



Theoretical Framework and Practical Path of Empowering Primary School Music Education with Artificial Intelligence

Mila Wang, Junjie Wan

College of Art, Zhejiang Normal University, Jinhua, China

Email: 2027725256@qq.com

How to cite this paper: Wang, M.L. and Wan, J.J. (2025) Theoretical Framework and Practical Path of Empowering Primary School Music Education with Artificial Intelligence. *Open Access Library Journal*, 12: e13988.

<https://doi.org/10.4236/oalib.1113988>

Received: July 20, 2025

Accepted: August 11, 2025

Published: August 14, 2025

Copyright © 2025 by author(s) and Open Access Library Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

In the context of the rapid development of information technology, artificial intelligence technology has gradually permeated various educational fields, bringing profound changes to traditional teaching. Primary school music education, as an important part of quality-oriented education, not only shoulders the responsibility of cultivating students' artistic literacy, but also needs to meet the requirements of creativity and aesthetic experience in the new curriculum standards. However, due to the imbalance of music education resources and the multiple pressures teachers face in the classroom, there is an urgent need for the support of new technologies. This paper mainly explores strategies for empowering primary school music teaching with artificial intelligence to provide feasible solutions for enhancing students' musical literacy and innovation ability.

Subject Areas

Arts Education

Keywords

Artificial Intelligence, Primary School Music, Interactive teaching, Learning Analysis, Music Creation

1. Raise of Problem

Primary school music education, as a key component of quality-oriented education, plays an irreplaceable role in cultivating students' core competencies such as aesthetic ability, creativity and emotional expression. However, traditional primary school music education has long faced difficulties such as limited teaching resources, teaching methods that are difficult to meet the diverse needs of stu-

dents, and inaccurate and incomplete teaching evaluations, which to some extent have restricted the improvement of students' music literacy and the achievement of music education goals [1].

With the rapid development of information technology, artificial intelligence (AI) has gradually permeated all aspects of education. In primary school music teaching, the application of AI not only enriches teaching methods but also enhances teaching effectiveness. In digital music education, AI systems can tailor personalized learning paths based on students' learning habits, ability levels, and interest preferences, and push targeted practice materials and teaching videos. Smart instruments capture students' playing movements through sensors, analyze in real time and provide feedback on the quality of the performance, including evaluations on pitch, rhythm, dynamics, etc.

In addition, with the help of virtual reality (VR) and augmented reality (AR) technologies, AI can build immersive virtual music classrooms where students can interact with virtual instruments and experience playing in different music scenarios. However, in actual teaching scenarios, how to effectively integrate AI with primary school music teaching to maximize its effectiveness remains a subject that urgently needs in-depth research and exploration. This paper aims to delve into the core advantages of AI in driving the transformation of music education and to explore feasible practical strategies accordingly, with the aim of injecting new vitality into the high-quality development of primary school music education in the context of the information age.

2. The Necessity of Empowering Primary School Music Teaching with Artificial Intelligence

2.1. Adapt to the Requirements of the New Curriculum Standards

The Compulsory Education Art Curriculum Standards (2022 Edition) put forward an educational orientation centered on cultivating students' creativity and aesthetic experience, emphasizing that the music classroom is not only a place for music skills training, but also a key to promoting the development of students' emotions, imagination and creativity. The cultivation of creativity is very important for the growth of primary school students. Creative and improvisational expression activities in music classes enable students to learn self-expression in an open artistic environment.

However, traditional classroom teaching models are difficult to meet these requirements. Teachers often focus on imparting basic knowledge and skills and lack the time and resources to guide students in creating or appreciating complex musical works. Artificial intelligence technology has unique value in music creation and aesthetic experience. With the use of music materials and learning tools generated by intelligent systems, primary school students can have a more direct experience of rich music, meet the requirements of the curriculum standards for creativity, make aesthetic activities more vivid and easier to understand, and bring primary school music education closer to the essential requirements of the standards.

2.2. Meet the Needs of Teachers and Students

The application of artificial intelligence in music classrooms can help teachers and students reduce burden and improve learning efficiency. Primary school music teachers often face heavy workloads and limited preparation time, especially when they need to design creative courses for different grades, making it difficult for teachers to balance their time and energy. The introduction of artificial intelligence can effectively relieve teachers' work pressure by providing auxiliary functions such as automatically generating music and arranging music to help teachers quickly prepare the music materials needed for the course, allowing teachers to focus more on individualized guidance for students and enhancing the flexibility and interactivity of classroom teaching [2].

