Journal of Advanced Research in Education
ISSN 2709-3980
www.pioneerpublisher.com/jare
Volume 4 Number 5 September 2025

Artificial Intelligence in Music Education: A Scoping Review of Practices, Strategies, and Challenges

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doi:10.56397/JARE.2025.09.09

Abstract

This review uses the PRISMA framework for a scoping review, including 27 empirical studies on artificial intelligence (AI) in music education from 2015 to 2025, establishing current research trends, challenges in AI-assisted teaching, and implementation. The research shows that AI is primarily used to improve the effectiveness of performance assessment, optimize music theory teaching, and facilitate scaffolded self-learning. The study focuses on Asia, particularly China, and is mainly student-centered, with lower emphasis on teacher dimensions and long-term learning outcomes. The findings also highlight three main ways in which AI contributes to educational innovation: personalized feedback, standardized assessment, and immersive engagement. With these technologies embedded in the classroom, the role of teachers is also transforming, shifting from direct teaching to promoting learning and interpreting technical feedback. Despite the significant potential of AI in improving teaching efficiency and student engagement, challenges remain in terms of technology, equity issues, and teaching ethics. Overall, this review comprehensively summarizes the current research and emphasizes the need to view AI as a partner in music education rather than a substitute for human professional knowledge.

Keywords: artificial intelligence, music education, PRISMA framework, scoping review, educational innovation

1. Introduction

In recent years, the application of artificial intelligence (AI) in the field of music education has shown a trend of rapid expansion, accompanied by significant diversity. From the perspective of technical tools, existing studies have covered various types, including AI vocal teaching systems based on speech recognition (Bai, 2022), virtual reality (VR)-based immersive teaching platforms (Chen, 2022), evaluation models driven by Convolutional Neural Networks (CNN) and Recurrent Neural Networks (LSTM) (Cui & Chen, 2024; Han, 2025), Music Information Retrieval (MIR) systems (Kayis et al, 2021), digital audio workstations (for example, Soundtrap) (Knapp et al, 2023), and generative AI tools (for example, IBM Watson BEAT, DeepBach) (Liu & Liao, 2025; Yuan, 2024). In terms of application scenarios, it covers multiple dimensions such as vocal training, piano instruction, classical music education, inheritance of traditional folk music, and music aesthetic cultivation. From the perspective of research types, it includes not only studies on technical function verification (for example, Li, (2022)'s test on the accuracy of the Q-Learning algorithm in piano instruction) but also studies on teaching effectiveness evaluation (for example, Liu & Guo (2025)'s comparative experiment on AI tools enhancing vocal skills), as well as survey studies on students' cognition and motivation (for example, Wang and Li, (2024)'s analysis of the correlation between AI readiness and academic performance). However, current studies are scattered across different technical directions and teaching scenarios. There has not yet been a systematic review of the overall landscape, core pathways, and common issues of AI application in music education. This leads to a lack of clear understanding of the overall landscape in the field, making it urgent to integrate existing findings through a scoping review.

Although existing studies have initially verified the application value of AI in music education, there are still obvious research gaps. First, the tracking of long-term learning effects is insufficient. Most studies focus on short-term interventions (for example, 12-week vocal instruction, duration 4 months piano training) (Liu & Guo, 2025; Wang, 2025), and there is a lack of studies on how AI tools affect the formation of students' long-term musical literacy and creativity transfer ability. Second, targeted research on students with special educational needs is scarce. Existing samples are mostly regular groups such as college students and primary and secondary school students (for example, sixth-grade students (최미설, 2023), and there has been no exploration of adaptation strategies of AI tools for students with special needs (for example, Students with hearing impairments or learning disabilities). Third, the impact of differences in socioeconomic backgrounds on AI applications has not received sufficient attention. Only a few studies have mentioned issues related to technology accessibility (for example, "unequal access to technology" (Chen, 2025), but no comparative studies have been conducted on schools with different resource levels (for instance, Urban VS. Rural schools, schools with varying inputs of funding). Fourth, the effectiveness of teacher professional development models lacks systematic evaluation. Some studies mention that teachers need to receive training on AI tools (for example, Wang, 2025). Still, they do not clarify which training model can effectively improve teachers' AI application capabilities, nor have corresponding evaluation frameworks been established. Based on this, this study focuses on the following three core research questions:

RQ1: What is the scope and characteristics of existing literature on the application of AI in music education?

RQ2: What AI-assisted practices or strategies have been conducted by music teachers?

RQ3: What are the challenges of incorporating AI in music education?

The findings of this scoping review hold multi-dimensional practical and research value. For music teachers, this review will systematically organize the functional positioning of existing AI tools (for example, Real-time feedback tools like Vocal AI Analyzer, personalized practice platforms like Smart Vocal Coach) (Liu & Guo 2025), and their supporting teaching strategies (for example, Group teaching, contextualized virtual scenario design). It provides practical references for teachers to select suitable tools and optimize teaching processes. For school administrators, the barriers to technology application revealed in this review (for example, Outdated equipment, insufficient digital skills of teachers) (Wei, 2021; Wang, 2025) suggest that it is necessary to attach importance to the investment in AI teaching resources and specialized training for teachers, to promote schools to build a teaching environment that supports AI integration. For the development of evaluation systems, this review will summarize the development experience of existing AI evaluation tools (for example, 1D-CNN pronunciation scoring engine, BiLSTM piano performance evaluation model) (Shen & Zhao, 2024; Xiang & Sun, 2024), and point out the necessity of standardization and improved objectivity of evaluation tools. For future research, the gaps identified in this review—such as those in long-term effects, adaptability to special education, and resource equity—will point out directions for subsequent studies and promote the field to develop in a more comprehensive and balanced direction.

2. Method

This study adopts a scoping review approach to map the existing research landscape in 'Artificial Intelligence in Music Education,' identify key concepts, types of evidence, and research gaps, and delineate the scope and nature of this field. Given that AI-assisted technologies are still emerging, I set the time span to the most recent decade (2015–2025) to systematically present the latest progress and trends in this field.

