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The Use of AI in Music Teaching in Higher Education: A Systematic Literature Review

Yangyang Wang
Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia
Xinxiang University, Xinxiang, Henan, China

Aidah Abdul Karim* **and Intan Farahana Kamsin**
Universiti Kebangsaan Malaysia
Bangi, Selangor, Malaysia

Abstract. With the advancement of Artificial Intelligence (AI) technology, its integration in music education within higher education has become a significant research focus, although systematic reviews remain limited. A systematic literature review (SLR) was conducted to analyze development trends, the subjects and types of AI employed, research themes, and future agendas in the past decade. The literature was retrieved from EBSCO, Scopus, Web of Science, and ProQuest using predefined search terms around "AI", "music education", and "higher education", yielding 29 articles after screening. Data analysis combined quantitative mapping (year, country, journal distribution) with qualitative thematic coding. Findings indicate: 1) The research demonstrates an upward trajectory, with China being the most active country and with clear evidence of increasing interdisciplinary integration. 2) AI has been widely applied across music subjects such as choral arts and vocal training, with major types including deep learning, machine learning, reinforcement learning, and a variety of AI tools. 3) Key themes include AI-powered personalized learning and recommendation systems, evaluation and optimization models for music teaching quality, the integration of AI with emotion and affect aspects in music education, multi-technology integrated teaching innovations, and AI-enhanced learning motivation, professional skills, and creativity. 4) Future research should refine multimodal teaching models, deepening personalized learning mechanisms, optimizing intelligent assessment and feedback systems, and developing AI literacy and ethics frameworks, while also advancing AI applications in teaching scenarios, addressing cold-start issues and algorithmic bias, refining multi-role collaborative mechanisms to foster the deep integration of AI and music education in higher education.

*Corresponding author: Aidah Abdul Karim; *eda@ukm.edu.my*

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1. Introduction

AI refers to "the science and engineering of making intelligent machines that have the ability to achieve goals as humans do" (McCarthy, 2007, p.2). The development of the AI industry is transforming our world at an unprecedented rate, and it will significantly impact human society (Cao & Tao, 2024). AI in Music Education is a branch of AI and Education (AIEd) that utilizes AI technology to enhance music education (Ng et al., 2024).

Beyond the transmission of musical skills and knowledge, music education fosters the expression of human emotions, moral values, and cultural heritage, which are crucial for shaping students' mental and cultural development (Khojageldiyeva et al., 2022). Hence, enhancing the quality of music teaching in higher education institutions is of significant importance (Gao, 2023). Music education in higher institutions has attracted widespread attention from numerous researchers, who are dedicated to promoting improvements in the field of music education (W. Zhou & Kim, 2024). AI is also expected to spark a new revolution that will bring unprecedented change and development to this industry (Cao & Tao, 2024).

Especially in music teaching in higher education, AI not only changes the teaching methods but also gradually reshapes teacher roles, curriculum design, learning paths, and educational assessment systems (Sánchez-Jara et al., 2024). Unlike logical learning in science and engineering courses, music education emphasizes emotional communication, aesthetic experience, and creative expression, which means that AI not only plays the role of an auxiliary tool in music education but has also gradually become a co-creative subject. It not only improves the efficiency and accuracy of music teaching at the technical level but also reshapes the teaching structure and learning ecology at the conceptual level (Cao & Tao, 2024; Cui & Chen, 2024; Lin, 2024; L. Zhang, 2025).

How to maintain the humanistic nature of music education in an AI-dominated environment has become an essential issue in the current wave of educational transformation. Existing studies have shown that the application of AI in music teaching in higher education covers a wide range of dimensions including vocal training (Cui & Chen, 2024; Guo & Tang, 2023), choral creation (L. Zhang, 2025), polyphonic composition (Yuan, 2024), music learning outcomes assessment (Gao, 2023), and virtual interactive performance (Y. Feng, 2023), showing a high degree of integration and innovation.

From the viewpoint of the existing literature, AI-enabled music teaching in higher education primarily exhibits three significant features: first, the degree of technological integration is continually increasing. For example, Convolutional Neural Networks (CNNs) have been widely used in vocal autonomous learning systems (Cui & Chen, 2024), along with gesture recognition algorithms (Y. Feng, 2023), and music recommendations (Bai, 2024), as well as speech recognition systems (D. Feng, 2023). Recurrent Neural Networks (RNNs) and its variants have been used in music sentiment analysis (Huang, 2024), ethnomusicological feature extraction (Hui, 2023), and learning preference prediction (Y. Chen, 2025). The Hidden Markov Model (HMM) has excelled in note recognition and the solfeggio teaching method (Y. Chen & Zheng, 2023; Shen & Wu, 2023) and the application scenarios have been gradually diversified.

AI not only plays a role in classroom teaching (Guo & Tang, 2023; Lin, 2024), teaching resources recommendation (S. Chen, 2024; Zhao & Razzouk, 2024), assessment systems (Gao, 2023; Liu, 2024), and a flipped classroom (Lv, 2023) but it has also shown its potential in performance anxiety (N. Wang, 2024) and emotional expression training (J. Zhang et al., 2021). Third, there has been a profound transformation of the educational paradigm is taking place, shifting from a teacher-centered to a learner-centered approach, evolving from standardized instruction to personalized learning path recommendations, and expanding from knowledge transmission to competency development and emotional guidance (L. Zhang, 2025; Zheng et al., 2024; W. Zhou & Kim, 2024).

