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ARTIFICIAL INTELLIGENCE (AI) IN VOICE PERFORMANCE EDUCATION: TYPES, OPPORTUNITIES AND CHALLENGES

Abstract

The traditional methods of teaching voice performance in Nigerian Universities are being challenged by the rapid advancement of AI-driven technologies. Studies in AI-driven voice performance education is so far not known in the Nigerian context, making this study relevant to music education. AI in music education is also at the inception stage and requires more engagement to develop a framework for its application in Nigerian music education. This study investigates the implication of integrating AI-driven technologies into voice performance education, exploring its benefits and challenges. It employs a mixed method research design. Findings show that AI-driven technologies have the potential of enhancing voice performance education by providing personalized feedback, improving vocal technique, and increasing student engagement. However, results also reveal challenges such as limited access to technology and inadequate training of lecturers responsible for the teaching and learning of voice performance. The study concludes that AI-driven technologies can complement traditional teaching methods. This will contribute significantly to the development of Music Education in Nigeria, thereby enhancing the quality of Voice performance education and providing valuable insights for educators, policy makers and stakeholders. The study recommends that educators and policy makers should invest in AI-driven technologies, provide training for educators, and develop strategies to address the challenges associated with the integration of AI-driven technologies.

Keywords: Technology, Voice Performance, Education, Music, Artificial Intelligence

Introduction

The rapid development of Artificial Intelligence (AI) is redefining educational paradigms globally, including the domain of music education. Innovations such as adaptive learning systems, real-time feedback tools, and virtual instruction platforms are being adopted in diverse educational fields to personalize learning experiences and enhance students' outcomes. Within Music education, AI is emerging as a transformative force, particularly in performance training where precision, practice, and feedback are critical. Voice performance education, in particular stands to benefit significantly from AI-driven technologies that can access pitch, diction, tone, and vocal technique.

In Nigerian universities, traditional methods dominate voice performance instruction: This involves face-to-face mentorship where students meet with their various supervisors for guidance, with minimal or no integration of digital tools. The traditional method, though valuable, is often constrained by shortage of qualified voice instructors, limited instructional time, and lack of individualized student feedback (Adedeji and Ajewole, 2008, Onyeji, E and Onwuekwe, 2020). In a previous study, it was discovered that there are very few lecturers who specialize in voice performance education across Nigerian universities (Onyeji, 2021). Training in voice performance in these institutions aim at equipping students on how to use, manage and develop the voice in addition to acquiring good performance skills. It also aims at empowering such students to face challenges of vocal music and voice performance in global competitive situations. Developing competitive manpower is critical in such trainings. The capacity to develop interpretive and perceptive vocal delivery is a significant component of voice performance education in such instances. However, this is not the case as many of the lectures who supervise voice performance are not specialists on voice performance and so lack the required skills and expertise to impact positively on the students (Adedeji and Ajewole, 2008; Onyeji, 2021). A situation whereby someone whose area of specialization is in other aspects of music studies rather than voice performance leaves the students with little or no guidance on how to navigate the intricacies of their studies. We can all agree that “the quality of the singing experience in school, or anywhere for that matter, is dependent on the skills and knowledge of the conductor or teacher who leads it” (Durant, 2003: 176). This shortage of lecturers who supervise voice performance presents a critical gap in the effective delivery of voice performance training programs in our institutions and the use of AI will help bridge this gap by serving as a

complementary tool for the teaching and learning of voice rather than leave it solely in the hands of “unqualified” lecturers. Adeogun (2007) states that “No nation can preserve and transform its musical heritage above the quality of music teacher. This is because the advancement of any musical tradition rests in the hands of its teachers”. (P. 4)

The use of AI-driven technologies for the teaching and learning of voice performance, therefore, offers a promising solution to bridging this gap. AI tools can provide consistent, scalable, and personalized instruction, making it possible for a large number of students to access high level voice instruction. By leveraging these AI-driven technologies, institutions can enhance both the reach and quality of their voice performance programs. The integration of AI into music education holds transformative potential, but it also raises important considerations regarding infrastructure, training, and cultural acceptance.

