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ICT Integration in Music Education Within Ghanaian Colleges of Education: Opportunities, Challenges, and Cultural Realities

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ABSTRACT: This qualitative multiple-case study examined how digital technologies shape music teaching and learning in three Ghanaian Colleges of Education: Abetifi Presbyterian, Offinso, and Agogo Presbyterian Women's.This is the first study to examine ICT use in music education across Ghanaian Colleges of Education and shows that sustainable integration depends on culturally aligned pedagogy, improved infrastructure, and ongoing tutor development. Data came from 12 interviews, 3 focus groups with 18 pre-service teachers and 12 classroom observations. The analysis identified three main findings. First, ICT supported creativity, inclusion and learner motivation as students used notation and audio tools to experiment and link theory with practice. Second, infrastructural and pedagogical barriers such as unreliable electricity limited devices poor internet access and inadequate tutor training restricted meaningful use of technology restricted meaningful use of technology. These gaps created inconsistent learning experiences and reduced tutors' ability to integrate ICT effectively and reduced tutors' ability to integrate ICT effectively. Third, tutors and students negotiated tensions between indigenous musical traditions and Western-designed digital tools, adopting selective strategies to maintain cultural authenticity. The findings reflect a widening digital divide between rural and urban Colleges of Education and raise concerns about producing teachers who feel unprepared for technology-based instruction. Sustainable ICT integration will require culturally responsive pedagogy targeted professional development and long-term investment in educational infrastructure to enable proper teaching methods.

Keywords: ICT Integration, Music Education, Ghana, Teacher Education, Digital Divide, Pre-Service Teachers, Cultural Pedagogy.

INTRODUCTION

Technology now plays a central role in music education, changing how teachers and students engage with creativity, performance, and knowledge and students engage with creativity, performance, and knowledge. Digital tools such as SmartMusic, MuseScore, and AuralBook allow learners to work with composition, aural training, and performance tasks that were previously limited to face-to-face instruction. Evidence shows that these platforms support learner-centred approaches and improve motivation, engagement, and self-directed learning (J. R. Hernández-Bravo et al., 2016; W. Y. Lam, 2024).

Globally ICT is promoted as a path toward equitable and expanded learning opportunities. Studies show that digital music instruction supports cognitive, technical, and emotional development. Lam (2024) highlights improved creativity and reflective practice whilst Shan, Wang, and Luo (2025) report gains in emotional resilience. Large-scale analyses however warn that ICT can deepen inequalities when infrastructure, teacher preparedness, and access remain uneven (El Amrani et al., 2022; Reedy, 2023). This is particularly concerning when you consider how technology is supposed to democratise education but ends up doing the opposite in many contexts.

Across Sub-Saharan Africa ICT adoption in teacher education has advanced slowly and inconsistently. Research shows that whilst digital tools create new opportunities for creative engagement their use often clashes with local pedagogical traditions and cultural practices (S. Yende & Madolo, 2024). As a result technology integration becomes as much a cultural and institutional challenge as a technical one. This tension is especially relevant in Ghana where Colleges of Education are responsible for preparing teachers for digital-era classrooms and the expectations placed upon these institutions are quite significant really.

Ghana's 2019 Teacher Education Reform Policy requires all pre-service teachers to develop ICT competence yet implementation remains fragmented. Studies identify unreliable internet access, limited devices, and insufficient staff training as major constraints (Akuffo, 2022). Urban-rural disparities in digital literacy persist (Quaicoe & Pata, 2020) and many students use ICT more for communication than for academic work (Buabeng-Andoh & Issifu, 2015). Policy expectations therefore exceed the infrastructural reality available in most Colleges of Education. The gap between what is required and what is actually possible creates a situation where teachers are expected to be digitally competent without the proper resources to develop that competence.

This creates a paradox: ICT is promoted as a tool for democratising music education yet without contextual support it may reinforce existing inequalities. Scholars caution that when teachers lack digital confidence or culturally relevant training technology risks becoming superficial and may marginalise traditional musical knowledge (Savage, 2010; Wise et al., 2011). Understanding how ICT is integrated into music education in Ghanaian Colleges of Education is therefore critical hence the need for more research in this area.

Despite global progress meaningful ICT integration in Ghanaian music education is still limited by infrastructural deficits, inconsistent teacher preparation and cultural misalignment. Digital instruction often depends on individual initiative rather than institutional strategy (Aikins & Akuffo, 2022) leaving pre-service teachers insufficiently prepared for technology-based teaching. Addressing these issues requires examining how ICT interacts with local culture, resources, and classroom realities actually.

