

Building and Implementing a “3+X” Integrated System for Music Education in K-12 Schools in the Context of Artificial Intelligence

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Abstract: *The deep integration of artificial intelligence technology with education and teaching has opened new pathways for innovation and transformation in K-12 music curricula. Based on the requirements of the national education digitization strategy, this paper addresses current issues in music curriculum instruction—such as scattered resources, lagging assessment, and insufficient personalization—by proposing and constructing a systematic and practical “3+X” AI-empowered music teaching system. This system is supported by a framework comprising three foundational modules—a digital resource repository, digital teaching materials, and arts curriculum standards—and integrates three representative application tools: virtual scenario construction, adaptive learning platforms, and intelligent assessment systems, thereby realizing a dynamic closed loop of “foundational support—intelligent application—data feedback.” The article further analyzes key challenges that may arise during the implementation of this system—such as enhancing teachers’ digital literacy, ensuring student autonomy, and addressing data privacy risks—and proposes targeted improvement strategies aimed at promoting the high-quality development of music education in primary and secondary schools and empowering the practice of educational digital transformation.*

Keywords: Artificial Intelligence; 3+X System; Music Education; Convergence Model.

1. INTRODUCTION

Artificial intelligence (AI) technology is becoming deeply integrated into the field of education, driving the transformation of music curriculum instruction toward digitalization and intelligence. The “Outline of the Plan for Building a Strong Country in Education (2024–2035)” (hereinafter referred to as the “Outline”), issued by the Central Committee of the Communist Party of China and the State Council, emphasizes the implementation of a national education digitization strategy to leverage AI in driving educational reform, thereby setting higher standards for music instruction. Against this backdrop, AI-enabled education has emerged as a key breakthrough for promoting the high-quality development of music education.

In recent years, the application of artificial intelligence in music education has gradually become a research hotspot, with related findings covering resource integration, the development of intelligent tools, the construction of personalized learning pathways, and diversified assessment methods. Existing research has explored the functional integration of digital resource repositories and digital teaching materials (Shan Xintao et al., 2024); the role of virtual reality (VR) and augmented reality (AR) technologies in promoting immersive teaching (Sun Xiaoye, 2025); and the value of adaptive learning platforms and intelligent assessment systems in learning path planning and process feedback (Xin Jixiang, 2024; Liu Zhijun et al., 2024), among other topics. However, current research generally tends to be fragmented, lacking a systematic integration approach that balances teaching standards, resource support, and technological application.

Based on an analysis of policy directions and existing research, this paper proposes a “3+X” AI-empowered music education system, where “3” refers to the three foundational modules—digital resource repositories, digital textbooks, and arts curriculum standards—and “X” represents typical application tools such as virtual environments, adaptive learning platforms, and intelligent assessment systems. This framework aims to bridge the key links from resource development and instructional implementation to evaluation and feedback, establishing a closed-loop integration of “foundational support + intelligent applications.” It seeks to construct a comprehensive theoretical framework for AI-enabled music curriculum instruction, providing technical pathways and methodological support for the high-quality development of music education in primary and secondary schools.

2. THE LOGICAL FRAMEWORK OF THE “3+X” SYSTEM

Against the dual backdrop of policy guidance and technological advancement, music education in primary and secondary schools urgently requires a systematic solution that both addresses current teaching realities and ensures sustainable development. The integration of artificial intelligence has not only transformed teaching methods but has also sparked profound changes in resource organization, learning approaches, and assessment mechanisms. Therefore, it is imperative to clarify, at the structural level, how artificial intelligence can be deeply integrated into music curriculum instruction.

Based on an in-depth analysis of the current challenges in K-12 music education, combined with systematic research on the application of AI technology in educational settings, this paper constructs the “3+X” AI-Empowered Music Curriculum Teaching System (as shown in Figure 1). This framework is grounded in constructivist learning theory, the concept of human-machine collaboration, and the principle of “alignment between teaching, learning, and assessment.” It unfolds along a dual pathway of “foundational support and innovative application,” aiming to address the intrinsic needs for a paradigm shift in music education in the digital age.