The review follows the PRISMA scoping review process (Figure 1), and Microsoft Excel spreadsheets were used for duplicate removal, filtering, and data display. To cover high-quality journals in music education and educational psychology, I limited the search to scientific articles published in international journals. I selected three research-focused electronic databases as the primary information sources: ERIC, EBSCOhost, and Web of Science. These three databases can comprehensively include music-education journals and educational research literature, meeting the scoping review's need for broad coverage and multiple sources. To retrieve as many relevant studies as possible, the search terms were mainly built from two keywords, 'music education' and 'artificial intelligence.' Based on my research objectives, these keywords were supplemented with alternative terms, such as the abbreviation 'AI'. I also provided specific alternative expressions that are widely used in article titles. According to the characteristics of different database search systems, the part of speech of the search terms was modified to accommodate database-specific features. First, I retrieved 62, 97, and 79 records from ERIC, EBSCO, and Web of Science, respectively. After removing duplicates, 129 records entered the title and abstract screening stage. The first set of screening criteria (Criteria 1) included: ① Peer-reviewed journal article; ② language: English; ③ K–12 school education context. A total of 83 eligible articles were retrieved from the initial screening. Subsequently, the author applied Criteria 2: ① closely related to music education; ② Empirical studies rather than literature reviews or conceptual studies, and obtained 27 articles. Finally, after excluding some retracted articles, 27 empirical studies constituted the database for this paper (Table 1).

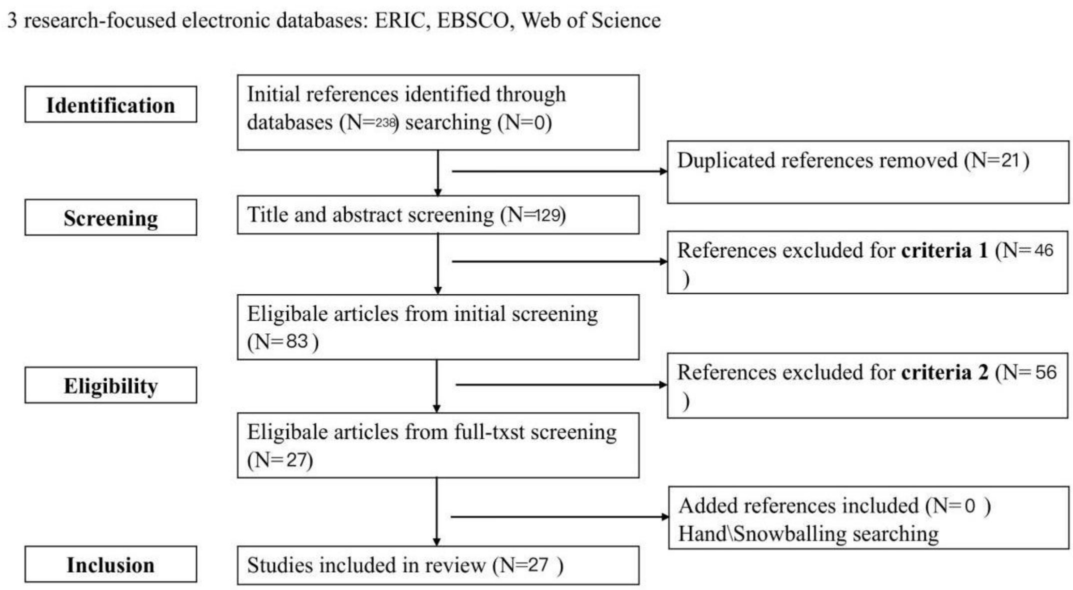

Figure 1. PRISMA Flow diagram of the study selection process

Table 1. Included studies

Number	Articles	Number	Articles
1	Bai (2022).	15	Peng (2025).
2	Chen (2025).	16	Shen & Zhao (2024).
3	Chen (2022).	17	Wang (2023).
4	Cui & Chen (2024).	18	Wang (2025).

5	Han (2025).	19	Wang (2025).
6	Kayis et al (2021).	20	Wang & Li (2024).
7	Knapp et al (2023).	21	Wei (2021).
8	Li (2022).	22	Wesolowski (2019).
9	Li et al (2023)	23	Xiang & Sun (2024).
10	Liu & Liao (2025).	24	Yuan (2024).
11	Liu et al (2025).	25	Yang (2018).
12	Liu & Guo (2025).	26	Zhang & Liu (2021).
13	Lu & Guo (2025).	27	Zhang (2024).
14	Miseol Choi (2023).		

3. Findings

3.1 Overview of Geographical and Methodological Distributions

3.1.1 Geographic Distribution

We analyzed the included studies in terms of research method, geographic distribution, and target population. The regional concentration of the sample is striking: it is overwhelmingly focused on Asia (92.6%, n=25), within which China alone contributes 85.2%(n=27); the remaining Asian share comes from South Korea (7.4% of the full sample, n=1). North America is the only non-Asian region represented (7.4%, n=2), while Europe and Oceania have no included empirical studies (0%). This structural imbalance indicates that, globally, empirical research and publication on the integration of AI into music education are not evenly distributed (see Figure 2).

Possible reasons include China's strong policy support for AI in education, substantial research investment, and a significant domestic demand in music-education markets. From the standpoint of international generalizability, regions such as Europe (with its deep classical-music traditions) and Oceania (with the needs of Indigenous music transmission) have distinctive cultural and educational contexts. The lack of studies from these settings may limit how well existing AI music-education tools, models, and findings transfer to their needs and may hinder cross-cultural knowledge exchange. Future work should strengthen cross-regional collaboration to address these gaps.