This study argues that ICT can enhance creativity, engagement, and access in music education but only when supported by reliable infrastructure, strong digital literacy, and culturally grounded pedagogy. Without these foundations Ghana risks missing the transformative potential of ICT and widening the digital divide affecting future music teachers. That's more than concerning. That's actually quite problematic for the entire educational system moving forward.

This study offers the first empirical analysis of ICT use in music education within Ghanaian Colleges of Education, showing how digital, infrastructural, and cultural factors interact in daily teaching. The findings provide new evidence that sustainable ICT integration in music teacher preparation requires not only access to technology but also culturally aligned pedagogy and continuous tutor development.

Global ICT Integration in Music Education

Information and Communication Technology, or ICT as everyone calls it now, has honestly reshaped how music is taught, learnt and even imagined. It's not just about pressing buttons or clicking icons, it's about how sound, image and interaction merge into one strange but exciting classroom. Digital tools create these mixed learning spaces where listening, performing and composing all sort of collide together, sometimes beautifully, sometimes confusingly. Students can work at their own rhythm and teachers, well, they become more like guides than the old-style information givers. They become more like guides than the old-style information givers.

Applications such as SmartMusic, AuralBook and MuseScore let learners practise alone yet not alone, because the software listens back and gives feedback that feels almost human though not quite. Before this, teachers couldn't easily track every mistake or every success, but now data follows the music like a shadow. Research from Europe and Asia says that these digital things don't just make students faster at scales but also more expressive, more motivated, sometimes even more daring. It's a curious thing, that screens can make people more human in their playing.

In Spain, for instance, a personalised ICT-based programme improved both musical skill and school marks among primary pupils. In rural Australia, blended learning helped students feel less nervous, less like they were being judged by the room. It made learning fairer, or at least that's what Crawford (2017) argued, though fairness is a slippery word.

ICT changes teachers too. The role of the teacher becomes less about control and more about connection, which sounds poetic but is actually quite messy in practice. Constructivist theory says that learners build knowledge through experience, and technology sort of builds the scaffolding for that, though sometimes the scaffolding wobbles. Some teachers use ICT confidently, mixing apps and notation tools, while others struggle with the simplest upload or with the fear that machines will replace their artistry. Some teachers use ICT confidently, mixing apps and notation tools, while others struggle.

Digital learning also opens doors for inclusivity, or at least leaves them half-open. Students with physical limits or those living far away can join virtual ensembles, playing together though separated by oceans. During the COVID-19 pandemic this became not just helpful but necessary, and it showed that music can survive even when the world stops moving.

Still, the problems are stubborn. Devices cost money, connections drop, and some educators resist the idea that technology belongs in the conservatoire. Without a clear plan, ICT risks becoming an accessory rather than a foundation, an extra gadget rather than a philosophy.

In the end, ICT in music education is both a revolution and a riddle. For it to work, teachers need skill, schools need structure and the culture must breathe with it, especially in places where reform and tradition still compete for the same song.

ICT and Music Education in Africa

Information and Communication Technology, or ICT, has become one of those things everyone keeps saying will change education forever, and maybe it will, but maybe it already has in ways we don't fully see yet. Across Africa, it's supposed to improve access, quality, inclusion—all the big words—but in music education, the story is still uneven. Some schools have computers and recording tools, others barely have electricity. The policies don't always match the practice, and the practice doesn't always match the culture. That's the strange loop of it. Studies from South Africa, Kenya, and Nigeria show that digital tools are slowly entering composition, performance, and theory classes, but this happens without strong institutional bones to hold it up. Without bones, the body shakes. Without bones, the body shakes.

In South Africa, Yende and Madolo (2024) observed that ICT is being used to bring together Western and indigenous music teaching, often through online resources or digital recorders. Students seem excited about it, but teachers often lack both confidence and training, which makes the use of technology more decorative than deep. Gorgoretti (2019) said something similar that teacher ability is the key to ICT success, otherwise technology just sits there like a shiny instrument no one knows how to play. It becomes a surface, not a substance.

In Nigeria, Adeogun and Olusoji (2021) found teachers who believed ICT could modernize the curriculum and make learning better, but they also complained about bad infrastructure unreliable electricity and low funding. Kenya's case, according to Nyang'au (2023), was not much different teachers wanted to use virtual learning but couldn't because of poor internet and low digital literacy. So there's enthusiasm, yes, but also exhaustion. A kind of digital hope mixed with daily struggle.