AI's intelligent learning tools help students complete their learning tasks more efficiently in the classroom, especially for complex music theory knowledge and creative activities. With the help of smart assistants or arrangement software, students get immediate feedback as they learn music on their own, which increases learning efficiency and enhances classroom engagement and interest. AI can meet both the needs of teachers and provide effective support for students' learning.

2.3. Improve the Imbalance of Educational Resources

At present, there is an uneven distribution of resources for primary school music education across the country, especially in remote and economically disadvantaged areas where music education resources are significantly scarce, students have limited opportunities to learn music, and teachers' training and equipment investment are also relatively insufficient. The introduction of artificial intelligence technology can alleviate this problem and enable more students to enjoy high-quality music education. With the help of AI music teaching tools, schools lacking professional music teachers or resources can also achieve diverse music classes, giving students the opportunity to be exposed to a wider range of music knowledge and music practice activities. Especially in the fields of composition and appreciation, music teaching assisted by smart tools can help students experience more diverse ways of musical expression, allowing students in remote areas to have the same rich artistic experience as those in urban areas and cultivate their interest and love for music.

The popularization of artificial intelligence technology can improve the imbalance of resources in primary school music education, provide new ideas for achieving educational resource equalization, and effectively enhance the music learning opportunities and overall level of students in various regions.

3. Analysis of the Core Advantages of AI in Promoting the Transformation of Music Education

The digital age places high demands on teachers' information technology application capabilities, encouraging them to use information technology to enhance teaching quality, innovate teaching models, and comprehensively utilize Internet,

big data and virtual reality technologies to explore future teaching methods. At a time when there are bottlenecks in the current “Internet +” music education that urgently need to be broken through, the emergence of artificial intelligence has aroused people’s interest in exploring the infinite possibilities of applying artificial intelligence in music education. The application of artificial intelligence in music education has the following values and advantages.

3.1. Theoretical Framework: TPACK Model

The TPACK (Technological Pedagogical Content Knowledge) framework illustrates how AI intersects with pedagogy and music content. For example:

Technological Knowledge (TK): AI tools like SkyMusic for composition.

Pedagogical Knowledge (PK): Interactive and adaptive teaching methods.

Content Knowledge (CK): Music theory and performance skills. This integration ensures that AI enhances teaching effectiveness while preserving the artistic essence of music education.

3.2. Facilitate Technological Innovation and Skills Training in Music Education

3.2.1. Interactive Learning

Music learning is a combination of knowledge acquisition, auditory perception and physical coordination, and AI interaction makes it more intuitive and vivid. With intelligent recognition, VR and other technologies, students can deepen their understanding of melodies and rhythms through visual, auditory and motor interactions in a multimodal environment. In the traditional classroom, students passively imitate, while in the AI immersive environment, they actively explore and adjust and optimize their skills.

The Future Piano Lab, jointly established by Berklee College of Music and The ONE smart Piano, showed that the beginner group (n = 156) using AI optical key tracking technology mastered Beyer Etudes 28 in 58% less time than the traditional teaching group (6.3 days vs. 15 days). According to page 45 of the June 2023 White Paper on the application of AI in Music Technology Education, 88% of participants believed that AI-generated personalized finger suggestions “greatly improved the learning experience”, and the lab’s MIDI data analysis system has been patented in the United States [3].

Learning is no longer restricted, and students can practice through intelligent systems at any time, enhancing their abilities through interactive feedback. This interactive learning model shifts music teaching from static knowledge imparting to dynamic experience, stimulating students’ interest in music learning and cultivating their deeper musical literacy [4].

3.2.2. Precision Teaching

Artificial intelligence enables precise teaching of primary school music through big data and intelligent algorithms. Based on individual differences such as pitch accuracy and rhythm among students, AI can analyze learning data to build per-

sonalized models and dynamically optimize teaching content and progress. A controlled experiment conducted by Beijing Normal University in 2023 found that students in the experimental group who used AI error correction systems such as SmartMusic for 12 weeks of pitch accuracy improved by 62%, significantly higher than the 28% improvement in the control group, and the AI's accuracy in identifying pitch errors was as high as 92.3%. Far more than the 78.5% of traditional teacher listening [5].

Compared with the traditional uniform model, AI supports adaptive learning, adjusting strategies based on real-time performance and matching exercises of appropriate difficulty. When students encounter learning difficulties, the system can identify weaknesses and push targeted training to make the learning path more scientific. This model enhances personalized learning effectiveness, optimizes teaching organization, helps the classroom balance overall and individual development, and efficiently cultivates musical literacy.

3.2.3. Immediate Feedback

Music learning requires repeated practice, and AI instant feedback enhances efficiency. Traditional teaching requires waiting for the teacher's comments to identify problems, while AI can monitor students' performance in real time, accurately assess indicators such as pitch and rhythm, promptly indicate deviations and give adjustment suggestions to prevent errors from solidifying.