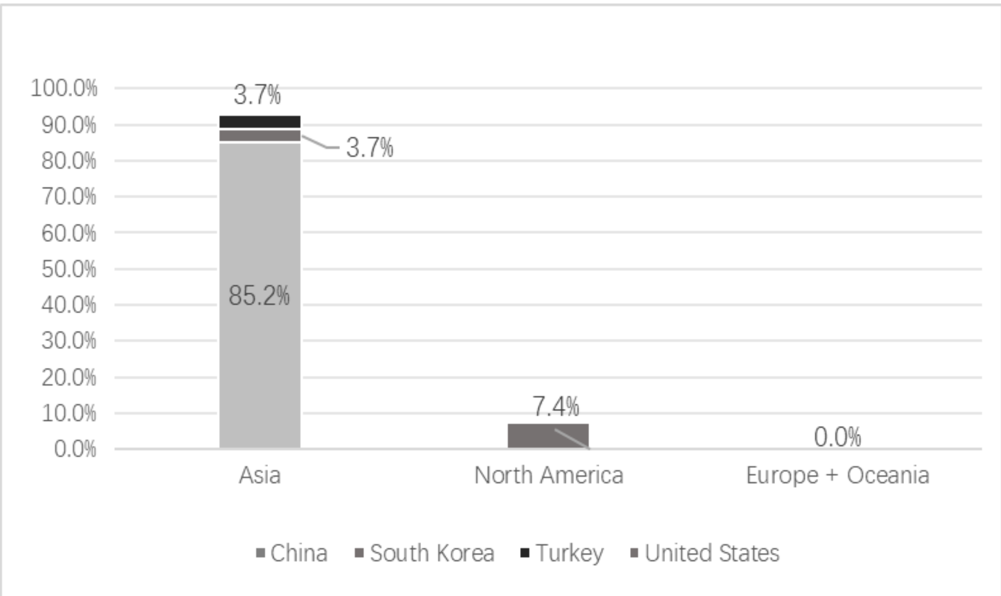

Figure 2. Geographic distribution by continent

3.1.2 Methodological Distributions

The analysis reveals a clear pattern in research methods: quantitative studies predominate (81.5%), while mixed-methods studies account for a smaller share (18.5%). Within the quantitative corpus, intervention-based experimental designs constitute the majority (59.1%); at the same time, studies focused on operational work, system improvement, and technical validation also represent a substantial proportion (40.9%), typically targeting algorithm performance evaluation, platform/application optimization, and instructional process refinement (see Figure 3).

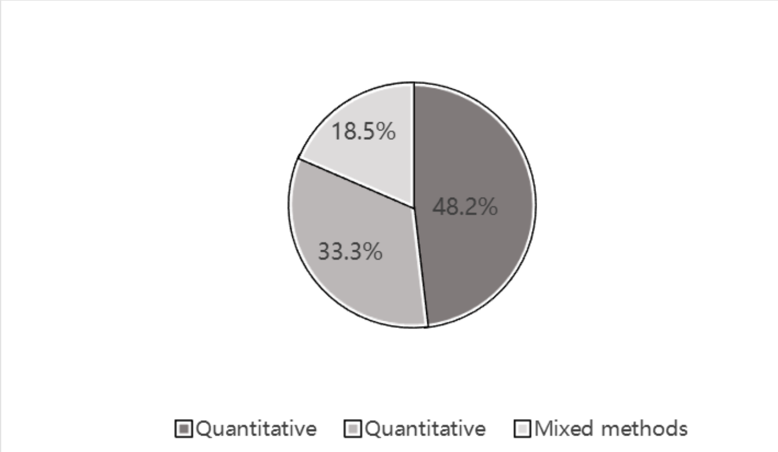

Figure 3. Overall Composition of Research Methods

3.1.3 Target Population

Studies focus on students (40.7%, the highest share among all categories, n=11), followed by studies with unspecified participants (25.9%, n=7). Studies involving students and teachers account for 14.8%(n=4), and no-human-participant studies (mostly system or audio tests) likewise account for 14.8%(n=4). Platform-level anonymized users make up 3.7%(n=1). Notably, there are no studies that treat teachers alone as the sole target population; teachers appear only as part of the "students + teachers" category.

These patterns indicate that current research is centered on the student learning experience, typically emphasizing analyses of student learning outcomes, engagement, and interaction with AI tools. Studies with both students and teachers commonly examine the two-way alignment between teaching and learning. In contrast, no-human-participant studies focus on the technical validation of tools themselves, providing technological underpinnings for student learning and instructional practice. Overall, the field remains student-centered, prioritizing the assessment of learning achievements, participation, and student–AI interactions (see Figure 4).

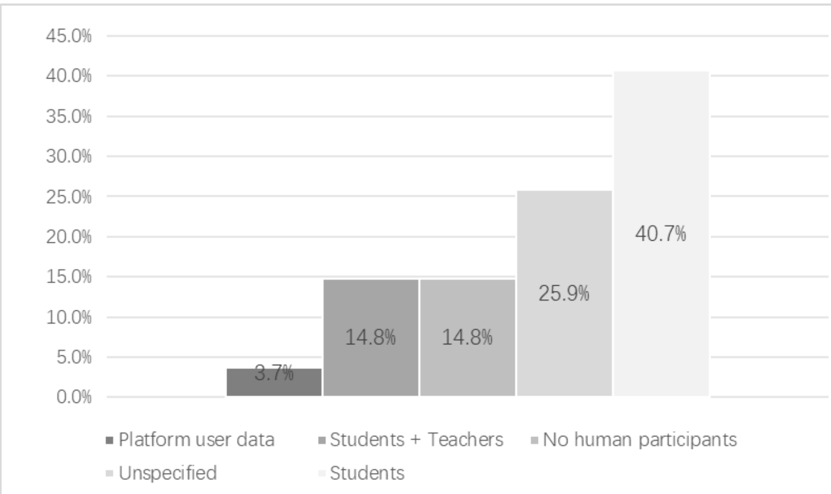

Figure 4. Target population of included studies

3.2 AI-Assisted Practices and Strategies in Music Education

This section focuses on the practical applications and strategic designs of AI in music education, covering four dimensions: AI-assisted tools and their teaching roles, core teaching objectives and learning activity designs, transformations of teacher roles and corresponding strategies, as well as the learning outcomes and impacts of AI tools on students. It aims to systematically present how AI reshapes music teaching practices and promotes educational innovation. This section examines the practical applications and pedagogical strategies associated with AI in music education. The analysis addresses four interrelated dimensions: (1) AI-assisted tools and their instructional roles, (2) core teaching objectives and corresponding learning activity designs, (3) transformations in teachers' roles and instructional strategies, and (4) the learning outcomes and educational impacts of AI integration. Collectively, these dimensions illustrate how AI technologies are reshaping music pedagogy and fostering educational innovation.