Multiple empirical studies have demonstrated the positive effects of AI in enhancing student learning efficiency, engagement, and musical creativity. For example, a CNN-based vocal learning framework has a high accuracy rate of 97.4% on vocal datasets (Cui & Chen, 2024). The DeepBach model has been shown to significantly improve students' motivation and ability in polyphonic music composition (Yuan, 2024). Students using ChatGPT-4 significantly outperform the traditional teaching model in terms of music knowledge mastery and learning experience (W. Zhou & Kim, 2024). Collaborative filtering algorithms have improved the accuracy of resource recommendations and student satisfaction (Cao & Tao, 2024; Zhao & Razzouk, 2024). The teaching assessment method based on Internet of Things (IoT) technologies and a multimodal perception system achieved an accuracy rate of 95.7% (Gao, 2023).

In addition, teaching platforms based on CNN, RNN, and other deep learning technologies can achieve high-accuracy music recognition and feedback (Y. Chen, 2025; Cui & Chen, 2024; Huang, 2024), and enhance the students' independent learning ability and personalized learning experience (Bai, 2024; Lin, 2024). The application of AI-based compositions and recommendation systems in music composition education has become increasingly mature. For example, programs such as KITS AI and the DeepBach model not only enhance students' creativity but also effectively improve their musical understanding and motivation (Yuan, 2024; L. Zhang, 2025). In addition, the introduction of fuzzy decision support systems and collaborative filtering algorithms has made content matching and resource recommendation more intelligent and refined (Cao & Tao, 2024; S. Chen, 2024; Zhao & Razzouk, 2024).

From the above literature review, it can be found that despite a large number of relevant research results, the field is currently facing the following deficiencies: firstly, the research perspectives are scattered, and the content is fragmented, lacking a comprehensive analysis of existing research trends. Secondly, there is an absence of systematic sorting regarding the subject area and types of technological usage of AI in music education within higher education. Thirdly, the research topics lack clear categorization, and the core themes have not yet been thoroughly identified. Fourthly, the exploration of future research agendas is insufficient with a lack of forward-looking reviews and systematic planning. These limitations make it difficult to provide a clear theoretical foundation and practical guidance for educational practice and academic research.

In response to these limitations, this study aimed to conduct a systematic review of AI use in music teaching in higher education, revealing its overall development trends, the subjects and varieties of AI employed, and the main research themes related to AI. This was as well as proposing future research agendas based on existing studies, thereby providing a clear knowledge map and theoretical support for subsequent academic exploration and teaching practice. This study addresses fragmented research and the lack of synthesized trends. Practically, it offers insights into curriculum design, teaching evaluation, and the application of technology in higher education music teaching, supporting the more effective integration of AI into practice.

Based on the above purpose, this study proposes the following research questions to systematically review the development of AI in music teaching in higher education, providing a clear map of its evolution for the academic community:

RQ1: What are the overall development trends of current AI usage in music teaching in higher education?
RQ2a. In music teaching in higher education, what subjects are being taught with the support of AI?
RQ2b. In music teaching in higher education, what types of AI are being applied?
RQ3: What are the main research themes of AI use in music teaching in higher education?
RQ4: What are the proposed future research agendas for AI use in music teaching in higher education?

2. Methodology

2.1 Research Design

To solve the above research questions, a systematic literature review (SLR) was conducted in this study. SLRs aim to minimize bias and enhance credibility and reproducibility by using a systematic screening approach to evaluate and map the current landscape and trends of a research area (Pati & Lorusso, 2017). In addition, an SLRs procedural design complements the empirical orientation of social science studies, serving effectively as a tool for assessing qualitative research through structured evaluation criteria (Deacon et al., 2023).

In practice, a standardized PRISMA procedure was first utilized in this study to screen for relevant literature (Moher et al., 2009; Özenç-Ira & Gültekin, 2023). PRISMA was chosen because its standardized review process helps clarify the research procedure and findings, thereby enhancing the transparency and overall quality of the study (Moher et al., 2009).

2.2 Search Strategy

As shown in Figure 1, the research process consisted of a systematic search strategy, a screening protocol, and a data synthesis procedure. These steps ensured a rigorous and replicable review process (Yang & Welch, 2023). In line with PRISMA guidelines, conducting an SLR generally involves utilizing no fewer than three databases to gather relevant literature (Moher et al., 2009). To ensure a comprehensive data collection, this study consulted earlier SLRs focused on educational technology (Luo et al., 2021; Radianti et al., 2020) and employed four key databases—EBSCO, Scopus, Web of Science, and ProQuest. These databases offer broad coverage of educational research journals, and their rigorous inclusion standards help ensure that the retrieved studies meet the methodological quality expected of SLRs.