Culture complicates things further. Teachers often find it hard to merge digital methods with traditional African ways of teaching music oral, communal, experiential. The software made in the West doesn't always understand African tonal systems or rhythms. It doesn't breathe the same way. So teachers improvise: they record performances on their phones, send assignments through WhatsApp, or show drumming patterns on YouTube. It's not official but it works, it works because it must work.

Gender adds another layer. Ojo and Adu (2024) found that female students in teacher-training programs often feel less confident using technology, partly because of social expectations and partly because they don't have the same access to devices. To fix that, programs need to be designed that actually see these differences instead of pretending equality already exists.

Still, there are bright notes. In Rwanda and South Africa, blended-learning projects that mix traditional music with digital tools have improved engagement and cultural identity. They show that ICT can work when it grows from local soil instead of being planted from somewhere else.

So the literature keeps saying the same thing in different ways: ICT in African music education is still forming, still learning its rhythm, but when it fits the culture and the context, it can truly sing.

ICT in Ghanaian Colleges of Education: a critical examination

Ghana's education reforms have long said that pre-service teachers must graduate with ICT competence, yet this promise often remains only on paper in Colleges of Education (CoEs). During the COVID-19 period tutors described a sudden and rather chaotic shift to online teaching that depended heavily on their own data bundles and phones, showing how little institutional support was actually present (Aikins & Akuffo, 2022). It was a kind of policy noise without the matching investment, a pattern that repeated itself across Ghanaian higher education during the pandemic (Kumi-Yeboah, Amoako, et al., 2023). Policy noise without matching investment, yes, that phrase could be said twice because it truly captures the emptiness of the promise.

Connectivity, electricity that stays on, and access to devices still decide who can take part. In basic schools, teachers' digital use follows the map—urban schools do more, rural schools do less (Quaicoe & Pata, 2020). The same uneven geography appears in higher education where data costs are high and devices are scarce so participation becomes a struggle. Some CoEs literally run out of resources and when that happens ICT-based music lessons become rare and sometimes almost decorative rather than educational.

The main issue is not exposure but integration. Research in music education keeps showing that teachers' own beliefs and skills shape how technology supports creativity, performance and listening (Wise et al., 2011). In Ghanaian CoEs, Aikins and Akuffo (2022) note that tutors have little time or encouragement to redesign lessons, so ICT ends up being used mainly to display slides instead of generating new musical tasks. This repeats what other studies have seen: one-off workshops produce shallow use while continuous professional learning tied to curriculum gives deeper results (Ahmed & Opoku, 2022). Continuous professional learning tied to curriculum gives deeper results.

Digitisation makes it easy to distribute assignments fast but it complicates planning and feedback when classes are large and the internet is weak. Tutors complain about workload pressures, which echoes what university lecturers also said—that digital teaching is flexible but time-hungry (El Amrani et al., 2022). Without proper scheduling or technical support, tutors sensibly narrow ICT use to safer, smaller functions. Sometimes the system seems to eat its own purpose, if that makes sense, because the more digital it becomes the less space there is for human rhythm.

Evidence also shows that earlier digital experience predicts later classroom use (Quaicoe & Pata, 2020). Students from rural or low-income families may finish training with less digital confidence, which then repeats inequality in the schools they will teach. Targeted support, loaned devices and

subsidised data helped universities (Kumi-Yeboah et al., 2023) but CoEs need the same or even more. They need the same or even more.

International studies warn that careless ICT adoption can let Western notation dominate and weaken ensemble practice (Crawford, 2017; Savage, 2010). For Ghana's teacher colleges, digital tools should instead support local repertoires and embodied traditions. Otherwise technology shrinks musicianship, making it sound thinner, smaller somehow.

The Ghanaian evidence is steady but not strong for music teacher training. The best studies point to systemic barriers and uneven digital literacy. What remains missing are CoE-level interventions proven to change music pedagogy outcomes. Until then the sensible reading is clear infrastructure, ongoing pedagogical training and culturally relevant materials are the things that make policy actually live inside the classroom.

METHOD

Research Design

This study used a qualitative interpretivist multiple-case study design to look at how ICT is integrated into music education in selected Ghanaian Colleges of Education and how ICT is integrated into music education in selected Ghanaian Colleges of Education. The interpretivist approach was chosen to understand tutors' and pre-service teachers' lived experiences and the meanings they attach to ICT use the meanings they attach to ICT use actually. The multiple-case design allowed comparison across three different institutional contexts highlighting how infrastructure teaching practices and cultural factors shape digital engagement in music lessons.

The study addressed three questions:

1. How do music tutors and pre-service teachers think about the role of ICT in music education?
2. What infrastructural pedagogical and cultural barriers stop effective ICT use from happening?
3. How does the digital divide impact pre-service teachers' confidence and readiness to apply ICT in future teaching?