Despite the growing recognition of AI across other fields of learning, voice performance education in Nigerian tertiary institutions faces challenges in the integration of AI into its teaching and learning process. While AI has been embraced in fields such as engineering, medicine, and business for its ability to optimize processes and personalize learning, its adoption in voice performance remains limited if not non-existent. The reason for this lag includes a lack of awareness, insufficient training, inadequate infrastructure, and a general skepticism about the role of technology in a creative aspect of music education. These challenges are explored and discussed in this paper, highlighting the structural and cultural barriers that must be addressed for successful integration.

This paper explores the potential of AI to augment traditional pedagogical practices in voice performance education, with a specific focus on the Nigerian context. It provides insights into the types of AI-driven technologies applicable, assess the opportunities and benefits they offer, and critically examine the challenges that may hinder their adoption in voice performance education in Nigeria.

What is Artificial Intelligence?

Artificial Intelligence (AI) is any computer-based learning system which has some degree of autonomous decision-making with respect to some aspect of its interaction with its users. (Holland, 2000: 2). This definition means that the user has to interact with the computer for it to

be able to function optimally. The more you interact with AI, the better it gets at solving your problems.

Artificial Intelligence (AI) is also defined as the field of computer science focused on creating systems or machines that can perform tasks typically requiring human intelligence. These tasks include learning, reasoning, problem-solving, understanding natural language, recognizing patterns and making decisions. Artificial Intelligence is implemented using two major tools:

- **Machine Learning** - A field of study in AI that uses algorithms that learn data generated from everyday procedures in one's lifestyle or an organization overtime, to make predictions. Machine learning systems learn patterns of performing tasks and are able to carry out such tasks or even improve on them, without explicitly being programmed. Machine learning gives AI the ability to learn using algorithms to discover patterns and generate insights for effective performance, from the data they have been exposed to.
- **Deep Learning** - A subcategory of Machine learning that provides AI with the ability to mimic a human brain's neural network (artificial neural network). It is capable of using multilayered neural networks, called deep neural networks to simulate the complex decision-making power of the human brain. Deep learning systems learn complex patterns and relationships within data sets, to model and solve complex problems. (Ibezim, 2024: 23)

Artificial Intelligence in Music Education

AI in music education has gained traction in recent years, particularly in Western contexts. Applications include intelligent tutoring systems, real-time feedback on pitch and tone, automated accompaniment, and vocal health monitoring tools (Li and Wang, 2023). These technologies have been shown to improve student outcomes, increase motivation, and enhance the overall learning experience. However, literature on the application of these technologies in Africa, particularly Nigerian music education remains sparse. Most departments of music in Nigerian universities continue to rely on traditional methods of teaching voice performance with minimal or no exposure to digital innovations. This gap underscores the need for localized studies examining the cultural, infrastructural, and pedagogical implications of AI integration. By

exploring the potential of AI in Nigerian music education, this study contributes to the growing body of research on technology-enhanced music education in Africa.

Types of AI-driven Technologies Applicable to Voice Performance Education

Several AI-driven technologies are relevant to voice performance: Below are some of the valuable AI-driven technologies used in voice performance education.

- 1. Pitch and tone analyzers:** Improving pitch and tone with AI. Provide real-time feedback thereby helping students refine vocal techniques, improve performance, and achieve their vocal goals. Pitch Analyzers provide real-time feedback by instantly recognizing pitch accuracy, gives a visual representation of the pitch using spectrograms or pitch graphs thereby helping the students focus on specific areas for improvement through targeted practice. Tone Analyzers on the other hand break down tone into frequency components (Spectral analysis), identify resonance patterns and areas for improvement (Resonance analysis) and analyze tone quality and characteristics (Timbre analysis). Some of the tools used in pitch and tone analysis are:
 - **Vocal Pitch Monitor:** Displays pitch in real time to help with singing accuracy.
 - **SingSharp:** Provides pitch training and vocal range analysis.
 - **Melodia:** A pitch analysis tool that provide a detailed feedback on pitch accuracy, helping singers improve their intonation.
 - **Tuna:** A pitch detection tool that help singers identify and correct pitch issues, useful for practice and performance.
 - **Pitch Perfect:** An App that analyses pitch and provides real-time feedback.
 - **Praat:** A software tool for speech and singing analysis, offering features like spectral analysis and pitch analysis.
 - **Voxengo SPAAN:** A spectral analyzer plugin that provides detailed visualization of audio frequencies, helping singers and producers optimize their tone and sound.