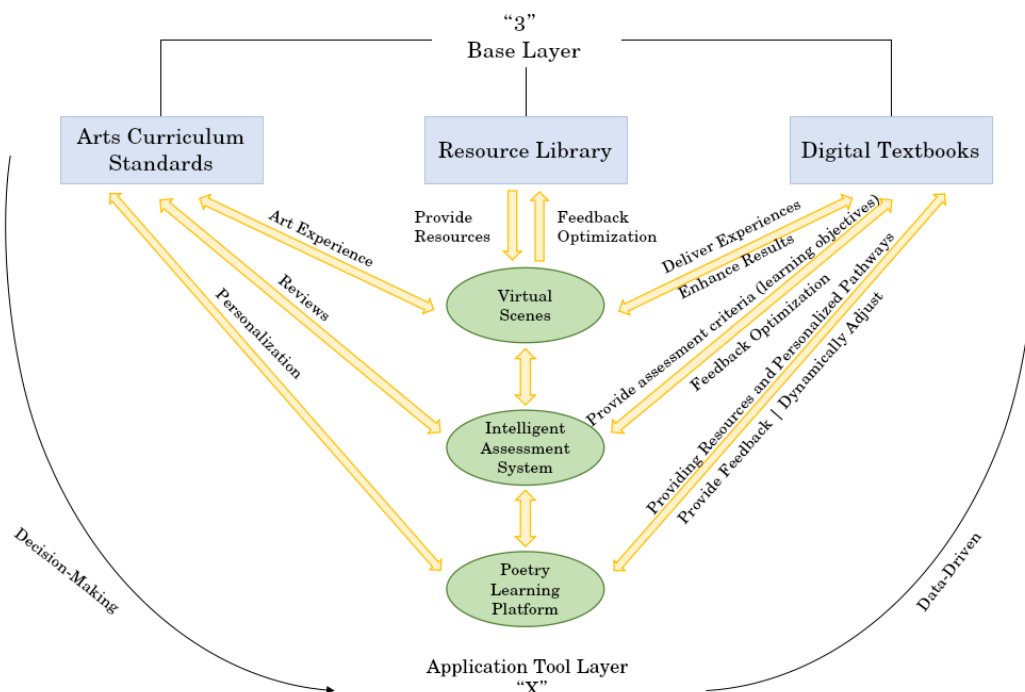


Figure 1: Schematic Diagram of the “3+X” AI-Empowered Music Education System

The “3+X” system consists of three foundational modules and a number of application tools working in concert. The “3” refers to the digital resource repository, digital teaching materials, and arts curriculum standards, which serve as the core support for instructional content, teaching methods, and learning objectives, thereby strengthening the institutional foundation and resource support of the curriculum system. “X” represents innovative application tools derived from AI, including virtual scenarios, adaptive learning platforms, and intelligent assessment systems, which embody the dynamic interconnection between teaching contexts, learning processes, and assessment feedback. This architecture not only aligns with trends in educational technology but also closely addresses students’ learning characteristics, such as personalization, immersion, and feedback-driven learning.

Faced with fundamental changes in students’ learning styles within a digital learning environment, traditional models are no longer effective in stimulating their motivation and creative potential. Therefore, building a solid foundation based on the “3” major modules and introducing “X” intelligent tools to achieve multidimensional expansion has become the key pathway to precisely address students’ diverse learning needs. Through the integration of “virtual and real” elements and the alignment of “standards and feedback,” the “3+X” system

achieves a complete closed loop—from curriculum standards to teaching practice, and from resource provision to data-driven decision-making.

Overall, this system combines the stability of foundational support with the forward-looking nature of technological application, establishing a logically coherent and structurally complete framework for AI-empowered music education. It provides theoretical guidance and practical pathways for promoting high-quality development in music education and achieving deep synergy between education and technology.

3. CONTENT STRUCTURE OF THE “3+X” FRAMEWORK

The “3+X” framework is based on the concept of “foundational support and innovative application” and consists of a foundational layer and an application tools layer that work in concert, mutually supporting and advancing each other. The curriculum standards in the foundational layer provide directional guidance for the application tools, while the digital resource repository and digital textbooks provide content support and path planning for the tools’ operation; The data and feedback generated by the “X” application tools in practice, in turn, inform the optimization and adjustment of the curriculum standards and teaching resources. Through this two-way interactive mechanism, the “3+X” system forms a closed-loop system through dynamic synergy, ensuring the capacity for continuous evolution and iterative optimization, thereby achieving efficiency, systematicity, and sustainability in AI-empowered music education.