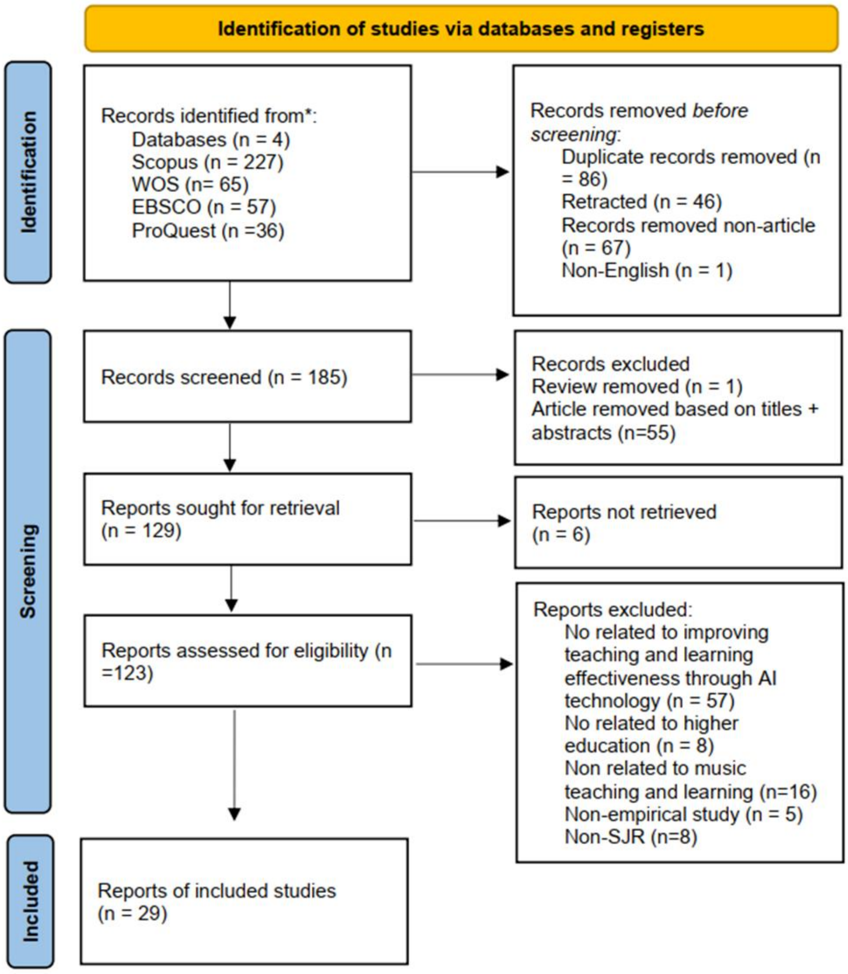

Figure 1: PRISMA flow chart for including studies to review

Regarding the search strategy, this study synthesized relevant research experiences from both AI and music education fields, designing a search plan based on commonly used keyword combinations (Table 1). For keyword configuration, the research team first linked AI and Music Teaching using the logical operator AND to ensure that the retrieval results encompassed both themes. Subsequently, Music Teaching was connected with Higher Education via AND forming the final retrieval strategy framework. Search fields were restricted to title, keywords, and abstract to enhance document relevance and precision.

To ensure the timeliness of the research, the search timeframe was set from April 1st, 2015, to April 1st, 2025, covering the latest research developments in AI within the field of music teaching in higher education over the past decade. All keywords were systematically combined using Boolean operators. Based on this strategy, the study retrieved the following articles from various databases: 65 from Web of Science, 227 from Scopus, 57 from EBSCO, and 36 from ProQuest. The 385 retrieved articles were imported into Zotero for unified management and subsequently exported to Microsoft Excel for preliminary organization and screening (Figure 1).

The search strategy employed in this study was designed in accordance with international systematic review standards regarding database selection, keyword configuration, and search scope. This ensured that the research remained focused on the intersection of AI and music teaching in higher education, providing a solid foundation for the subsequent literature screening and analysis.

Table 1: Database search strings and keywords used

AI	Operator	Music teaching	Operator	Higher education
(i.e., "artificial intelligence" OR "AI" OR "AIED" OR "machine learning" OR "intelligent tutoring system" OR "expert system" OR "recommended system" OR "recommendation system" OR "feedback system" OR "personalized learning" OR "adaptive learning" OR "prediction system" OR "student model" OR "learner model" OR "data mining" OR "learning analytics" OR "prediction model" OR "automated evaluation" OR "automated assessment" OR "robot" OR "virtual agent" OR "algorithm" OR "deep learning" OR "neural network" OR "reinforcement learning" OR "automatic")	AND	"music education" OR "musical pedagogies" OR "music teach* "(music teaching, music teacher. . .) OR "music course" OR "music class" OR "music curriculum"	AND	"Higher Education" OR "college" OR "academy" OR "higher vocational" OR "university".

2.3 Inclusion/Exclusion Criteria for Study

The initial search yielded a total of 385 records. After preliminary processing, 86 duplicate records across the databases, 46 retracted papers, 67 non-article sources (such as conference papers and books), and one non-English publication were excluded. Ultimately, 185 records were retained as the final candidate set. With the aim of this study to explore the use of AI in music teaching within higher education, the research team established clear inclusion and exclusion criteria (Table 2) to ensure the relevance and quality of the selected literature.