To use the pitch and tone analyzers, begin by warming up the voice with lip trills, humming and by singing a comfortable five note scale (d r m r d) which is sung using the vowel sounds like “Ah”, “Oo” etc. Next open the App and allow microphone access, then select “Pitch Monitor” or

“Practice Mode”. Finally, sustain a note by singing a steady vowel, like “Ah” and watch the pitch line on the screen for the feedback. Next is to analyze the feedback. If the line wavers, work on your breath control and if the pitch is flat or sharp, adjust your singing until a stable straight line is achieved on the screen. Practice scales, singing ascending and descending forms. Monitor note transition for smoothness. Record and review, using playback to hear intonation issues. Repeat until pitch stability improves.

These tools can be valuable resources for students, instructors, and music producers looking to improve pitch accuracy, tone quality, and overall sound. Some of the benefits are listed below:

- **Improved pitch accuracy:** Develop precise pitch control.
- **Enhanced tone quality:** Optimize resonance and timbre.
- **Personalized practice:** Target specific areas for practice.



Figure 1. SingSharp App showing the vocal range and voice type of one of my students.

2. **Speech recognition systems:** Enhancing pronunciation and diction with AI. These are AI tools used for pronunciation and diction training. They do this by:

- **Analyzing articulation:** Identifying incorrect pronunciation of words and phrases.
- **Provide feedback:** Offering real-time feedback on pronunciation accuracy.
- **Practicing lyrics:** Helping singers practice lyrics with accurate pronunciation.

Types of tools used for this include:

- **Speech-to-text systems:** Transcribing sung lyrics to analyse pronunciation.
- **Phonetic analysis tools:** Breaking down words into phonemes to assess pronunciation accuracy.
- **Pronunciation assessment algorithms:** Evaluating pronunciation accuracy based on acoustic features.

Some of the applications include:

- **Vanido:** An AI powered vocal training platform that offers personalized feedback on technique, pitch, tone, and pronunciation. It uses Machine Learning and Deep Learning algorithms to analyse singing and provide tailored exercises.
- **SingTrue:** A singing App that helps improve pitch accuracy and pronunciation. It uses AI to provide feedback and correction.
- **Forvo:** A pronunciation guide platform that provides audio clips for words and phrases in various languages. It relies on user-generated content and machine learning for organization and search functionality.
- **Speechling:** An AI-powered pronunciation coaching platform that provides personalized feedback on pronunciation. It uses machine Learning Algorithms to analyse speech patterns and offer targeted feedback.
- **ELSA Speak:** An English Language learning App that uses AI to provide pronunciation feedback. It employs Machine Learning algorithms to assess pronunciation accuracy and offer personalized coaching.
- **Melodyne (by Celemony):** While mainly for pitch editing, it also recognizes and maps syllables and phrasing in vocal tracks.
- **SPEAR (Speech Prosody Editor and Recognizer):** Used in research and music education to analyze lyrical phrasing and intonation.

To use Vanido or Singtrue, open the app and select a lesson. Pitch matching or interval training for example are recommended for beginners. Follow the exercise by listening to the reference note and repeating it immediately: watch the feedback on the screen. Green means that you have hit the correct pitch while red or orange indicate a pitch deviation. Repeat difficult intervals like

thirds, fourths, and fifths to build your interval memory. To use Forvo, Speechling or Elsa Speak to enhance diction clarity and stylistic authenticity, input lyrics in various languages such as Italian, German, or French, and access native pronunciation. Record your rendition and compare it to the native version utilizing waveforms or AI-driven feedback. Subsequently, integrate the phrase into your singing initially performing it at a slow tempo with precise articulation, and progressively increasing the tempo. This methodological approach facilitates accurate pronunciation and fosters an authentic vocal expression.