3.1 Arts Curriculum Standards Guide the Use of Smart Tools

In April 2022, the Ministry of Education issued the *Compulsory Education Arts Curriculum Standards (2022 Edition)* (hereinafter referred to as the “New Arts Curriculum Standards”). Grounded in the needs for educational transformation in the digital age, these standards translate objectives such as artistic experience, diverse assessment, and personalized development into actionable practical tools, thereby promoting high-quality development in compulsory education and cultivating talent suited to the demands of the times.

The New Arts Curriculum Standards emphasize education through aesthetics, prioritize students’ artistic perception and emotional experiences during the learning process, and advocate for diverse practices to enhance artistic literacy and creativity. ① Based on this, teachers should actively integrate digital technology resources such as VR and AR to create diverse teaching scenarios that stimulate students’ perception and emotional resonance. At the same time, the New Arts Curriculum Standards fully respect individual differences and encourage the provision of diverse learning options and personalized guidance. ② Regarding curriculum resources, the standards also advocate leveraging modern information technology to integrate resources and build digital platforms. ③ Against this backdrop, adaptive learning platforms have emerged, enabling the digital integration and precise delivery of resources, and providing students with personalized learning paths tailored to their individual needs. In terms of assessment mechanisms, the new arts curriculum standards emphasize the process-oriented and experiential nature of practice, requiring consistency among “teaching, learning, and assessment.” ④ Formative and performance-based assessments have become the focus of assessment reform. Leveraging artificial intelligence to build intelligent assessment systems can efficiently achieve multidimensional, full-process evaluation, providing objective and precise feedback for arts education.

3.2 The Resource Library Empowers the Construction of Virtual Music Teaching Scenarios

At the foundational level, in addition to the new arts curriculum standards, there are two core components: the resource library and digital textbooks. The resource library integrates various types of resources—including curricula, audio and video files, and documents—to support teaching and the construction of virtual scenarios. Digital textbooks systematically integrate and precisely distill these resources based on curriculum requirements, enabling on-demand delivery and effectively empowering the creation of virtual music scenarios. ⑤ By drawing on the rich musical resources within the repository, educators can not only efficiently utilize and vividly present these materials but also create a multidimensional experience with digital music textbooks, helping students deepen their understanding of the content and enhance their artistic appreciation.

Virtual scenarios create an immersive and interactive learning environment for students, significantly enhancing the sensory experience of music education. Teachers can comprehensively utilize virtual reality (VR) and augmented reality (AR) technologies to construct diverse scenarios such as concert halls and theaters, stimulating learning interest through multisensory engagement. ⑥ For example, when studying musical works from different

countries, technology and materials from the resource library can be used to reconstruct the contextual background of the works, allowing students to “immerse themselves” in the setting and gain a more intuitive understanding of musical styles and cultural implications. In addition, virtual instruments can enrich classroom instruction, enabling students to master timbre and performance techniques through hands-on experience, while enhancing their sense of collaboration through virtual ensemble playing.

To implement the “Bringing Traditional Culture into Schools” initiative, the integration of virtual environments with traditional opera culture has become a highlight of arts education. In 2021, the “Li Peihong Traditional Opera Art Studio” took the lead in proposing the concept of the “Digital Campus for Chinese Traditional Opera” and launched innovative practices such as the “Campus Opera XR Classroom.” By employing an innovative “opera + technology” model, it has integrated high-quality opera content into the core resources and application framework of the XR industry. This exploration has facilitated the integration of traditional opera with modern technology and provided a forward-looking practical pathway for opera education in China.^⑦ In elementary and secondary school music classes, VR and AR technologies can be used to create immersive traditional opera stage scenarios, allowing students to closely observe details such as performers’ vocal styles, physical movements, and facial expressions, thereby gaining a deeper appreciation of the art form’s charm. By incorporating virtual costumes, props, and interactive games, these technologies not only spark students’ interest but also instill a basic understanding of traditional opera’s music and dance, guiding them to gradually grasp the historical origins, artistic characteristics, and cultural depth of traditional opera, thereby promoting the popularization and legacy of traditional opera culture.