Subsequently, manual screening of titles and abstracts excluded 55 articles irrelevant to the topic and one review article, leaving 129 full-text articles. During this process, six articles were excluded due to inaccessibility of the full text, resulting in 123 articles included in the eligibility assessment. Based on the inclusion and exclusion criteria, further exclusions were made as follows: not related to improving teaching and learning effectiveness through AI technology (n = 57), not related to higher education (n = 8), not related to music teaching and learning (n = 16), and non-empirical study (n = 5). To further ensure the quality of the literature, this study also referred to the Scimago Journal Rank (SJR) indicator and excluded eight articles not indexed in this ranking. Here, 29 articles fully met the research criteria and were included in the quality assessment.

Table 2: Criteria used for selecting relevant studies

Inclusion criteria	Exclusion criteria
The literature concentrates on music teaching in higher education.	The literature does not focus on music teaching in higher education.
Research that explicitly addresses the use of AI technologies to improve teaching and learning effectiveness.	Research that does not explicitly involve AI technologies.
The literature adopts empirical research methods.	Literature is non-empirical research.
Published in English.	Not published in English.
Publications limited to journal articles.	Non-journal publications.
Appeared in SJR.	Articles not indexed in SJR.
The literature is available in full text.	The literature is not available in full text.

2.4 Quality Assessment

Quality assessment of the 29 articles was conducted in accordance with the principle of flexible adaptation proposed by Petticrew and Roberts (2006) and simplified in line with the research topic into three core dimensions: methodological rigor, relevance to the research questions, and reporting transparency and completeness (Table 3). Each dimension was comprised of two key evaluation indicators, rated on a three-level scale (High / Medium / Low). The scoring criteria and overall quality thresholds were defined as follows:
Dimension scoring: Both indicators rated as High → dimension rated High. High + Medium / High + Low / Medium + Medium → dimension rated Medium. Medium + Low or Low + Low → dimension rated Low.

The overall quality thresholds (for inclusion in analysis) were High: all dimensions rated High, or ≥2 dimensions High, with the remaining rated Medium (no Low allowed); Medium: ≥2 dimensions rated High/Medium with no more than one Low; and Low: not meeting the above criteria.

Table 3: Quality appraisal criteria

Dimension	Core indicators	Rating scale
1. Methodological Rigor	① Whether the research design and data analysis are scientifically sound and aligned with the research questions ② Whether the sample and data sources are appropriate	High / Medium / Low
2. Relevance to the Research Question	① Whether the study directly focuses on the theme of AI in university music education ② Whether the educational context and the type of technology are appropriately matched	High / Medium / Low
3. Transparency and Completeness of Reporting	① Whether the methods and results are clearly described and reproducible ② Whether the conclusions are supported by data and potential biases are disclosed	High / Medium / Low

The assessment was conducted independently by two experts, with a consensus reached through discussion. Only studies rated high or medium were retained for the subsequent analysis to ensure the scientific rigor and credibility of the review results. In total, 7 articles were classified as high quality and 22 as medium quality, yielding 29 articles included in the final analysis (Table 4). The specific scores are presented in Appendix 1.

2.5 Synthesis and Analysis of Results

This systematic review incorporated 29 studies (see Table 4). To systematically address the research questions, this study employed a multi-level analysis approach combining quantitative analysis with qualitative thematic analysis. To examine the overall development trends of AI in music teaching in higher education, this study adopted two complementary analytical approaches.

First, text analysis was conducted by extracting titles, abstracts, and keywords from all included studies and uploading them to Wordclouds.com for term frequency analysis and visualization, thereby identifying the overarching research trajectory. At the same time, bibliometric analysis was carried out by systematically recording the complete metadata (such as the authors, publication years, journal title, and first authors' country) in Microsoft Excel spreadsheets. Descriptive statistics and visualization techniques were then applied to reveal the distribution patterns, geographical trends, and temporal development trajectories.

To address the research questions concerning AI-supported subjects and the types of AI employed in music teaching in higher education, this study employed a systematic content analysis. Relevant data was extracted from the included studies and organized into a standardized Microsoft Excel template for statistical analysis, classification, and cross-comparison. Through this process, the analysis identified specific music subjects supported by AI, the types of AI used, and the effectiveness of AI in music teaching in higher education.

To identify the main research themes, this study followed the six-stage thematic analysis framework proposed by Braun and Clarke (2006). The process involved familiarization through repeated reading of all studies; hybrid inductive-deductive coding that combined established theoretical frameworks including the TPACK model, Technology Acceptance Model, and music education theory to establish broad coding categories as analytical starting points.

This simultaneously allowed new codes and themes to emerge naturally from the data without being constrained by preset frameworks through three-stage coding, comprising open coding without predetermined categories, theoretical dialogue with frameworks, and integrated synthesis, achieving inter-coder reliability of $\kappa = 0.87$. Theme generation through iterative pattern identification, a theme review for internal coherence and external distinctiveness, and precise theme definition resulted in five core themes, and a synthesis in the results presentation (Table 6). Building upon thematic analysis results, research gaps and future directions were examined through gap analysis, methodological assessment, recommendation synthesis, and trend projections to construct a comprehensive future research agenda.