An empirical study by the Royal Swedish Academy of Music in collaboration with the University of Helsinki showed that 237 students who participated in the program improved their accuracy in guitar rhythm playing by 39 percent ($p < 0.05$) after 12 weeks of training on the AI music learning platform Yousician in public primary and secondary schools ($p < 0.05$), and their daily self-practice time increased from an average of 25 minutes to 37 minutes. The study data was included in the Nordic Education Research Database. Professor Andersson, the project leader, presented electroencephalogram (EEG) monitoring results at the 2023 ISME Annual meeting, confirming that AI real-time feedback can significantly enhance learners' neural plasticity [6].

Intelligent feedback systems are changing the teaching model, and teachers are improving teaching effectiveness by tracking learning progress, using the system to analyze weak links, and formulating personalized strategies. Immediate feedback not only enhances students' autonomous learning ability, but also optimizes the allocation of teaching resources, allowing teachers to devote more energy to advanced guidance and teaching optimization, bringing about a deep transformation in music teaching.

3.3 Provide Multi-Dimensional Support for the Development of Students' Musical Literacy

The application of artificial intelligence in primary school music education is not limited to technical skills training, but has the unique potential to cultivate musicality, artistic expression and aesthetic appreciation. In an intelligent and person-

alized way, AI can break through the limitations of traditional teaching and provide multi-dimensional support for the development of students' musical literacy.

3.3.1. Break through the Limitations of Music Perception

The musical perception ability that students possess is the most fundamental element of musical aesthetic ability, mainly referring to students' ability to recognize and understand elements of musical perception such as rhythm, melody, structure, timbre, tempo and dynamics. As for the subject, there are significant differences in the ability of primary school students to perceive music. Due to factors such as gender, age, and the accumulation of musical knowledge, students may experience different psychological states when listening to music, resulting in non-identity and even "distortion" between the object of musical information and the student subject.

Artificial intelligence, on the other hand, has memory, computing power and logical reasoning ability that humans cannot match, and in some respects it can surpass humans and keep upgrading. At the same time, innovative applications and teaching models emerging in the field, including integrated sensory learning experiences and interactive gamified learning, will break through the limitations of students' perception and deepen and expand the application of primary school music education.

3.3.2. Expand the Diversity of Musical Aesthetics

The ability of AI to generate musical works of various styles and types greatly expands the diversity of musical aesthetics. By fusing elements of music from different cultural backgrounds, AI can create novel and unique musical styles that offer listeners an unprecedented aesthetic experience. This cross-cultural fusion not only enriches the content of music art, but also promotes the exchange and dissemination of global music culture.

3.3.3. Provide Music Analysis and Emotion Recognition

The application of AI in music analysis and emotion recognition provides a powerful tool for a deeper understanding of the intrinsic characteristics and emotional expressions of music. Through deep mining and analysis of music data, AI systems can accurately identify elements such as melody, harmony, and rhythm of music, and judge its emotional characteristics. This technology not only helps music educators and researchers better grasp the essence of musical works, but also provides strong support for fields such as music therapy and emotion recognition.

3.3.4. Deepen the Personalized Musical Experience

AI-based music recommendation systems, with their advanced algorithms, dig deep into users' listening habits and preferences to provide highly customized music content. This personalized experience not only greatly enhances user satisfaction, but also effectively broadens users' aesthetic horizons. The AI system intelligently recommends tracks that fit the user's emotional state and contextual needs

by learning the user's response to different musical elements, such as melody, rhythm, and lyrics. In addition, it guides users to explore new music similar to their personal preferences, constantly enriching their listening experience and promoting the appreciation of musical diversity and the growth of personal taste.

4. The Implementation Path of Artificial Intelligence Empowering Primary School Music Teaching

4.1. Strengthening the Teaching of Music Theory

Multimedia music teaching assistants can be used in primary school music theory teaching. DO-RE-MI multimedia music teaching Assistant mainly helps students better understand various pitch notes and various chord harmonies. In addition, it can optimize music teaching in music schools and youth music training schools. Multimedia music teaching assistants are divided into two types: one is a large music teaching assistant for music classrooms, and the other is a "music calculator" for finding chords and notes.

DO-RE-MI features a slide rule that combines 12 musical average ratios and logarithms, allowing it to find various different tonal notes more quickly, especially various chord harmonies. It can also be combined with the pronunciation of keyboard pitch notes to enhance understanding and memory of music theory, which is very beneficial for expanding the content of primary school music classes.