These platforms leverage AI to enhance language learning, singing, and pronunciation skills. Some of the benefits are listed below:

- **Personalized feedback:** Instant feedback on pronunciation, intonation, and fluency.
- **Improved accuracy:** Enhanced accuracy in language learning, singing, and other applications.
- **Increased efficiency:** Automated assessment and feedback save time for instructors.
- **Enhanced engagement:** Interactive and immersive experience for learners.
- **Accessibility:** Supports learners with disabilities or language barriers.
- **Data-driven insights:** Analytics and insights on learner performance and progress.
- **Flexibility:** Can be used in various settings, such as language learning, singing, and public speaking.

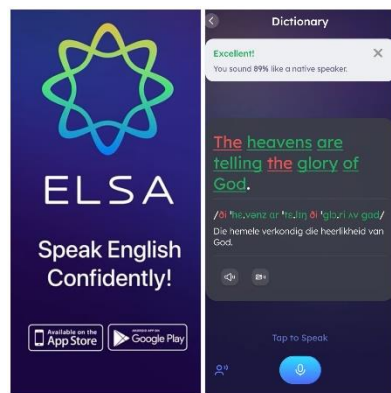


Figure 2: Using **ElsaSpeak App** to teach correct pronunciation.

3. **Virtual voice coaches:** AI-powered virtual coaches simulate vocal instructors. They offer guided practice sessions tailored to individual learning patterns, track progress, give instant feedback on pitch, breathing, and technique, and adapt lessons to the singer's skill level. They can support traditional instruction by providing additional support to help singers achieve their goals effectively. Example of virtual coaches are listed below:

- **Vocaloid** (by Yamaha): A voice synthesis software that helps in practicing and comparing vocal performances.
- **Riffusion:** Generate singing exercises and provides feedback on pitch and tone.
- **Swiftscales:** Is a versatile, user-friendly mobile app available on iOS/Android for singers of all levels to warm up train and improve vocal technique.
- **Smule:** Singing App with AI powered feedback and scoring.
- **Yousician:** Includes singing exercises and feedback.
- **Sinsharp:** Also provides singing exercises, and feedback on students' performance.
- **Singscope:** Provides real time pitch tracking and feedback like a vocal couch.
- **Erol Singer's Studio:** Offers guided lessons, vocal exercises, and real-time performance evaluation.

To get started with Yousician and Smule, choose a song or exercise and select a vocal difficulty level that suits you. Put on headphones to prevent feedback interference. Sing along with the pitch guide on the screen, then review your score to check your rhythm accuracy and pitch percentage. Reattempt the parts where you struggled until you get it right. For Vocaloid and Riffusion, to explore your creativity, generate a backing track by imputing a melody or style and choosing a tempo and genre. Practice improvisation by singing over the AI-generated harmony, then record yourself and evaluate your stylistic interpretation. This process enhances creativity and supports contemporary vocal expression exploration, helping you discover new sounds and styles. To initiate vocal training with swiftScales which happens to be my favourite, commence by downloading and installing the application, subsequently granting microphone access upon opening. Select your voice type or choose your comfortable vocal range thereby preventing strain and ensuring that the exercises are within your tessitura. For warm-up exercises, access the "Warm-Up" or beginner module, incorporating lip trills, humming and five note scales (d r m f s)

while monitoring the pitch indicator for accuracy. Progress to scale practice, choosing a pattern and tempo, and focusing on smooth transitions and breath support. Advanced users can customize exercises to prepare for challenging repertoire or safely extend their range. Finally, record and review performances to track progress, scrutinizing vibrato consistency, breath noise, note accuracy, and stability in sustained tones, with regular recordings enabling effective progress tracking.