Table 4: The final selection of articles for the review

Article No.	References	Year	Country	Final judgment
1	(Cui & Chen, 2024)	2024	China	High
2	(L. Zhang, 2025)	2025	China	Medium
3	(Guo & Tang, 2023)	2023	South Korea	High
4	(Lin, 2024)	2024	China	Medium
5	(Yuan, 2024)	2024	China	High
6	(Cao & Tao, 2024)	2024	China	Medium
7	(Y. Feng, 2023)	2023	China	High
8	(Zhao & Razzouk, 2024)	2024	China	Medium
9	(Y. Chen & Zheng, 2023)	2023	China	High
10	(Y. Wang, 2024)	2024	China	Medium
11	(W. Zhou & Kim, 2024)	2024	South Korea	Medium
12	(N. Wang, 2024)	2024	China	Medium
13	(Sui & Zhu, 2024)	2024	China	Medium
14	(Hui, 2023)	2023	China	Medium
15	(Y. Chen, 2025)	2025	China	Medium
16	(Lv, 2023)	2023	China	Medium
17	(P. Wang, 2025)	2025	China	Medium

18	(Huang, 2024)	2024	China	Medium
19	(Bai, 2024)	2024	China	Medium
20	(S. Chen, 2024)	2024	China	Medium
21	(Zheng et al., 2024)	2024	China	Medium
22	(Shen & Wu, 2023)	2023	China	High
23	(Wei et al., 2022)	2022	China	Medium
24	(Gao, 2023)	2023	China	Medium
25	(J. Zhang et al., 2021)	2021	China	High
26	(D. Feng, 2023)	2023	China	Medium
27	(H. Zhou, 2023)	2023	China	Medium
28	(Liu, 2024)	2024	China	Medium
29	(Li, 2024)	2024	China	Medium

3. Results

3.1 The Overall Development Trend of Current AI Usage in Music Teaching in Higher Education

To comprehensively present the development trend of this research field, this study carried out a systematic quantitative analysis based on the word frequency statistics and word cloud visualization results generated from the titles, abstracts, and keywords of the literature, as well as the distribution of publication year, the source of the selected journals, and the distribution of the authors by country.

3.1.1 Trends and cluster

To identify the research focus of AI usage in higher education music teaching, this study conducted a visualization analysis of the core literature keywords using a word cloud (Figure 2). The results indicate that the highest frequency terms are education, teaching, music, learning, and students, highlighting that research primarily focuses on music teaching and learning in higher education contexts. High-frequency terms such as artificial intelligence, technology, system, model, and algorithm suggest that a substantial body of research concentrates on the integration of AI system development, model applications, and algorithm optimization into teaching practices.

In addition, the prominence of terms such as performance, evaluation, neural network, data, and virtual, indicates that this field extensively employs neural networks, virtual reality (VR), and multimodal teaching technologies to enhance teaching effectiveness and student performance. In summary, the word cloud analysis reveals that current research trends favor the experimental design and data modelling in methodology, while focusing on the enhancement of teaching effectiveness and the optimization of the learning experience through AI empowerment in terms of content, providing directional guidance for future studies.