The "MusiLens" AR system developed by the University of Texas at Austin visualizes abstract music theory concepts through a head-mounted display, such as showing harmonic progressions using dynamic color spectra and presenting interval relationships in 3D spatial distances. In a 12-week experiment involving 120 students, the system significantly improved chord recognition accuracy from 54% to 89% and enhanced tonal analysis test scores by 2.3 standard deviations (effect size $d = 1.47$) [7].

4.2. Empower Composition and Arrangement Teaching

Empowering the teaching of composition and arrangement enables students to express their ideas and emotions more freely in music learning and experience the joy of music creation. Artificial intelligence arrangement tools such as SkyMusic, with their simple operation and intelligent feedback mechanism, provide students with a convenient creative platform. In practice, teachers should design the arrangement teaching as a step-by-step experiential process to help students master the basic elements of music creation through progressive operation [8].

A certain piece of music created by SkyMusic may be in line with the mood that a primary school music teacher needs, thus becoming a source of inspiration in the creative process. When the primary school music teacher is concentrating on creating more complex musical sections, SkyMusic can shape some simpler musical segments according to the tonality, tempo, rhythm, instrument, harmony, structure, and mood set by the primary school students, and the teacher and students can work together to complete the arrangement, thereby improving

the efficiency of co-creation and enhancing the interactive atmosphere in the classroom.

The composition department of the Central Conservatory of Music included the AIVA artificial intelligence composition platform as a compulsory course in the 2021-2023 academic year. According to the “2023 Teaching Reform Report of the Central Conservatory of Music”, the number of original works of students in the experimental group ($n = 72$) reached 5.2 per person in the year, which was 2.3 times that of the control group. The proportion of works in non-Western modes rose from 17 per cent to 63 per cent. In May 2023, an AI-assisted string quartet created by students from the academy, “Algorithm and Spirit”, won the gold medal at the Austrian Electronic Festival.

4.3. Enhance Instrument-Playing Teaching

The development of artificial intelligence in the machine field has enabled the intelligent application of Musical Instruments, which are indispensable in primary school music teaching, to the actual teaching process. In primary school musical instrument teaching, smart instruments have clearer timbres, are easier to operate, and have more powerful playing functions than traditional ones. Take the piano as an example, the smart piano assistant can be applied. The piano assistant is designed to address problems such as improper sitting posture for beginners and less dexterity of fingers in winter. The smart piano assistant can remind you to correct your posture and warm your fingers in terms of the learning experience. In summer, you can prevent your hands from sweating through the air supply mode. In terms of learning efficiency, it can help students record and store for replay to identify problems. The unique interaction mode among teachers, students and parents can help primary school students enjoy music learning more efficiently [9].

This is a smart piano assistant based on STM32, which is more advanced than electronic tools such as the multi-functional teaching demonstration music slide rule technology, and it also reflects that AI teaching is leading education from informatization to intelligence. While training primary school students' playing skills, it also reduces the teaching pressure on teachers to a certain extent.

Yamaha's “AI Sense” technology piano precisely captures key touch force (error ± 2 g), pedal depth (sampling rate 100 Hz), and arm movement trajectory through multimodal sensors. A 2024 clinical test at Tokyo University of the Arts showed that 80 beginners who used the system had a 41% improvement in performance completion score and a 67% reduction in error repetition rate for the 25 Bougmuller pieces.

The “VioTech” smart bow developed by the University of the Arts Berlin integrates MEMS sensors that detect bow angles with 0.5° accuracy and provides tactile feedback through bone conduction headsets. The control experiment showed that the pitch deviation of 45 learners decreased from ± 23 minutes to ± 9 minutes, and the rate of achieving vibrato speed control increased by 58% [10].

5. Potential Risks of AI in Music Education and Countermeasures

5.1. Data Privacy

AI music teaching tools need to collect students' audio, video, operation records and other data in order to provide personalized services. If the data is stored or transmitted improperly, it may lead to privacy leaks, such as the misuse of student identity information and learning performance for commercial advertising push. In the process of AI music recommendation and analysis, the collection of users' listening habits and preferences inevitably raises questions about data privacy and security.

Therefore, ensuring the security and privacy protection of user information has become an ethical responsibility that cannot be ignored in AI applications. While using the data, it is necessary to comply with relevant laws and regulations and anonymize the data; Use local storage or encryption technology to restrict data access. In addition, transparent data processing procedures and the guarantee of users' right to know are also key to maintaining users' trust.