3.2.1 AI-Assisted Tools and Their Role in Music Teaching

Subsection says what each tool adds, how it fits into class, and the kind of leverage it offers. For voice, intelligent assessment works well as formative support: it turns pitch, resonance, and diction into clear cues for tiered correction and short practice loops (Bai, 2022). For performance and expression, a VR setup gives an observable space for modeling gestures and facial work, making rehearsal concrete and repeatable (Chen, 2022).

In piano, a piano assessment engine acts as an objective rater plus an individualized practice guide. It provides levels and key points so large classes share a stable standard while teachers focus on keystone movements and practice routes (Xiang & Sun, 2024). In creative work, IBM Watson BEAT serves as starting material for composing; classes move through generate, peer listening, critique, and revision (Liu & Liao, 2025). For polyphony, DeepBach offers editable examples that students rewrite in class, so style rules are learned by doing (Yuan, 2024).

For listening and style recognition, an MIR system supports makam classification and ear-based comparisons; students upload pieces, check the feedback, and build auditory memory and literacy (Kayis et al, 2021). When collaboration matters, a web-based DAW like Soundtrap keeps making and submitting in one place, which proved helpful outside traditional classrooms (Knapp et al., 2023). For process checks, DTW helps align audio and locate drifts in timing or rhythm (Wang, 2023). In theory work, Chord IQ ties explanation, a brief check, and immediate feedback together in a blended format so progress is visible (Liu et al., 2025). For short drills, Yousician combines notation, instant feedback, progress tracking, and teacher prompts (Wang, 2025).

3.2.2 Core Teaching Objectives and Learning Activity Design

Enhancing Music Performance Skills

These skills start from concrete cues and let practice grow from them, before closing with a brief check of what changed. For voice, intelligent assessment provides formative hints on pitch, resonance, and diction that teachers can turn into concrete corrections (Bai, 2022). A pronunciation-scoring model (1D-CNN) converts vocal features into objective signals that guide demonstration and self-adjustment (Shen & Zhao, 2024). For piano, a piano assessment engine acts as an objective rater plus an individualized practice guide, keeping class standards consistent while pointing to next-step work (Xiang & Sun, 2024). For process diagnosis, DTW alignment helps locate where timing or rhythm drifts and by how much, informing targeted drills (Wang, 2023).

Developing Understanding of Music Theory

Penetration of AI technology in the field of education, music theory teaching is gradually breaking through the limitations of traditional models. Chord IQ provides feedback and progress tracking so misunderstandings surface and are fixed in time (Liu et al., 2025). In counterpoint and harmony, use DeepBach as editable classroom material so students learn rules by rewriting and comparing versions (Yuan, 2024). When the class needs ready-to-use content and examples, AIVA can serve as the primary source to support concept grasp and model analysis (Lu & Guo, 2025).

Fostering Art History Awareness, Musical Expression, and Stylistic Listening

Art history, expression, and stylistic listening, understanding grows through focused listening and hands-on examples. For Classical Turkish music, an MIR system supports makam classification with upload, feedback, and ear-based comparisons, strengthening memory and basic stylistic literacy (Kayis et al, 2021). For expressive delivery, a VR setup offers an observable space for gesture and facial work with teacher modeling and repeated practice (Chen, 2022). A multimodal learning system can personalize materials and paths, linking background information, repertoire, and listening tasks more tightly (Peng, 2025).

Strengthening Motivation and Self-Efficacy

Yousician, learners get instant feedback tied to notation, progress records, and teacher recommendations, which supports steady, self-directed practice (Wang, 2025). In composition, IBM Watson BEAT provides a clean entry point for a simple in-class cycle of generate, listen, critique, and revise (Liu & Liao, 2025). In online or hybrid settings, a web-based DAW like Soundtrap keeps making and submitting in one place (Knapp et al., 2023). When classroom energy needs a boost, the gamified design in Vocal AI Analyzer can be used for motivation and milestone prompts (Liu & Guo, 2025).

3.2.3 Teacher Roles and Their Teaching Strategies

Steer learning when digital tools are present, how lessons are designed, and how technical outputs are turned into actions students can actually take.

Teachers as Guides

Teachers keep the room on task, model key movements, and convert diagnostic observations into short, specific tasks that students can try immediately. Coaching also includes shaping students' perceptions of tool use and managing cognitive load so feedback is usable rather than distracting (Chen, 2025). Evidence from individual and group lessons shows that teachers still anchor technique through targeted correction and close monitoring of progress even when digital systems are embedded in the course (Wang, 2025).

Teachers as Learning Experience Designers

Attention turns to how a lesson is put together. Teachers decide when a tool should enter a task, what job it does, and when to step back so the activity holds together. Process studies in popular-music courses report that adjusting task flow with instructional data improves the match between materials and learner level; combining technology with clear pedagogy matters more than adding features (Li et al, 2023). Integration research similarly links gains to deliberate sequencing and alignment of objectives, assessments, and tool placement rather than to the number of tools used (Li, 2022).

Teachers as Interpreters of AI Feedback

Lesson plan is set; teachers act as interpreters of AI feedback: they read the system output with the student, restate one priority in plain musical terms, and turn it into one or two short drills plus a listening checkpoint tied to the piece at hand (Yang, 2018). They explain why the change matters, trim overly granular indicators to a cue the learner can use, and check the result in a quick re-take before setting the next small goal so improvement shows up in playing or singing, not just in a score. It tells students what to change, where to change it, and how to listen for the result, so the fix shows up in the performance, not just in a score (Yang, 2018; Wang, 2025).