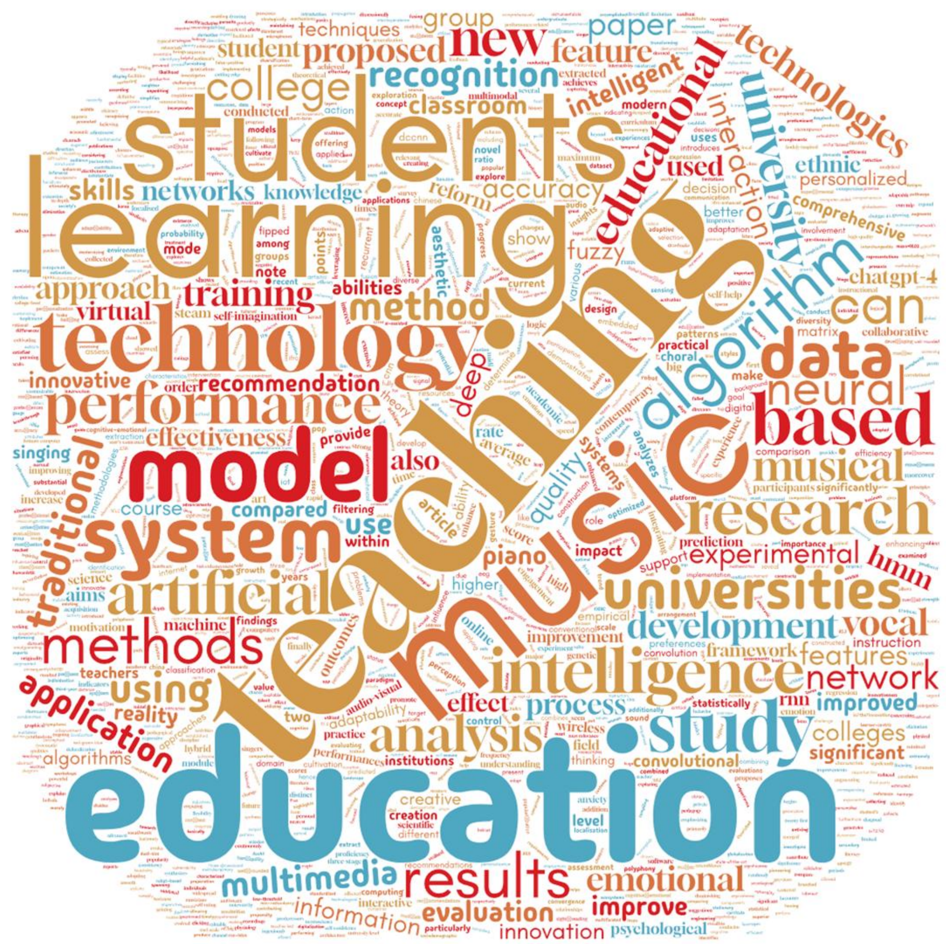

Figure 2: Most frequently used words

3.1.2 Year distribution

As shown in Figure 3, there were almost no studies on AI usage in music teaching in higher education from 2015 to 2020. Since 2021, research began to emerge with publications rising to 9 in 2023 and peaking at 15 in 2024. By mid-2025, 3 studies had already been published, suggesting a continued upward trend and indicating that AI has become a rapidly developing research hotspot in this field.

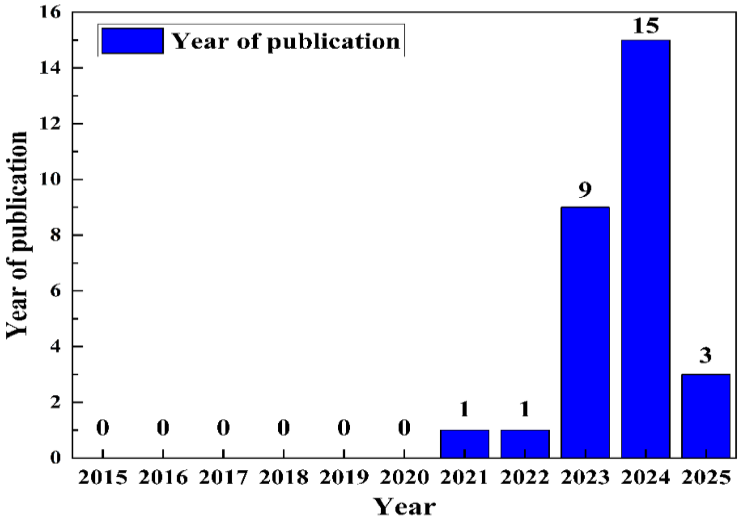

Figure 3: Publication year distribution of the selected articles

3.1.3 Countries and journals of publication

To assess national research productivity, the country of the first author's affiliation was used. As shown in Figure 4, China leads this field with 27 publications (93%), while South Korea contributes only 2 (7%). This reflects the substantial scholarly attention and resource commitment from Chinese researchers in this field and the limited international involvement, suggesting the need for broader global collaboration and cross-cultural studies.

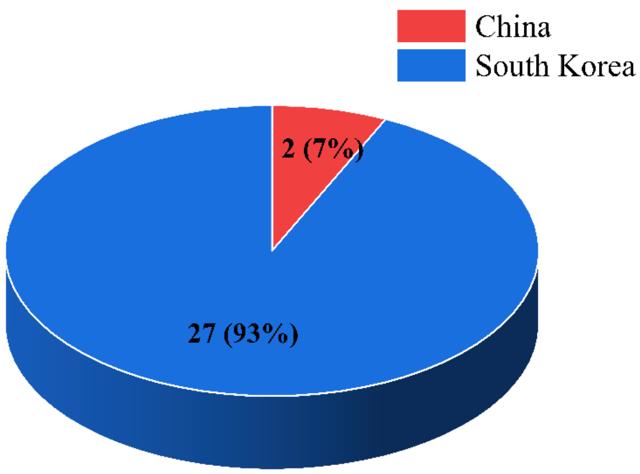

Figure 4: Distribution of research studies by country

As observed from Figure 5, journals publishing research on the use of AI in music teaching in higher education are mainly concentrated in the fields of educational technology, AI, computer science, and interdisciplinary areas. Among them, the International Journal of Web-Based Learning and Teaching Technologies has the highest number of publications, reflecting a research focus on the construction and evaluation of web-based and AI-supported teaching platforms. The appearance of technically oriented journals such as Soft Computing and

Intelligent Systems with Applications also indicates that intelligent algorithms, learning systems, and other technological means are widely used in these studies. Some research also touches on psychology and neuroscience, focusing on learning, motivation, and cognitive mechanisms. Overall, the field shows a clear trend of multidisciplinary integration, emphasizing the potential of AI technology to enhance the quality of music education and support personalized learning experiences.