The Setting of the Research

The study was done in three public Colleges of Education, selected mainly because they looked different from each other in geography and in what they had, or didn't have, in terms of buildings and wires and such. Abetifi College of Education in the Eastern Region is quite urban, with some ICT tools and a fair internet that sometimes works, sometimes not. Agogo Women College of Education, in Ashanti, is more semi-urban, using a mixture of learning ways, a mixture of learning ways. Then there's Kibi Presbyterian College of Education, also Eastern, more countryside, often losing power and digital hope.

All three teach performing arts, mostly music, mixing Western and local teaching styles. That mixture, that mixture, made them strong examples for how technology meets culture and situation, or maybe collides with it really.

Population

There were 24 people in the study, six music tutors and eighteen pre-service music teachers aged between 19 and 36, though one might say the numbers felt smaller somehow, maybe because the room was quiet. Participants were chosen on purpose to make sure there was a mix of gender digital literacy and education but also just to make it fair. The tutors had taught for five to fifteen years, five to fifteen years exactly, which sounds oddly specific.

Data collection

To ensure triangulation the study employed three data collection methods which were semi-structured interviews, focus groups and classroom observations.

Twelve interviews were competed with music tutors and pre-service teachers and questions focused on their experiences with ICT tools such as MuseScore, SmartMusic and Audacity including benefits and challenges. Each interview lasted 30–45 minutes and was conducted in English or Twi, recorded and transcribed. The interviews were conducted in English or Twi, recorded and transcribed actually.

Three focus group discussions were held one in each College of Education involving six pre-service teachers per group and sessions lasted about one hour and explored shared views on ICT challenges, institutional support and aspirations for ICT use in music education. The focus groups were designed to capture the collective experiences of pre-service teachers hence they could express their thoughts more freely in a group setting.

Twelve non-participant observations were carried out in music lessons including choral work, drumming and theory classes. Field notes documented how tutors and students used ICT tools during instruction and how digital resources shaped teaching practices really. The observations were non-participant which means the researcher did not interfere with the natural flow of the classroom activities.

Table 1. Summary of Data Collection Methods.

Method	Participants	Duration	Focus
Semi-Structured Interviews	12 (6 tutors, 6 students)	30–45 min each	Individual experiences of ICT use
Focus Group Discussions	3 groups (6 students each)	60 min	Collaborative reflection on ICT integration
Classroom Observations	12 lessons	45–90 min	Pedagogical use of ICT tools

Data Analysis and Ethical Considerations

Data were analysed using Braun and Clarke's six-step thematic framework and transcripts and field notes were repeatedly reviewed and coded in NVivo 14, using both descriptive and interpretive codes. Codes were then organised into themes and compared across the three colleges to ensure consistency and compared across the three colleges to ensure consistency. This process generated three themes: ICT as a tool for creativity and engagement, structural and pedagogical constraints, and cultural–technological negotiation. Findings were supported with direct quotations to retain participant voice which is important for maintaining the authenticity of what participants actually said in their own words.

Reliability was addressed through Lincoln and Guba's criteria and credibility was strengthened through data triangulation and member checking. Transferability was ensured by providing contextual detail about the research sites. The dependability was supported through documentation of coding decisions and analytic memos that tracked the process. Confirmability was enhanced through reflexive journaling and peer debriefing which helped to make sure the findings were not just based on researcher bias but actually reflected what was there in the data.

Ethical procedures followed BERA (2018) guidelines and participants gave informed consent anonymity was maintained through pseudonyms and all data were encrypted. Audio recordings will be retained for five years and securely deleted thereafter.

RESULT AND DISCUSSION

Thematic Analysis of ICT in Ghanaian Music Education

Thematic analysis of interview, focus group, and observation data produced three interconnected themes:

1. ICT as a catalyst for creativity, inclusion, and engagement
2. Structural and pedagogical limitations that restrict effective integration
3. The negotiation of cultural and technological identities in music teaching

Each theme is discussed with supporting evidence and links to relevant scholarship.

ICT as a Catalyst for Creativity, Inclusion, and Engagement

Participants repeatedly described Information and Communication Technology (ICT) as a kind of spark something that made students more creative, more involved, and more included in the process of learning music. Pre-service teachers from the three Colleges of Education said that when they used programs like MuseScore, Audacity, and SmartMusic, their learning changed from passive watching to active doing. The software allowed them to compose, edit, and play back their own scores, linking theory with practice in a way that felt immediate and satisfying.