Virtual coaches offer personalized singing instruction and feedback through AI-powered tools, providing benefits such as:

- **Personalised feedback:** Instant analysis of technique, pitch and tone.
- **Customised exercises:** Tailored warm-ups and songs to improve specific skills.
- **Flexible practice:** Practice anytime, anywhere, with virtual guidance.
- **Progress tracking:** Monitoring improvement anytime.



Figure 3: The **SwiftScale** app.

4. **AI-powered learning platforms:** Facilitate personalized learning pathways and track student progress. These platforms use machine learning to create customized learning paths, analyze performance trends, and suggest targeted exercises. They often integrate audio analysis, video demonstrations, and progress tracking for holistic vocal training. Some of the platforms include:

- **Yousician:** Offers AI-based feedback for singing, guitar, and piano with tailored lesson plans,
- **Smule:** A social singing app that includes AI-based pitch correction and performance evaluation.
- **Voca.ai:** Originally for virtual agents, its voice interaction engine has been used in experimental singing and speech training platforms.
- **Khan Academy:** Uses AI to personalize learning experience.

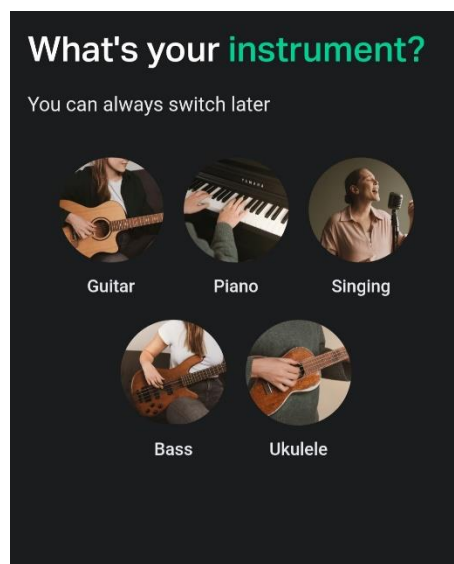


Figure 4: A picture of the musical instrument you can learn using the Yousician app. Picture was taken from <https://www.yousician.com>.

Effective vocal training involves a structured approach, commencing with theoretical foundations. Begin by studying breathing mechanisms, reviewing posture and understanding resonance theory. Immediately apply these concepts by practicing exercises taught in lessons. To track progress, record yourself weekly, capturing performances that reflect real-world scenarios. Utilize AI feedback tools to review comments on pitch, tone, timing, leveraging technology to refine technique. Finally, simulate performance conditions by singing full songs without

interruption, evaluating stage presence, and incorporating self-assessment through minor practice or recording review.

These technologies have the potential to transform voice performance education in Nigeria, providing students with access to high-quality instruction and feedback.

Methodology

This study adopts a mixed-methods research design that combines quantitative and qualitative approaches to ensure a comprehensive underscoring of the topic. During the quantitative phase, questionnaires were administered to 25 voice performance students and 10 lecturers across five Departments of Music in Nigerian universities whose students opt for voice performance for their final year project defense. The Universities are: The University of Nigeria, Nsukka, Nnamdi Azikiwe University, Awka, University of Uyo, Uyo, Delta State University, Abraka and Obafemi Awolowo University, Ile Ife. The survey focused on awareness, usage patterns, perceived usefulness, and challenges related to AI tools. The qualitative phase involved in-depth interviews that were conducted with 5 lecturers and 10 randomly selected students to gain deeper insights into their experiences, expectations, and apprehensions regarding AI in music education. This approach enhances validity through data triangulation (Creswell & Creswell, 2018). The combination of numerical data and narrative responses provides a balanced perspective on the current state and future potential of AI integration in Nigerian music education.

