Learning Inc.

Kaufman, J. (2015). Creativity is life (commentary). *Journal of Creative Behavior, 49*(3),233-237.

Kohn, A. (1993). *Published by rewards*: *The trouble with gold stars, incentive plans, A's praise, and other bribes.* New York, NY: Houghton Mifflin.

Murray, M. (2002). Music technology and educational practice: Integrating technology into the music classroom. *Music Educators Journal*, *88*(6), 44–50.

Murray, J. (2002). Music technology and education. *Journal of Music Technology, 5*(2), 45–58.

Pierroux, P., & Rudi, J. B. (2020). Technology and contemporary music practices: Transformations in performance and production. *Digital Creativity, 31*(1), 1–15

Pierroux, P., & Rudi, A. (2020). Digital technologies in creative music production. *Music and Technology Review, 12*(1), 1–15.

Santrock, J. W. (2010). *Child development* (13th ed.). McGraw-Hill.

Savage, J. (2004). *Re-imagining music education for the 21st century*. Unpublished doctoral dissertations, University of East Angia.

Walton, K. (2014). Music and early literacy development in young children. *Early Childhood Education Journal, 42*(1), 55–62.

Walton, P., & Walton, K. (2002). Using music to support reading instruction in early childhood. *Journal of Research in Childhood Education, 17*(2), 108–120.

Wiggins. J., &Medvinsky, M. (2012). Scaffolding students composers. In M. Kaschub& J. Smith (Eds.), *Composing our future: Preparing music educators to teach composition* (pp. 109-125). Oxford: Oxford University Press.

Wiggins, J., &Medvinsky, M. (2012). Developing musical creativity in early childhood through digital tools. *Early Childhood Music Journal*, *18*(2), 45–59.