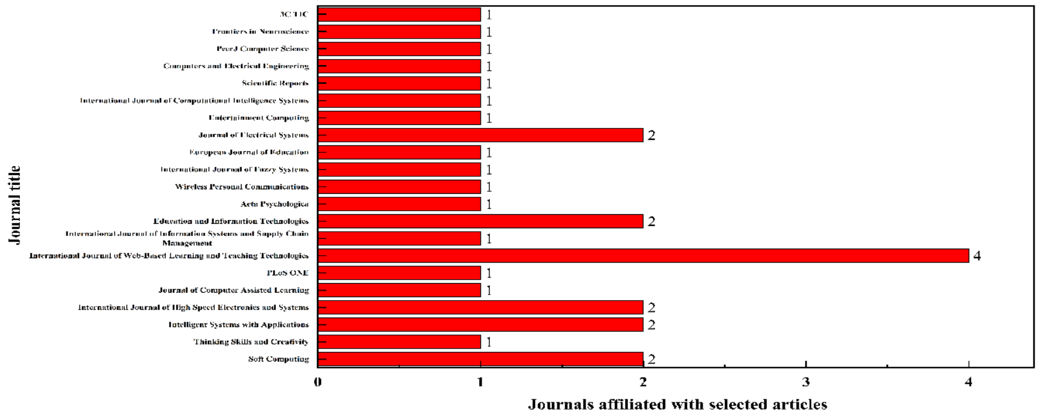

Figure 5: Journals affiliated with the selected articles

3.2 AI-based Music Teaching in Higher Education: Subjects, Types of AI Usage, and Effectiveness

3.2.1 Subjects of AI employed

As shown in Table 5, AI-assisted music instruction encompasses diverse subjects such as choral arts, vocal music teaching, the creation of polyphonic music, solo vocals, piano teaching, solfeggio teaching, instrumental music education, pop music teaching, and music education. This indicates that AI-enabled pedagogy is applicable across a broad spectrum of musical content without subject-matter constraints.

3.2.2 Types of AI usage and effectiveness

Currently, the main types of AI usage in this field（Table 5）mainly cover deep learning, machine learning, reinforcement learning, and the development and application of diverse AI tools. These tools range from third-party generation platforms (P. Wang, 2025) to self-built systems or platforms such as the Definitive Teaching Support System (DTSS) and the Music Education and Teaching based on AI (MET-AI) (S. Chen, 2024; Wei et al., 2022).

In this field, deep learning technology has demonstrated remarkable advantages. Through models such as CNN and RNN, it enables efficient feature extraction and pattern recognition from multimodal data, including music audio, images, and gestures, thereby enhancing the quality of music learning and teaching (Cui & Chen, 2024; Y. Feng, 2023; Gao, 2023; Huang, 2024). By integrating fuzzy decision systems, recommendation algorithms, and flipped classroom approaches, deep learning supports personalized learning and real-time feedback, meeting the diverse needs of students (Bai, 2024; Y. Chen, 2025; Lv, 2023). The integration of deep learning with AI, VR, and 6G technologies has not only enriched the instructional approaches and interaction models in music education but also significantly enhanced the students' learning motivation, creativity, and practical skills (Sui & Zhu, 2024; Yuan, 2024; L. Zhang, 2025; Zheng et al., 2024).

At the same time, methods such as the Multi-layer Residual Deep Convolutional Neural Network (MR-DCNN) model and the Back Propagation (BP) neural network optimized by an adaptive genetic algorithm (AGA-BP) have enabled the accurate evaluation and monitoring of teaching quality, providing a scientific and systematic quality assurance framework for music teaching in higher education (D. Feng, 2023; Guo & Tang, 2023). Overall, deep learning technology has driven the development of personalized, intelligent, and innovative higher education music programs, offering strong support for the transformation of future music education models.

Leveraging AI and machine learning technologies, the collaborative filtering (CF) algorithm has effectively achieved personalized recommendations and feedback in higher education music programs, significantly stimulating students' interest in learning and improving their academic performance (Cao & Tao, 2024). The HMM has enhanced the efficiency and accuracy of note recognition, supporting the development of musical skills (Y. Chen & Zheng, 2023; Shen & Wu, 2023).

Optimizing teaching methods through Intelligent Fuzzy Regression Classification (IFRC) technology not only generates personalized learning pathways but also provides real-time feedback for both students and teachers (Li, 2024). Additionally, AI methods such as fuzzy neural inference systems and particle swarm optimization have increased the accuracy and efficiency of piano teaching assessment (Liu, 2024). These studies demonstrate the multifaceted impact of machine learning on personalization, interactivity, innovation, and teaching quality in higher education music programs.

The integration of machine learning and deep learning is reflected in the use of embedded neural networks and deep affective vector modelling for the automatic classification of music styles and emotions, while machine learning techniques are further employed to analyze learning behaviors and interests, thereby optimizing personalized learning paths and feedback (Lin, 2024). Zhao and Razzouk (2024) improved the CF algorithm to address the sparse matrix problem and enhance recommendation effectiveness while introducing neural networks to process textual features of resources and establish user interest models, thereby achieving more precise personalized music resource recommendations.

Together, these approaches are driving the development of higher education music education toward greater intelligence, personalization, and emotional engagement. A reinforcement learning-driven cognitive-affective interaction model in pop music teaching has achieved personalized guidance and emotional resonance through emotion recognition, state assessment, and strategy optimization. This model has not only enhanced the quality of instructional interaction and student engagement but has also promoted the integration of traditional music culture with modern music education (H. Zhou, 2023).