As one tutor put it quite simply:

> *"Before, a lot of students didn't get how to write. The software lets them see and hear their scores right away, which makes them want to try."* (Tutor 3, Kibi CoE)

This comment reflects what many international researchers have already noted—that technology-based environments help learners visualise and manipulate musical ideas, giving them a stronger sense of control and curiosity (Hernández-Bravo et al., 2016; Lam, 2024). Real-time feedback, as several participants said, made students "want to fix their own mistakes before anyone told them to." That's a kind of constructivist learning in action, even if they didn't call it that.

ICT also opened up access for students who lacked traditional instruments or formal training. Students who couldn't afford a keyboard or guitar found digital tools to be a fair substitute, or maybe not a substitute but a new path entirely. This supports UNESCO's idea that technology can "level the field" for learners with different resources (UNESCO, 2021). In this sense, ICT did not just add to existing teaching it redefined who could take part and how.

The results echo Revenko, (2021) and León-Garrido et al., (2022), who found that ICT encourages multimodal learning by mixing sound, sight, and movement. Digital notation engages spatial awareness; audio-editing sharpens listening; and interactive rhythm apps build timing through touch. These multiple modes help students with different learning styles stay engaged and remember more (Moldovan, 2021;Madalinska-Michalak, 2022).

However, the success of ICT use depended heavily on the tutor. In Ghanaian Colleges of Education, some tutors were confident and curious, using MuseScore for composition tests or SmartMusic for group feedback. Their students were more active, more daring. But in other schools, tutors used ICT merely for PowerPoint slides or not at all, and students said they felt "boxed in." This shows that having technology is not enough; what matters is how teachers use it and whether they feel capable of doing so (Merrick & Joseph, 2023; Wise, 2016).

Bauer and Mito (2016) argue that digital music teaching requires a shift from teacher-led delivery to student-driven exploration. Tutors become facilitators, not lecturers. Yet this shift is still developing in Ghanaian CoEs, where both technical skill and teaching confidence are uneven (Aikins & Akuffo, 2022). It's a slow change, and sometimes tutors feel like they are "teaching the computer instead of the student," as one participant oddly phrased it(Revenko, 2021).

Collaboration also came up as a strong benefit. Group projects using shared platforms encouraged teamwork, peer review, and even cultural exchange between students from different ethnic groups. Merrick and Joseph (2022) found similar results in Australia, where online ensembles kept students musically connected even when learning remotely. The Ghanaian experience mirrors that, though with more interruptions due to connectivity issues.

In short, ICT worked as a transformative and equalising force when used well. It made students more creative, widened participation, and bridged the gap between theory and practice. But it still relied on tutors' digital literacy and institutional backing. The promise of ICT in music education, therefore, is not just about buying hardware or software. It's about shaping teachers who are digitally fluent and culturally sensitive, who can merge technology with the expressive heart of music. It's about shaping teachers who are digitally fluent and culturally sensitive.

Structural and Pedagogical Limitations in ICT Implementation

Despite the enthusiasm, all three Colleges of Education faced serious structural issues that made consistent ICT use difficult. Participants mentioned unreliable internet, too few working computers, and expired or missing software licences. One tutor summed it up bluntly:

> *"We don't have computers or a music lab that work."* (Tutor 5, Abetifi CoE)

These material shortages reflect Ghana's wider digital divide, where rural schools lag behind urban ones in access to devices and connectivity (Quaicoe & Pata, 2020; Kumi-Yeboah et al., 2023). The result is a kind of educational inequality that favours students who can afford their own laptops or data bundles. It's not just about missing equipment it's about who gets to participate fully.

Tutors often compensated by using their personal laptops or encouraging students to share devices. Some downloaded offline programs like MuseScore or Audacity to keep lessons going even without internet. These improvisations showed creativity and resilience but also revealed the unfairness of the system. Students without smartphones or computers were left out of creative tasks, forming two different learning experiences within one classroom.

From a teaching perspective, ICT use was often more supportive than transformative. Many tutors used it mainly to show videos, display lyrics, or run PowerPoint slides rather than for interactive composition or analysis. Wise, Greenwood, and Davis (2011) note that this pattern is common teachers use technology as a presentation tool rather than as a space for critical or creative engagement. This limited approach restricted opportunities for improvisation, digital collaboration, and deeper musical thinking.

Another recurring issue was tutors' lack of confidence. Most had attended only brief workshops that focused on technical demonstrations how to open software, not how to teach with it. One tutor said, "We were trained to open software, not how to teach with it," repeating the same frustration others shared. Sun & Abramauskienė, (2025) argue that short, one-off training sessions rarely lead to lasting skill development. Teachers need continuous, context-based support, including mentoring and peer exchange, to truly integrate ICT into their subject teaching.