3.3 Digital Textbooks Facilitate the Adaptation of Adaptive Learning Platforms

Digital textbooks serve as the foundation for building adaptive learning platforms, providing systematic and precise content support. By modularizing and presenting core topics—such as music theory, performance techniques, and music history—in a multidimensional manner, they comprehensively address the personalized needs of students at different learning stages. Building upon this, a knowledge graph for music is constructed to systematically link key concepts, helping students form an organic network of musical knowledge.

Building on digital textbooks, adaptive learning platforms can dynamically adjust content difficulty and design personalized learning paths based on students’ progress and mastery levels. They can also provide precise individualized guidance tailored to differences in students’ knowledge bases, cognitive levels, and activity preferences, helping students identify and resolve issues in a timely manner while allowing them to flexibly adjust their learning methods and pace according to their own needs or platform recommendations.^⑧ Additionally, the platform can collect contextual data such as students’ learning paths, resource types, and time spent on each resource.^⑨ By integrating and analyzing learning data, student learning needs can be accurately identified. The analysis results are fed back to the digital textbooks, providing a clear basis for content iteration and optimization; they are also fed back to the platform to guide the precise allocation and selection of resources, thereby more efficiently supporting teaching and learning. Teachers can use this information to scientifically adjust teaching priorities and pacing, enhancing the relevance of instruction; students, in turn, can continuously optimize their learning paths and methods based on personalized feedback, engaging in self-directed learning more effectively. This data-driven, personalized teaching model not only effectively improves students’ learning outcomes but also stimulates their initiative in learning, thereby powerfully driving the optimization and upgrading of the teaching process and achieving a significant improvement in teaching effectiveness.

3.4 Optimizing Closed-Loop Feedback Through Multidimensional Evaluation

China’s teaching evaluation system faces challenges such as simplistic evaluation criteria, a single evaluator, one-sided evaluation methods, and an excessive focus on outcome-based data.^⑩ The deep integration of artificial intelligence technology has opened up a new path for evaluation reform; the comprehensive application of intelligent assessment systems is expected to drive a transformation in teaching evaluation—from an experience-based approach to a scientific one, and from a focus solely on static results to an emphasis on tracking dynamic processes.

Intelligent assessment systems can convert classroom performance into feedback data, enabling dynamic analysis of student learning, process visualization, and real-time alerts. With the help of AI, teachers can accurately monitor students’ classroom engagement and activity levels, promptly identifying any negative trends. Through technologies such as facial recognition and posture analysis, these systems deeply analyze students’ emotional

states and listening behaviors, providing insights into their learning experiences and mastery of knowledge, thereby offering data-driven support for teachers to implement targeted instructional interventions.⁽¹¹⁾

The intelligent assessment system employs a multi-dimensional evaluation approach aimed at comprehensively assessing students' musical literacy, breaking through the limitations of previous evaluation models characterized by a single-dimensional approach and one-sided, results-oriented outcomes. Taking the "Hui Meiyu" cloud platform developed by the Ruian City Teacher Development Center as an example, this system has already implemented a multi-module evaluation mechanism combining online and offline elements in actual teaching practice.⁽¹²⁾ In terms of assessment content design, the platform balances knowledge mastery, individual strengths, and classroom performance; through data integration and analysis, it enhances the scientific rigor and personalized adaptability of evaluation results.

Within the "3+X" framework, the intelligent assessment system—based on the learning objectives and evaluation standards set by digital textbooks—integrates real-time classroom performance, adaptive platform learning data, and diverse assessment results to achieve dynamic tracking and precise identification of students' learning status. System-generated analysis results can be instantly fed back to both teachers and the platform, forming a highly efficient closed-loop feedback system that aligns "assessment, teaching, and learning."

4. RECOMMENDATIONS FOR IMPLEMENTING THE "3+X" SYSTEM

4.1 Enhancing Teachers' Digital Literacy

Many music teachers have extensive experience in traditional teaching but lack a full understanding of the educational value of artificial intelligence and have limited proficiency in using related tools and platforms. Insufficient digital literacy among teachers limits the application and promotion of artificial intelligence in K–12 music education.