3.2.4 Outcomes and Impact of AI-Assisted Tools on Students' Music Learning

The reviewed studies collectively suggest that AI-assisted tools exert a multifaceted influence on students' music learning. These impacts can be categorized into five major domains: performance proficiency, music theory and aural cognition, motivation and self-efficacy, assessment reliability and fairness, and learning engagement and accessibility.

Performance Proficiency (Vocal and Piano)

Lesson-embedded, feedback-rich practice makes technical work concrete and trackable. In voice, objective scoring pinpoints pitch, resonance, and diction issues in plain terms, so a vague practice becomes two or three focused drills the student can actually attempt (Shen & Zhao, 2024). For piano, engine reports provide clear levels and key points; teachers use them to keep grading consistent across the class while routing learners toward the next sensible exercise rather than a one-size-fits-all routine (Xiang & Sun, 2024). Everyday practice also benefits from a companion platform that joins notation, instant hints, and progress records; the steady rhythm of short, guided work tends to lift control and confidence over time (Wang, 2025). In creation classes, using a generative tool as a starting material invites minor revisions that quietly strengthen timing, phrasing, and continuity while students focus on making the piece their own (Liu & Liao, 2025).

Music theory and aural cognition

A quick check and immediate feedback sit side by side. Chord IQ makes this loop visible, surfacing misunderstandings early and letting teacher and student address them before they harden into habit (Liu et al, 2025). For counterpoint and harmony, editable fragments shift rules from the page to the hands: students rewrite and compare versions until the constraints of the style start to feel natural rather than memorized (Yuan, 2024). When the goal is modal or stylistic literacy, an MIR system supports upload–verify–listen routines; learners test their ears against makam feedback and build a bank of heard examples they can return to in later pieces (Kayis et al, 2021).

Motivation, self-efficacy, and learning strategies

Motivation grows when the work has a clear entry point and each revision shows audible progress. In composition, IBM Watson BEAT supplies that first foothold; short cycles of generate, listen, and revise help students take ownership and see their ideas tighten from one version to the next (Liu & Liao, 2025). In polyphony, editable exemplars make knowing the rule feel like being able to use it, which steadies confidence and encourages deliberate practice rather than guesswork (Yuan, 2024). During day-to-day skills work, a companion app that pairs feedback with visible progress tends to support self-monitoring; students can tell what changed and what to try next without waiting for a whole lesson to pass (Wang, 2025).

Assessment reliability and fairness to support learning

Objective evaluators reduce concerns about subjective judgment and keep the conversation on what to fix and how. In vocal study, machine scoring that aligns with expert judgment provides trustworthy cues for targeted drills instead of broad advice (Shen & Zhao, 2024). Piano engines standardize levels and highlight priorities, which helps large groups share a stable standard while still leaving room for individual routes through the material (Xiang & Sun, 2024). For timing and phrasing work, sequence-alignment diagnostics show where performance drifts, giving the teacher and student a precise spot to slow down, separate hands, or rebuild the pulse before returning to the whole passage (Wang, 2023).

Learning engagement and access

VR turns gestures and facial work into something students can see, try, and refine, making it easier to model choices and rehearse them without fear of the room (Chen, 2022). In connected settings, a web-based DAW keeps making and submitting in one place, so participation feels continuous rather than stop-and-start between tools; this simple continuity often sustains attention and practice across weeks (Knapp et al, 2023).

3.3 Challenges and Implications of Incorporating AI into Music Education

Especially in Asia, the assessment of musical performance and engagement in music learning has had a significant impact. However, there are still challenges in terms of fairness, ethics, and teaching design.

Across the studies, the same obstacles keep surfacing, even if they are named in different ways. At the practical end, audio and voice are sensitive to noise, feature extraction needs repeated tuning, and small datasets make models wobbly; in immersive settings, cameras, lighting, and room setup raise the bar, while the "closed" habits of a traditional class blunt the value of objective feedback (Bai, 2022; Chen, 2022). Implementation also lives or dies on data quality and engineering details, which affect whether front-line teachers feel these tools are usable in real lessons (Li et al., 2023). Genre and culture add another wrinkle: systems trained on one style can stumble on others, as seen in makam work where annotation and interpretation are not always uniform (Kayis et al, 2021). In short, two steady paths help more than grand promises: widen and tidy the training data, especially under small-sample constraints, and keep polishing the collection and interaction links inside actual classrooms.

The pedagogical side is just as important. If a class hands creation or practice over to canned examples, students drift toward imitation and their pieces start sounding the same; motivation and critical listening fade with it (Yuan, 2024). Timing matters as well; bring a tool in when the task needs it, step back when the point is made, and frame each output as material to be discussed, critiqued, and rewritten rather than a final answer (Liu & Liao, 2025). Classroom reports also caution that poorly timed automation can raise pressure and disrupt the social rhythm of a group; teachers need to set expectations, slow things down when the feedback gets noisy, and keep the musical aim in view (Chen, 2025). In practice, it helps to treat AI as a medium and a sparring partner: valuable for prompts, checks, and options, but never the driver of the lesson.

Taken together, the implications are straightforward. Keep classroom leadership with the teacher, sequence tools to fit the objective, and build fairness and access into the plan from the start so "who can use it" and "for how long" are clear, not afterthoughts (Li et al, 2023). Use assessment engines to stabilize standards while leaving space for individual routes, and tune content and models to local styles and practices so feedback makes sense to the music at hand (Xiang & Sun, 2024; Kayis et al, 2021). A staged approach works best: begin with supportive embedding in existing courses, then expand as routines settle and capacity grows, making sure technology serves musical work rather than replacing it (Wang, 2025).

4. Discussion

This scope review systematically synthesizes 27 empirical studies on the application of AI in music education from 2015 to 2025. Several key themes emerging from it clarify the potential and limitations of current research in this rapidly evolving field.