This absence of sustained training keeps a cycle going: tutors without confidence or institutional backing use ICT superficially, which in turn limits students' experiences. It's a loop that reinforces itself. The paradox is striking Ghana's 2019 Teacher Education Reform emphasises digital literacy, yet implementation in CoEs remains inconsistent due to weak professional development and poor infrastructure (Asare et al., 2023). There is a persistent misalignment between policy rhetoric and classroom realities.

That sentence might sound odd but it captures the feeling many tutors expressed of chasing a moving target. Ultimately, technological readiness in music education involves more than just having computers and software. It requires teacher preparedness, institutional investment, and equal access for all students. Without national coordination and ongoing teacher training, the digital shift risks widening inequalities instead of reducing them. The digital shift risks widening inequalities instead of reducing them.

ICT, then, is both a promise and a problem. It has the potential to democratise learning but can also deepen divides if left unsupported. The findings from these Colleges of Education suggest that the future of digital music pedagogy in Ghana depends not only on technology itself but on the people who teach with it, the systems that sustain them, and the willingness to see technology as a living part of culture, not just a tool plugged into it.

Table 2. Reported Challenges to ICT Integration in Ghanaian CoEs

Category	Description	Frequency (n = 24)
Poor internet connectivity	Frequent interruptions during lessons	22
Limited ICT facilities	Inadequate computers, no digital labs	20
Inconsistent training	Short-term workshops without follow-up	18
High data costs	Students unable to access online platforms	19
Power outages	Interruptions during multimedia use	15
Resistance to change	Some tutors prefer traditional methods	10

These obstacles affirm that access to infrastructure and ongoing institutional investment are essential prerequisites for successful ICT integration (El Amrani et al., 2022; Ahmed & Opoku, 2022).

Negotiating Cultural and Technological Identities

The third main theme shows how tutors and pre-service teachers found a balance between new technology and cultural authenticity. Participants recognised the efficacy and adaptability of ICT tools in enabling notation, playback, and recording. But they also said they were worried about what they saw as a Western bias in most digital music apps. A student said:

> *"The software is good, but it can't play African music." It has to fit with our music.* (Pre-service teacher, Abetifi CoE)

This sentiment resonates with Yende and Madolo's (2024) findings that Western-designed music technologies frequently inadequately represent African tonal systems, rhythmic patterns, and improvisational aesthetics. Numerous pre-service teachers in the current study experienced limitations due to the incapacity of software like MuseScore or SmartMusic to support asymmetric rhythms, call-and-response textures, and tonal inflections inherent to Ghanaian traditional music.

Tutors changed their teaching methods by using a mix of different ones. ICT was frequently employed for the instruction of Western notation and theory, whereas indigenous instruments, including fontomfrom drums, seperewa (harp-lute), and atumpan, were preserved for lessons in rhythm, ensemble performance, and improvisation. This two-pronged strategy aimed to protect cultural integrity while making the most of what digital technology has to offer in terms of teaching. It corresponds with Asare, Twum, and Amoah (2023), who define this synthesis as culturally responsive digital pedagogy—a framework where ICT enhances rather than replaces conventional learning methods.

Similar evidence from South Africa corroborates this trend. Kruger and Viljoen (2022) discovered that digital adaptation rooted in local culture enhances students' musical identity, self-efficacy, and sense of community belonging. By placing technology in the context of indigenous aesthetics, teachers help students see ICT not as an imposition but as a way to work together to express their culture. These kinds of approaches show that when it comes to integrating technology into African music education, cultural alignment is just as important as technical skill.

Still, the fact that there isn't much culturally adaptable software makes real integration harder. The prevalence of Eurocentric notation systems in mainstream platforms can inadvertently marginalise African idioms, perpetuating epistemic hierarchies in music education (Yende & Madolo, 2024). If not dealt with, this could lead to what scholars call "digital coloniality," which is when imported technologies make people dependent on other cultures.

People who took part in this study suggested new ideas that were based on their own culture, like Ghanaian sound libraries, mobile drumming apps, and digitised indigenous rhythm banks. These suggestions show that people are becoming more aware of the need for technology design that takes into account Ghana's diverse music traditions. These kinds of new ideas would fit with the African Union's Agenda 2063 goals for digital inclusion and cultural preservation. They could also serve as a model for making digital music education more accessible across the continent.