Discussion

Findings indicate a cautious optimism among educators and students. While there is enthusiasm for the potential of AI, actual integration remains minimal due to infrastructural and human capacity limitations. The survey conducted among 10 lecturers from the selected Universities, revealed some key insights regarding Artificial intelligence (AI) in Voice Performance education. In terms of awareness, all the lecturers (100%) are aware of AI in music education, but only one (10%) actually uses AI for voice training. They use tools like *Voice coach* for personalized feedback and coaching with feedback on vocal technique, pitch, and tone. Responding to a set of interview questions, Dr. Onu Samson, one of the lecturers at the Department of Music, University of Nigeria, Nsukka Enugu State, Nigeria, said that,

For vocal warm ups and exercises, I explore AI-Powered tools that guide me through Vocal exercises, such as breathing exercises, scale singing, and articulation drills. Voice training and speech coach is a great resource for this. For speech clarity and diction improvement, I utilize AI tools that focus on improving articulation, pronunciation and diction...

When asked what AI tools he uses to improve students' pronunciation, he listed about four different Apps: *Speakometer* and *ELSA Speak* for articulation and diction and *Deeprtrue* and *langua talk* for diction. He affirms that AI can complement traditional teaching methods and not replace the teachers. He concluded by saying that "it is not designed to give assessment based on student's psychological, emotional and, socio-economic backgrounds".

Three (30%) of the Lecturers are aware of the AI tools that can be used for voice training even though they do not currently use them in teaching voice performance. They mentioned three applications that can be used for voice training, namely: *SingTrue*, *Vanido* and *ELSA Speak*.

Regarding the potential of AI in voice performance education, seven (70%) agree that AI can complement traditional learning, for a number of reasons and that stake holders should intervene to facilitate this integration. One of the reasons they gave is that students can practice on their own wherever they are without having to look for their supervisors every time there's need to practice. They believe that this helps save time and resources.

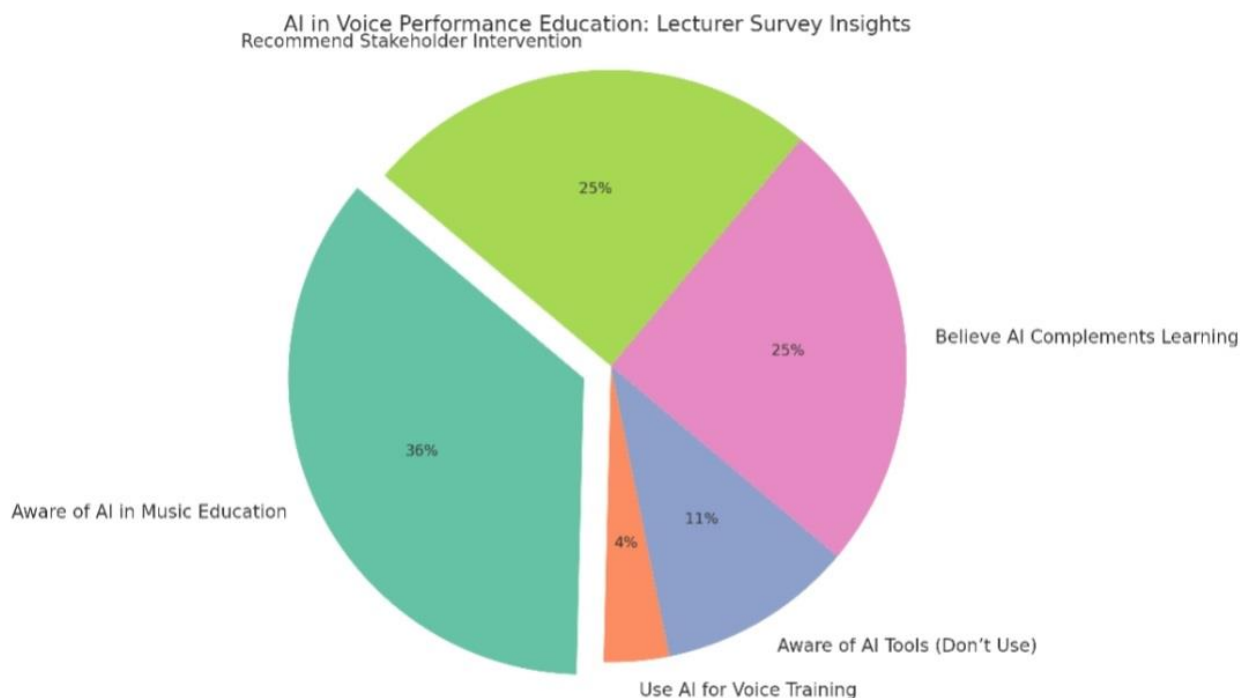


Figure 5: Lecturers' response.