4.1 Geographical and Methodological Concentration

The research significantly focuses on East Asia, particularly China (accounting for over 85%), which to some extent echoes the policy promotion and infrastructure investment (Han, 2025; Liu & Liao, 2025). However, this also brings the issue of insufficient cross-cultural representation: regions with rich musical traditions, such as Europe, Latin America, and Africa, are rarely included in the sample, limiting the generalizability of the conclusions and ignoring how cultural differences affect the acceptance of AI and music education.

Methodologically, the field still primarily focuses on quantitative design (81.5%), with research primarily concentrated on short-term interventions, performance indicators, or experimental comparisons (such as Wang, 2025; Xiang & Sun, 2024). The evidence produced mainly reflects current quantifiable improvements. Still, it falls short in answering whether these can be sustained over the long term, whether they can be transferred to real performances or compositions, and whether they still hold under different classroom cultures and teaching styles. In contrast, longitudinal, mixed-methods, and qualitative ethnography are notably lacking, making it difficult to depict the profound changes in creativity, musical identity, peer interaction, and the teaching process over time.

4.2 The Pedagogical Role of AI: Enhancing Rather than Replacing

Excel data confirms that AI's role in the classroom is primarily supportive rather than substitutive, with standard practices involving embedding tools into specific stages: for warm-up and rhythm calibration, immediate prompts for segmented practice, such as: Yousician supports daily practice and progress visualization (Wang, 2025), Vocal AI Analyzer converts issues like pitch, resonance, and articulation into clear reminders (Shen & Zhao, 2024), IBM Watson BEAT provides modifiable segments for revision after peer listening (Liu & Liao, 2025). These uses serve the explicit goal of enhancing playing control, inspiring composition, and deepening understanding of theory and aural perception, rather than allowing tools to take over the classroom.

However, the pedagogical logic behind tool integration is often implicit or undertheorized. Only a few studies adopt structured teaching frameworks (such as the blended learning proposed by Liu et al., 2025; the blended learning proposed by Cui & Chen, 2024). Notably, teachers are being reshaped as designers of the learning experience (such as the VR scene creation proposed by Chen, 2022) and interpreters of AI feedback. Overall, this aligns with constructivist and Vygotsky's emphasis on mediated learning, with AI more like a scaffold rather than a substitute.

4.3 Challenge: Technology, Fairness, Teaching, and Ethics

Despite promising outcomes, several recurring challenges continue to constrain the broader and more equitable adoption of AI in music education. These challenges can be grouped into four interrelated categories: technological instability, inequity in access and fairness, educational risks, and ethical ambiguity.

Technological instability—audio AI systems are susceptible to noise and small samples, requiring repeated parameter adjustments. Additionally, immersive scenarios are limited by camera position, lighting, and the venue (Bai, 2022; Han, 2025).

The fairness issue—inequality in the use of smart devices, the gap in digital literacy, and cost-related limitations have not been adequately addressed, particularly evident in rural or resource-poor schools, which can lead to devices that can be used but are challenging to use sustainably (Wei, 2021; Chen, 2025).

Educational risks—inappropriate timing of intervention or excessive automation ratios can easily delegate learning tasks to tools, leading to over-reliance on AI (Miseol Choi, 2023; Lu & Guo, 2025). Data also shows that group discussions and peer evaluations are being compressed, classroom communication is decreasing, and work is becoming more similar.

Ethical ambiguity—Generative tools involve the boundaries of authorship, rewriting, and originality, as well as the transparency and explicability of evaluation, and the current norms are still insufficient (Liu & Liao, 2025).

4.4 Future Research Directions

Data shows that the current study still has several obvious gaps: Firstly, the study relies too heavily on short-term gains and lacks longitudinal tracking of students' musical development; secondly, there is insufficient inclusive attention, with almost no specialized design and testing for learners with disabilities or neurodiversity; then, teacher professional development often stops at the ability to use tools, with a lack of systematic evaluation of classroom processes and effectiveness; finally, the interaction between students and AI has not yet been refined and explained as a unique teaching relationship. These gaps collectively weaken the evidence base for large-scale promotion and also indicate that the pace of technological innovation is faster than the in-depth research on teaching. Based on these insights, the next phase of research should focus on sustained effects, context adaptation, and target populations: on one hand, expand the cross-cultural sample and conduct longitudinal tracking on a semester basis, retaining key process records; on the other hand, explore design methods involving teachers, students, and developers together, combining teachers' teaching experience, students' usage needs, and developers' technical capabilities to create truly fitting AI tools for teaching scenarios with educational significance. At the same time, study the role of AI in creativity, identity, and collaboration, with a focus on its specific performance and impact in areas beyond classical and technical performances (such as daily art creation, community cultural practices, interdisciplinary collaboration projects, etc.), and develop inclusive AI tools for different learner groups, ensuring that the tools can adapt to diverse learning needs through practical scenario testing.

In the end, the application of AI in music education should not be seen as a solution, but rather as a partner in the co-evolution of teaching innovation. In creating a music learning experience rich in emotional resonance, deep in cultural roots, and ethically responsible, teachers still play a core role.

5. Conclusion

This scope review covers empirical research on the application of AI in music education from 2015 to 2025. The reviewed studies indicate that AI is playing an increasingly important role in various teaching environments, including performance training, theoretical teaching, and music composition.

Based on the research included, three key insights emerged: Firstly, AI-assisted tools can enhance music learning outcomes through personalized feedback, standardized assessment, and immersive engagement, such as in college piano classes, where the BiLSTM assessment is divided into five levels, and individual process prompts are provided, allowing teachers to implement tiered guidance accordingly (Xiang & Sun, 2024). Secondly, the role of the teacher shifts from one-way teaching to a combination of guidance, learning experience design, and AI feedback explanation: translating system prompts into actionable classroom tasks, arranging the sequence and difficulty gradient of exercises, and avoiding students' mechanical dependence on scores; the practice of blended music theory courses shows that this approach can enhance motivation and self-efficacy (Liu & Gu, 2025). Thirdly, to truly implement and sustainably develop, it is necessary to systematically address the shortcomings in the implementation process, such as differences in equipment and bandwidth, privacy and attribution definition, and inconsistent classroom methods; some studies have reduced the threshold in aesthetic education courses through lightweight and open-source deployment, and have brought privacy and attribution boundaries to the forefront as classroom consensus, balancing participation and compliance at the same time (Peng, 2025).