In conclusion, the relationship between technology and cultural authenticity in Ghanaian Colleges of Education shows both potential and conflict. ICT provides significant pedagogical efficiency and engagement; however, its present design and application are culturally asymmetrical. The way forward is through collaborative innovation, where teachers, technologists, and cultural practitioners work together to make tools that accurately show how Ghanaian and African music works. 4.3 Finding a Balance Between New Technology and Real Culture

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In conclusion, the relationship between technology and cultural authenticity in Ghanaian Colleges of Education shows both potential and conflict. ICT provides significant pedagogical efficiency and engagement; however, its current design and application exhibit cultural asymmetry. The path forward involves collaborative innovation, wherein educators, technologists, and cultural practitioners jointly create tools that accurately reflect Ghanaian and broader African musical epistemologies.

Integrative Conversation

The results of this study show a clear tension in how Information and Communication Technology (ICT) is used in Ghanaian Colleges of Education. Digital tools increased opportunities for creativity and participation in music learning, yet their transformative potential was limited by structural constraints, uneven pedagogy, and cultural misalignment. Applications such as MuseScore, Audacity, and SmartMusic supported composition, feedback, and multimodal learning, but these benefits were inconsistent across institutions.

This pattern mirrors findings from other African contexts. Adeogun and Olusoji (2021) reported that ICT reforms in Nigerian music education were hindered by unreliable infrastructure and insufficient staff preparation. Ojo and Adu (2024) identified similar barriers in South African teacher education, noting irregular access and weak institutional support. These parallels position the Ghanaian case within a wider continental landscape where technological promise is repeatedly undermined by systemic vulnerabilities.

The findings align with constructivist perspectives that view technology as a tool for exploration, reflection, and self-directed learning. ICT becomes transformative only when supported by adequate infrastructure, sound pedagogy, and cultural relevance. When any of these elements is weak, particularly teacher competence, ICT use becomes superficial and fails to shift learning outcomes.

Sustainable ICT integration in Ghanaian CoEs therefore depends on coordinated development across three domains:

Tutor Capacity: Tutors need continuous mentorship and structured professional learning that goes beyond one-off workshops. Limited training produces shallow adoption and leaves pre-service teachers with inconsistent digital exposure.

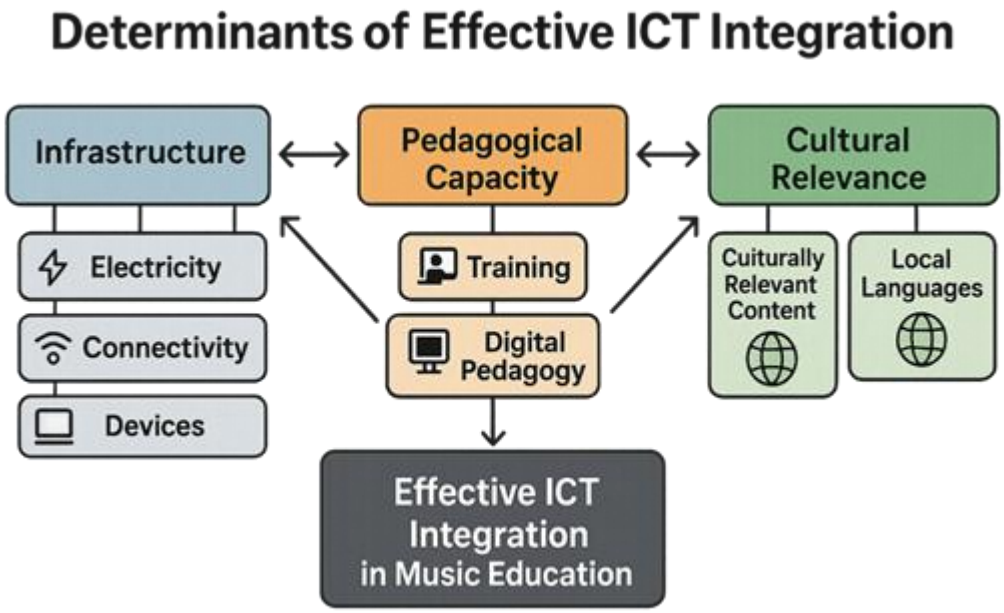
Infrastructure: Effective digital learning requires reliable electricity, campus-wide internet access, and licensed software. Without these foundations, ICT remains aspirational rather than practical.

Cultural Relevance: Digital platforms must incorporate Ghanaian musical idioms through indigenous sound libraries, rhythm resources, and contextually designed curricula. This ensures that ICT strengthens rather than displaces cultural knowledge.