On the part of the students, all the students are aware of Artificial intelligence in music education, demonstrating a high level of awareness about this emerging technology even when they do not currently use it as a learning tool. It is common knowledge that students in this generation are “tech savvy” and can navigate the digital world with ease. So this didn’t come as a surprise to me. What was shocking is the percentage of students who actually use AI in spite of the awareness.

Only two students (8%) had actually used AI for voice training. One of the respondents was introduced to the usage by their lecturer while the other one said they use it when their voice teacher was always not available, so they resorted to the digital world for assistant. This indicates a significant gap between awareness and practical application. Additionally, five students (20%) are aware of AI tools that can be used for voice training but had not utilized them due to the cost of data subscription and lack of internet connection.

Despite these challenges, a significant majority of these students (88%) believe that rather than depend solely on AI for the teaching and learning of voice, AI can complement traditional

methods of teaching voice. This goes a long way to suggest that students recognize the potential benefits of integrating AI into music education.

Regarding access to the internet hindering the use of AI tools, all the students (100%) agree that internet access can hinder access to AI tool, highlighting the need for improved infrastructure to support the use of AI tools in voice performance education.

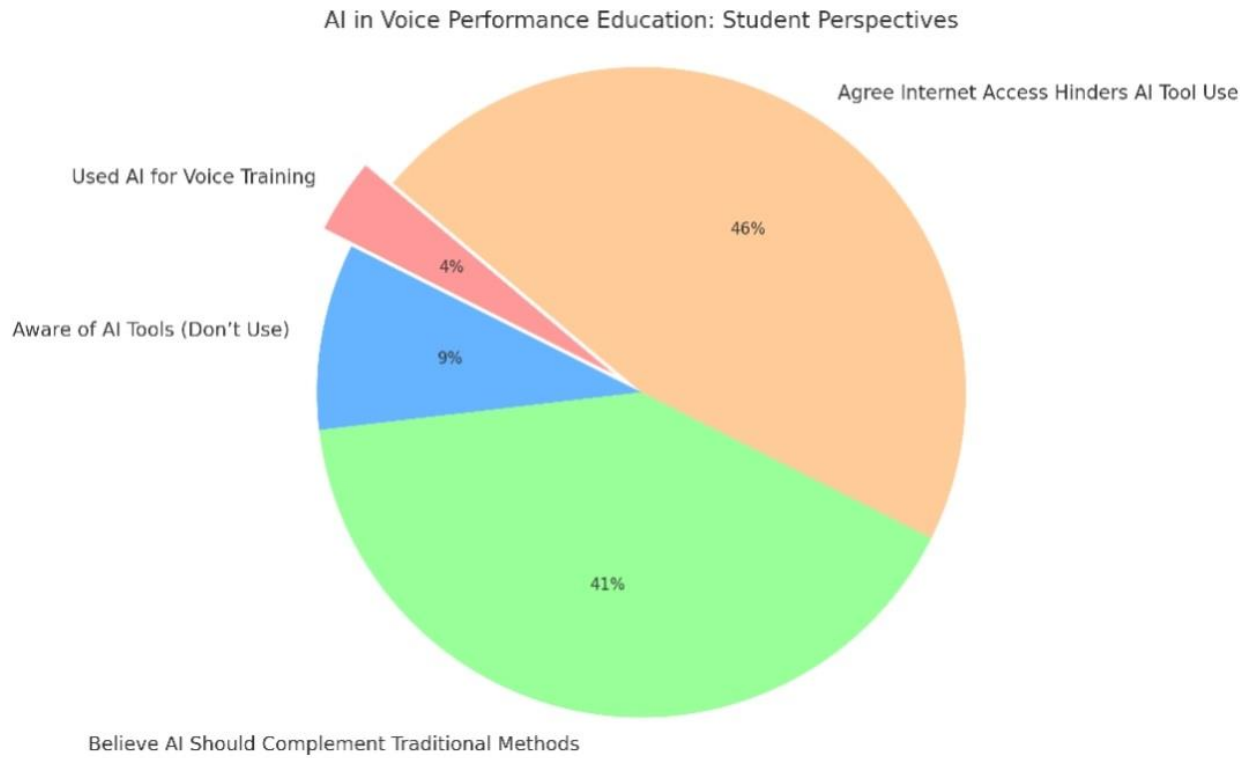


Figure 6: Students' Response.

Overall, the study highlights the potential of AI-Driven technology to enhance voice performance education, but also emphasizes the need for stakeholders to address issues relating to access, infrastructure, and cost. With support and intervention, AI can indeed compliment traditional learning and improve the outcome of voice performance education in our universities. The study therefore, suggests a hybrid model where AI complements rather than replaces traditional instruction. The hybrid model offers a promising approach to AI integration, allowing educators to leverage the benefits of technology while maintaining the human connection and creativity that are essential to music education.

Opportunities Presented by AI Integration

The study identified multiple benefits:

1. Personalized learning: AI adapts to individual vocal strengths and weaknesses, offering tailored exercises.
2. Enhanced engagement: Interactive platforms can increase student motivation and consistency.
3. Skill development: Real-time feedback aids rapid improvement in vocal technique.
4. Expanded access: Students in remote areas can access quality instruction via AI tools.

These benefits have the potential to improve student outcomes, increase access to music education, and enhance the overall quality of music instruction in Nigeria.