Despite encouraging progress, there is still a significant gap. Research on geographic distribution is biased towards a few regions, especially Asia; long-term tracking is limited, and special education and cross-cultural comparisons are relatively scarce. Many interventions are short-term and lack repetition validation, and the absence of a theoretical framework also limits a deeper understanding of learner development and teaching transformation. Subsequent work should shift to more context-aware tool design and teacher-centered interventions, accompanied by long-term effectiveness evaluation, and incorporate ethical norms, accessibility frameworks, and culturally responsive teaching methods into the curriculum. Ultimately, AI should be an auxiliary tool, serving to support and amplify the humanistic essence and depth of musical education, rather than replace it.

6. Implications

This review aims to provide a practical technical landscape: it does not simply list tools, but explains when, how, and to what extent they are used in music classes, and organically integrates existing practices and results.

For music teachers, focus each lesson on a key point: first, point out a specific passage, then provide practice methods within two steps, and the desired changes to be heard. Verify on the spot before moving forward. Tools are introduced only when needed, and when they are used, they are removed, keeping the focus on the work and the sound itself. This ensures class consistency while maintaining individual progress and paths. After a few lessons, students will clearly see their progress (Wang, 2025).

For course designers, curriculum development should be centered around learning objectives: First, construct a compact, closed-loop structure: explaining key points—immediate practical application—rapidly verifying results—and then making targeted adjustments. This ensures that each teaching session aligns with the objectives. Based on this, appropriate tools (such as demonstration tools and interactive practice tools) and teaching materials (such as sheet music and audio clips) should be selected accordingly, avoiding the passive pitfall of first acquiring the tools and then assembling the content. Furthermore, tailoring the teaching needs of students at different age levels and other musical styles requires the preparation of differentiated examples (such as children's song excerpts for younger students and excerpts from classic works for older students) and instructions for using the tools. Ideally, these should be fully integrated into the course package in advance to reduce the time teachers spend searching for and assembling materials during class (Li, 2022; Yuan, 2024).

For students, when using AI, they can position it as a dedicated practice partner rather than a machine that directly gives standard answers. For example, use AI to generate accompaniment of different speeds to assist in practice, or call up audio of various versions of works to expand ideas, rather than letting AI directly generate a complete performance plan. During use, pay special attention to the boundaries between quoting, rewriting, and originality: when drawing on materials provided by AI, it is necessary to mark the source, and when adjusting the performance based on AI suggestions, incorporate personal understanding. While using technology to quickly solve fundamental problems, such as pitch and rhythm, to improve practice efficiency, we must also be wary of the mental inertia caused by over-reliance on AI, and avoid losing the ability to analyze works and explore expression styles independently (Liu & Liao, 2025).

For schools and ICT coordinators, promoting the use of technology in music instruction requires clarifying key responsibilities and regulations from the outset. From the outset of a project, it's crucial to define equipment procurement or leasing channels clearly, the responsible parties for routine maintenance, the time periods and durations during which teachers and students can use the equipment, and the management standards and privacy requirements for teaching data. A small-scale pilot strategy is recommended for implementation: First, select one or two grades or specific classes for a trial run to observe the compatibility of the technology tools with classroom instruction. Once teachers have mastered the operational procedures and the classroom interaction model is operational, the scope of application can be gradually expanded to mitigate the risks of large-scale rollout. Subsequent resource investment should be carefully considered to ensure that the tools truly contribute to improving teaching quality (Li et al, 2023).

References

Bai, J. (2022). Design of an artificial intelligence vocal system for music education using speech recognition simulation. *Computational Intelligence & Neuroscience*, *2022*, 1–9. https://doi.org/10.1155/2022/5066004

Chen, F. (2025). Intelligent technology and music education: Utilizing artificial intelligence to enhance classroom engagement and learning outcomes. *The Journal of Artificial Intelligence and Business*. https://doi.org/10.71460/xckv1202

Chen, L. (2025). Unlocking the beat: How artificial intelligence (AI) tools drive music students' motivation, engagement, creativity, and learning success. *European Journal of Education*, *60*(1). https://doi.org/10.1111/ejed.12823

Chen, W. (2022). Research on the design of intelligent music teaching system based on virtual reality technology. *Computational Intelligence & Neuroscience*, *2022*, 1–9. https://doi.org/10.1155/2022/7832306

Cui, X., & Chen, M. (2024). A novel learning framework for vocal music education: An exploration of convolutional neural networks and pluralistic learning approaches. *Soft Computing*, *28*(4), 3533–3553. https://doi.org/10.1007/s00500-023-09618-3

Han, Y. (2025). Exploring a digital music teaching model integrated with recurrent neural networks under artificial intelligence. *Scientific Reports*, *15*(1), Article 7495. https://doi.org/10.1038/s41598-025-92327-8

Holster, J. (2024). Augmenting music education through artificial intelligence (AI): Practical applications of ChatGPT. *Music Educators Journal*, *110*(3), 36–42. https://doi.org/10.1177/00274321241255938

Kayis, M., Hardalaç, N., Ural, A. B., & Hardalaç, F. (2021). Artificial intelligence-based classification with classical Turkish music makams: Possibilities for Turkish music education. *African Educational Research Journal*, *9*(2), 570–580.