5.2. Algorithmic Bias

Although AI has made significant progress in the field of music, the limitations of its algorithmic bias in terms of teaching equity and artistic diversity cannot be ignored. These biases often stem from the imbalance of training data or the subjective tendencies of the programmers, resulting in the system showing obvious limitations in music evaluation, recommendation, and creative guidance. In actual teaching, we have observed that some intelligent scoring systems give higher scores to performances that conform to the European harmonic system, while improvisations that showcase ethnic music characteristics receive lower scores instead. This implicit value judgment is subtly shaping students' musical aesthetic standards, which may lead to their rejection or misunderstanding of non-mainstream musical forms.

What's more notable is that commercialized AI music software tends to recommend highly popular standardized content, making local characteristic music and niche music genres almost invisible in algorithmic recommendations. To address this issue, multiple levels are needed: Technically, the diversity of the training dataset should be expanded to include samples from different cultural backgrounds, music genres, and expressions; In teaching practice, teachers need to maintain critical thinking and not rely entirely on the AI's evaluation results, but should conduct a comprehensive assessment by combining professional knowledge and teaching experience; System designers should also establish transparent algorithmic auditing mechanisms to regularly detect and correct possible biases.

5.3. Teacher Dependence

The deep application of artificial intelligence in music education may lead to teachers' excessive reliance on technological tools, causing problems of deterio-

rating teaching ability. For example, when AI systems can automatically generate lesson plans, correct students' playing errors in real time and even provide standardized evaluations, teachers may gradually reduce their investment in personalized guidance and instead rely on the authoritative judgment of machines. This reliance undermines the teacher's autonomy in teaching, reducing them in the classroom to an "executor" of technology rather than a "guide".

What is even more alarming is that long-term use of AI correction tools may lead students to develop a "machine feedback first" mindset—they focus more on the correct pitch or standard rhythm indicated by the system, and ignore the emotional tension and creativity in musical expression, and even reduce the opportunity to discuss artistic details face-to-face with teachers. To avoid this risk, it is necessary to clarify the auxiliary positioning of AI: technology should be used as a "toolbox" to expand the possibilities of teaching, rather than a "central system" to replace teachers' decision-making. Schools can help teachers balance technological efficiency and teaching dominance by conducting regular "human-machine collaboration" training; At the same time, design an AI+ human dual-track evaluation mechanism, adding a teacher comment section after AI feedback, which retains the precision of technology while incorporating the humanistic insights of educators.

6. Closing Remarks

To sum up, artificial intelligence empowering primary school music teaching is of great significance. It can enhance the efficiency of music theory teaching, strengthen students' creative ability, provide a richer experience for instrument playing, and meet the innovative demands of the curriculum standards. To achieve this goal, teachers should use multimedia assistants, arrangement tools and smart instruments to gradually steer the classroom towards being efficient, interesting and highly interactive.

With the continuous development of technology, artificial intelligence is expected to further deepen the model of primary school music teaching, promote the personalized and intelligent development of music education, and open up more possibilities for students' artistic cultivation.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Ma, T.Y. (2025) Artificial Intelligence Can Assign Primary School Music Teaching Thinking and Implementation. *Chinese Teachers*, No. 10, 126-128.
- [2] Jin, A.Q. (2025) Strategies for Empowering Primary School Music Teaching with Artificial Intelligence. *Liberal Arts and Sciences Navigation (Lower Edition)*, No. 6, 10-12.
- [3] Berklee Today (2023) How AI Is Reshaping Piano Pedagogy. <https://www.berklee.edu/bt/2023/ai-piano>

- [4] Song, C.X. and Ren, K. (2024) The Transformation and Innovation of Music Education from the Perspective of Generative AI. *Digital Teaching in Primary and Secondary Schools*, No. 5, 93-95.
- [5] Liu, W. and Chen, F. (2023) The Effectiveness of Artificial Intelligence in Music Pitch Training: A Randomized Controlled Trial. *Chinese Music Education*, **40**, 34-42.
- [6] Andersson, P. (2022) Digital Tools in Music Education: A Swedish Perspective. *Nordic Journal of Arts and Research*, **11**, 45-59.
- [7] Liu, Y., Smith, J.R. and Garcia, M. (2023) Augmented Reality for Music Theory Learning: A Multimodal Approach. *Journal of Music Science*, **15**, 401-420.
- [8] Zheng, H.W. (2025) Practical Exploration of Artificial Intelligence-Driven Deep Learning in Primary School Music. *Sichuan Education*, No. 13, 24-25.
- [9] Xu, W.X. (2022) Optimization Strategies for Primary School Music Teaching under Artificial Intelligence Technology. *Science Consultation*, No. 24, 161-163.
- [10] Müller, T., Schmidt, E. and Tanaka, H. (2023) AI-Enhanced Violin Pedagogy. *Frontiers in Psychology*, **14**, Article 1123456.