Challenges of AI Integration in the Nigerian Context

Despite the potential, several barriers hinder effective adoption of AI in the teaching and learning of voice performance education. Some of these are:

1. Technological infrastructure: Many institutions lack the hardware and internet bandwidth necessary for AI implementation.
2. Lecturer preparedness: Limited training opportunities for educators on how to integrate AI tools.
3. Cost: High cost of AI technologies can be a deterrent.
4. Cultural resistance: Some educators and students are skeptical about replacing human guidance with technology.

These challenges highlight the need for strategic investments in infrastructure, training, and policy support to facilitate successful AI integration in Nigerian music education.

Recommendations

To foster effective AI integration in voice performance education, the following steps need to be taken:

1. Capacity building: Departments of Music should organize workshops and training for music educators on AI tools, bringing in qualified experts to provide needed knowledge on types and uses for improved teaching and learning in the area.

2. Policy support: Government and institutions should formulate policies supporting tech-based education.
3. Investment in infrastructure: Improve internet access and provide the necessary devices for implementation.
4. Curriculum development: Update music education curricula to include digital competencies and AI literacy.

These recommendations offer a roadmap for successful AI integration in Nigerian music education, highlighting the need for a comprehensive approach that addresses the technological, pedagogical, and cultural implications of AI adoption.

Conclusion

While voice pedagogy and voice performance education have been conducted in the traditional forms in various Nigerian institutions over the years, AI-driven technologies offer transformative potential for voice performance education in Nigeria. This study reveals the importance of common ground for both parts to voice performance education with the promise of AI not being a threat to the traditional method but being a support and enhancement means to achieving the goals of the teaching and learning processes in the performance area. The evidence of the teachers and learners justify the need for the integration of AI in voice performance education as a critical platform for improving the training process. While challenges exist, strategic investments in infrastructure, training, and curriculum reform can facilitate successful integration. By incorporating artificial intelligence technology, it is possible to develop a music education system that caters to individual learning needs, providing customized educational experiences for students, resembling the guidance of a genuine music teacher. Ultimately, AI should be viewed as a complementary tool that enhances rather than replaces the artistry and human connection inherent in music education.

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