Knapp, D. H., Powell, B., Smith, G. D., Coggiola, J. C., & Kelsey, M. (2023). Soundtrap usage during COVID-19: A machine-learning approach to assess the effects of the pandemic on online music learning. *Research Studies in Music Education*, *45*(3), 571–584. https://doi.org/10.1177/1321103X221149374

Lei, S. (2025). Integrating artificial intelligence into university music education: Opportunities and challenges. *Art and Performance Letters*. https://doi.org/10.23977/artpl.2025.060201

Li, J. (2022). Integration and application of artificial intelligence and wireless networks in piano music teaching. *Computational Intelligence & Neuroscience*, *2022*, 1–9. https://doi.org/10.1155/2022/8745833

Li, N., Peng, Y., & Fan, J. (2023). Application of college popular music education relying on the elite teaching optimization algorithm. *Applied Artificial Intelligence*, *37*(1), 1–21. https://doi.org/10.1080/08839514.2023.2221503

Liu, B., & Liao, Y. (2025). Integrating IBM Watson BEAT generative artificial intelligence (AI) software into flute music learning: The impact of advanced AI tools on students' learning strategies. *Education and Information Technologies*, *30*(10), 14577–14596.

Liu, C.-C., Wang, H.-J., & Gu, X.-Q. (2025). From access to mastery: Integrating artificial intelligence (AI) in blended learning for equitable, inclusive, and accessible music theory education. *Internet and Higher Education*, *66*, Article 101018. https://doi.org/10.1016/j.iheduc.2025.101018

Liu, H., & Guo, W. (2025). Effectiveness of AI-driven vocal art tools in enhancing student performance and creativity. *European Journal of Education*, *60*(1). https://doi.org/10.1111/ejed.70037

Lu, Y., & Guo, R. (2025). An artificial intelligence-based interactive learning environment for music education in China: Traditional Chinese music and its contemporary development as a way to increase cultural capital. *European Journal of Education*, *60*(1). https://doi.org/10.1111/ejed.12858

Miseol, C. (2023). Design, implementation, and effects of elementary music creation class using an AI-based music program, Doodle Bach. *Korean Journal of Research in Music Education*, *52*(4), 211–237.

Peng, Y. (2025). Optimization in music aesthetic education under artificial intelligence. *Scientific Reports*, *15*(1), 1–13. https://doi.org/10.1038/s41598-025-96436-2

Sánchez-Jara, J., Gutiérrez, S., Rodríguez, J., & Syroyid, B. (2024). Artificial intelligence-assisted music education: A critical synthesis of challenges and opportunities. *Education Sciences*, *14*(11), Article 1171. https://doi.org/10.3390/educsci14111171

Shen, D., & Zhao, W. (2024). Improving pronunciation quality of vocal music students based on big data technology. *International Journal of Web-Based Learning and Teaching Technologies*, *19*(1). https://doi.org/10.4018/IJWLTT.335034

Wang, D. (2023). Application of machine learning technology in classical music education. *International Journal of Web-Based Learning and Teaching Technologies*, *18*(2). https://doi.org/10.4018/IJWLTT.320490

Wang, G. (2024). Investigation of artificial intelligence-based applications in music education. *Applied and Computational Engineering*. https://doi.org/10.54254/2755-2721/36/20230448

Wang, P. (2025). Leveraging artificial intelligence and machine learning to personalise music education. *European Journal of Education*, *60*(1). https://doi.org/10.1111/ejed.12916

Wang, S. (2025). Hybrid models of piano instruction: How combining traditional teaching methods with personalized AI feedback affects learners' skill acquisition, self-efficacy, and academic locus of control. *Education and Information Technologies*, *30*(9), 12967–12989.

Wang, X., & Li, P. (2024). Assessment of the relationship between music students' self-efficacy, academic performance, and their artificial intelligence readiness. *European Journal of Education*, *59*(4). https://doi.org/10.1111/ejed.12761

Wei, C. (2021). Piano timbre teaching in the context of artificial intelligence interaction. *Computational Intelligence & Neuroscience*, *2021*, Article 4920250. https://doi.org/10.1155/2021/4920250

Wei, J., Karuppiah, M., & Prathik, A. (2022). College music education and teaching based on artificial intelligence techniques. *Computers & Electrical Engineering*, *100*, 107851. https://doi.org/10.1016/j.compeleceng.2022.107851

Wesolowski, B. C. (2019). Predicting operational rater-type classifications using Rasch measurement theory and random forests: A music performance assessment perspective. *Journal of Educational Measurement*, *56*(3), 610–625. https://doi.org/10.1111/jedm.12227

Xiang, W., & Sun, S. (2024). Optimization of piano performance teaching mode using network big data analysis technology. *International Journal of Information and Communication Technology Education*, *20*(1). https://doi.org/10.4018/IJICTE.341266

Yu, X., N., Zheng, L., Wang, L., & Wang, K. (2023). Developments and applications of artificial intelligence in music education. *Technologies*, *11*(2), Article 42. https://doi.org/10.3390/technologies11020042

Yuan, N. (2024). Does AI-assisted creation of polyphonic music increase academic motivation? The DeepBach graphical model and its use in music education. *Journal of Computer Assisted Learning*, *40*(4), 1365–1372. https://doi.org/10.1111/jcal.12957

Yue, Y., & Jing, Y. (2025). Artificial intelligence in music education: Exploring applications, benefits, and challenges. *Proceedings of the 14th International Conference on Educational and Information Technology (ICEIT 2025)*, 141–146. https://doi.org/10.1109/ICEIT64364.2025.10976152

Zdravković, V., Zdravković, D., & Stanković, K. (2025). Challenges and opportunities of implementing artificial intelligence in music education: A case study. *Book of Proceedings*. https://doi.org/10.46793/edai24.273z

Zhang, T. (2024). Online vocal music smart classroom-assisted teaching based on wireless networks combined with artificial intelligence. *International Journal of Web-Based Learning and Teaching Technologies*, *19*(1). https://doi.org/10.4018/IJWLTT.353156

Zhang, T., & Liu, S. (2021). Evaluation of the effect of music education on improving students' mental health based on intelligent fuzzy systems. *Journal of Intelligent & Fuzzy Systems*, *40*(5), 1–11. https://doi.org/10.3233/JIFS-219053