These insights expand global discussions on educational technology by emphasising the realities of postcolonial, resource-constrained environments. They challenge assumptions about the neutrality of technology and show that educational value is shaped by local culture, institutional capacity, and pedagogical purpose.

For ICT to become a meaningful part of music teacher education in Ghana, policy and practice must prioritise capacity building, contextualisation, and cultural co-creation. Hardware and software alone are insufficient; sustainable progress requires systems that support teachers, reflect Ghanaian musical identities, and enable equitable participation.

Figure 1. Conceptual Model of ICT Integration in Ghanaian Music Education



These obstacles affirm that access to infrastructure and ongoing institutional investment are essential prerequisites for successful ICT integration (Chen, 2020; Debevc et al., 2020).

Negotiating Cultural and Technological Identities

The third theme shows how teachers and students worked out a balance between new technology and cultural authenticity. Participants appreciated ICT for its efficiency but voiced apprehension regarding excessive dependence on Western music software. A pre-service teacher said:

> "*The software is good, but it doesn't know how to play African music.*" You have to make it fit our music.

This comment is similar to what Yende and Madolo (2024) said about how Western-designed technologies often don't do a good job of representing African tonalities and rhythmic complexity. Tutors adjusted by using ICT in a limited way, using notation software for theory but going back to native instruments for rhythm and ensemble lessons(Gbadamosi, 2023; Kumi-Yeboah, Kim, et al., 2023; Lyu et al., 2023).

These kinds of mixed strategies point to a new type of "culturally responsive digital pedagogy" (Asare et al., 2023), where ICT adds to traditional learning instead of replacing it. This method is similar to what South African studies have shown, which show that digital adaptation that is based on local culture improves student identity and engagement (Kruger & Viljoen, 2022).

But the fact that there aren't many culturally adaptable software options makes real integration harder. Digital music education could reinforce cultural marginality if there aren't platforms that understand Ghanaian idioms. This underscores the necessity for contextual innovation, including the creation of indigenous sound libraries or mobile applications tailored to local needs(Oduro & Mensah, 2021).

Integrative Conversation

The results reveal a contradiction. ICT makes creative learning opportunities more available to everyone, but structural inequities and cultural misalignment keep it from being as powerful as it could be. The situation in Ghana is similar to what is happening in other African countries: ICT has a lot of potential, but there are still systemic barriers (Adeogun & Olusoji, 2021; Ojo & Adu, 2024).

The results substantiate constructivist learning models that perceive technology as a mediating instrument for exploration and reflection (Revenko, 2021). In practice, the study confirms that digital transformation necessitates a triadic alignment among infrastructure, pedagogy, and culture. When one of these dimensions is weak, especially teacher competence, ICT stays on the outside.

In the context of the Ghanaian CoE, sustainability will depend on:

1. For tutors, ongoing professional development;
2. Putting money into dependable infrastructure; and
3. Putting local music traditions into digital platforms.

These findings enhance the global discourse by contextualising ICT integration within postcolonial and resource-limited educational environments—areas frequently neglected in Western-centric research.

CONCLUSION

This study examined how Information and Communication Technology (ICT) is integrated into music education in Ghanaian Colleges of Education (CoEs) focusing on the influence of infrastructure pedagogy and culture. Data from interviews focus groups and classroom observations show that ICT supports creativity participation and independent learning but also reflects persistent institutional and structural inequities. When used effectively ICT strengthens composition performance and reflective learning. Students reported increased confidence and tutors with stronger digital skills integrated software more meaningfully aligning with global evidence on ICT's contribution to musical understanding (J. A. Hernández-Bravo et al., 2024; W. M. Lam, 2024).

These benefits however were inconsistent. Limited internet access inadequate devices and high data costs continue to constrain ICT use (Akyeampong, 2021; Chen, 2015). ICT is often competed for content display rather than creative engagement reflecting gaps in pedagogical training and the absence of sustained professional development. That's more than just a technical issue actually. A key cultural challenge also emerged here. Western-designed software poorly represents Ghanaian and African musical systems requiring tutors and students to adjust tools that do not fully support local tonalities or rhythmic structures hence the software doesn't really match what students need to learn. The software doesn't really match what students need to learn and this creates barriers.

Overall ICT integration in Ghanaian CoEs is not only a technical process but a socio-cultural one and it's designed to be innovative. Progress depends on coordinated improvements in infrastructure pedagogical capacity and cultural contextualisation and without alignment across these areas ICT risks widening digital and cultural divides particularly in relation to teacher readiness access and cultural relevance which society as a whole is created to address.

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