As early as 2022, the Ministry of Education issued the "Teacher Digital Literacy" document, which details the framework of skills and qualities required of teachers in the digital age. The 2025 "Outline" further emphasizes the need to formulate and refine digital literacy standards for teachers and students and to deepen the use of artificial intelligence to support teacher development.⁽¹³⁾ Enhancing teachers' digital literacy requires support from systematic training initiatives. This development should emphasize the integration of theory and practice, stimulating teachers' intrinsic motivation through scenario-based demonstrations and comparisons of teaching outcomes. At the same time, the assessment system must be refined to accurately measure proficiency levels. Furthermore, efforts should be made to strengthen the digital environment by improving hardware infrastructure and optimizing the soft environment—including policies and culture—to foster the formation and development of teachers' digital literacy.⁽¹⁴⁾ Collaborative efforts should also be integrated into this development process; through school-enterprise partnerships, practical scenarios should be provided to jointly promote the deep integration of teachers' digital literacy with music teaching practices.

4.2 Upholding Students' Central Role

Heavy reliance on artificial intelligence is reshaping students' learning methods and cognitive patterns, causing them to gradually cede their agency to technology. In music education, once students become accustomed to relying on AI to generate sheet music and provide arrangement suggestions, their musical perception, comprehension, and creativity may all weaken, and their willingness and ability to create independently and explore on their own will also diminish. Although technology makes learning easier and more efficient in the short term, in the long run, the student's status as the primary agent of learning may be supplanted.

In light of this situation, teachers' guidance is crucial. Music classrooms should reduce reliance on AI and emphasize students' agency. For example, during music appreciation, teachers should guide students to listen independently and experience the emotions and connotations of works in different styles, rather than relying directly on AI interpretations. In music composition, students should be encouraged to first conceive melodies on their own, then use intelligent tools to optimize them, and compare and analyze the changes before and after optimization to cultivate their ability to use AI critically. Through guidance and practice, students' active agency can be effectively harnessed, solidifying their central role in the learning process.

(3) Mitigating Privacy and Security Risks

In the practice of AI-enhanced music education, blurred privacy boundaries and compromised security pose significant ethical risks. Frequent data mining by educational platforms renders student privacy excessively transparent, and the use of smart devices has also sparked numerous privacy controversies. ⁽¹⁵⁾ Although smart devices offer convenience, unresolved privacy and security issues can turn them into sources of risk, hindering the application of AI in music education.

In response to this issue, the *Outline* explicitly calls for strengthening cybersecurity safeguards and reinforcing data security, AI algorithm safety, and ethical safeguards.⁽¹⁶⁾ By improving laws, regulations, and ethical frameworks; establishing a system of privacy protection protocols; formulating data mining standards and enacting specialized legislation; and building a system of security oversight and prevention, we can establish a moral theory and regulatory framework for AI in music education to ensure the safe and controllable development of intelligent music education. ⁽¹⁷⁾ At the same time, schools and teachers must also strengthen education on privacy protection for students, enhancing their awareness and ability to protect themselves when using smart devices.

5. CONCLUSION

Addressing current issues in primary and secondary school music education—such as insufficient resource integration, monotonous teaching methods, and weak personalized support—this paper proposes and systematically constructs the “3+X” AI-Empowered Music Curriculum Teaching System in alignment with the national education digitization strategy. Centered on the core logic of “foundational support + innovative application,” this system leverages systematic support from curriculum standards, digital textbooks, and resource repositories, while integrating key technological pathways such as virtual scenarios, adaptive platforms, and intelligent assessment. It achieves an organic integration of teaching content, methods, and evaluation, thereby providing an initial response to the urgent need for systematic upgrades in music education driven by the digital transformation of education.

The core value of the “3+X” system lies in the dynamic synergy and feedback-driven optimization of its operational mechanisms. The bidirectional empowerment between the foundational and application layers establishes a sustainably evolving closed-loop system, endowing the framework with high adaptability and scalability to address the ever-changing teaching scenarios and diverse student needs. With the continuous evolution of artificial intelligence technology and its deeper integration into the educational sphere, the “3+X” system will unlock even greater potential in music education. It will not only contribute to the comprehensive enhancement of students’ musical literacy but also serve as an engine driving the high-quality development of music education in elementary and secondary schools. In the future, only by upholding the organic unity of technological rationality and educational values can we propel music education onto a path of high-quality development that equally emphasizes intelligence and a human-centered approach.

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