The application of AI tools demonstrates a rich diversity of innovative approaches, including natural language processing (such as ChatGPT-4 (W. Zhou & Kim, 2024)), rule-based psychological intervention apps (such as Thrive (N. Wang, 2024), machine learning-driven personalized education applications (such as Musicfy and Stable Audio (P. Wang, 2025)), big data and fuzzy decision support systems (such as DTSS (S. Chen, 2024)) and fully AI-integrated teaching platforms (such as MET-AI (Wei et al., 2022)).

These tools have not only shown significant advantages in music knowledge acquisition, learning experiences, and instructional effectiveness (P. Wang, 2025; Wei et al., 2022; W. Zhou & Kim, 2024) but they have also played a positive role in reducing performance anxiety, enhancing adaptability, and supporting personalized learning (S. Chen, 2024; N. Wang, 2024). Challenges such as experiment duration, sample size, system compatibility, and long-term effectiveness have also been identified. Future research needs to explore pathways for the continuous optimization and innovation of AI technologies in music education.

Table 5: AI-based music teaching in higher education: subjects, usage types, and teaching effectiveness

Article No.	Music subjects	AI types	Teaching effectiveness
1	Vocal music teaching	Deep learning	Enhanced self-directed learning ability and the quality of music education.
2	Choral arts	Deep learning	Development of musical skills and creativity.
3	Vocal music teaching	Deep learning	Improved the accuracy of quality assessment.
4	Music education	Deep Learning + Machine learning	Achieved intelligent recommendations on teaching content and learning pathways.
5	Creation of polyphonic music	Deep learning	Enhancement of learning motivation, comprehensive competence, and professional competence.

Article No.	Music subjects	AI types	Teaching effectiveness
6	Music education	Machine learning	Personalized resource recommendation, academic feedback, and assessment.
7	Music education (piano teaching)	Deep learning	Enhanced the effectiveness and interactivity of music teaching.
8	Music education	Deep learning + Machine learning	Effectively recommend course resources to students, enhancing their learning interest and efficiency.
9	Music education	Machine learning	Improved the quality of music teaching and cultivated the students’ musical exploration ability and creativity.
10	Music education	Machine learning	Improved the students’ musical knowledge and promoted their overall development.
11	Music education	AI tool	Enhanced the students’ learning experience.
12	Solo vocals	AI tool	Alleviated the students’ music performance anxiety.
13	Music education	Deep learning	Effectively realize intelligent interaction between VR movements and music.
14	Ethnic music education	Deep learning	Effectively extract musical features to improve the students’ behavior and performance.
15	Music education	Deep learning	Improvements were achieved in musical

Article No.	Music subjects	AI types	Teaching effectiveness
			expressiveness, performance accuracy, teaching efficiency, and personalized recommendations.
16	Piano teaching	Deep learning	Providing personalized feedback and guidance improved the students' learning outcomes and engagement.
17	Music education	AI tool	Enhanced learning outcomes.
18	Music education	Deep learning	It enables an in-depth understanding of the rhythmic accuracy, dynamics, phrasing, and other expressive elements in university music performance courses.
19	Music education	Deep learning	Modelling based on the students' preferences helps teachers dynamically and promptly understand the types of music students enjoy.
20	Music education	AI tool	Enhanced the personalization of music teaching and provided students with a better learning experience.
21	Vocal music teaching	Deep learning	Enhanced the students' audiovisual aesthetic ability, learning confidence, and

Article No.	Music subjects	AI types	Teaching effectiveness
			learning efficiency.
22	Solfeggio teaching	Machine learning	Improved the efficiency and accuracy of note feature recognition.
23	Music education	AI tool	Improved the students' learning outcome rate, efficiency ratio, mean square error rate, accuracy, teaching performance analysis rate, false positive rate, true positive rate, and flexibility ratio.
24	Instrumental music education	Deep learning	Improved the accuracy of the music teaching assessment.
25	Vocal music teaching	Machine learning	Achieved effects in stimulating singers' emotions and enhancing emotional singing performance.
26	Music education	Deep learning	Improved the quality of music teaching and the students' learning interest.
27	Pop music teaching	Reinforcement learning	Enhanced the quality of the teaching interaction and student engagement.
28	Piano teaching	Machine learning	Improved the accuracy and efficiency of teaching effectiveness assessment.
29	Music education	Machine learning	Improvements were achieved in specific musical skills such as sight-singing,

Article No.	Music subjects	AI types	Teaching effectiveness
			aural training, and music theory comprehension.

Note. The AI type is based on the primary technologies adopted in research.

3.3 Research Themes on AI Usage in Music Teaching in Higher Education
Exploring the research themes within the field not only helps scholars grasp the current state of the research but also provides a basis for predicting future trends. Based on a systematic analysis of 29 articles, this study identified five main themes, as shown in Table 6.

Table 6: Research themes on AI usage in music teaching in higher education

Serial number	Research themes	Article numbers
1	AI-powered personalized learning and recommendation systems	1, 4, 6, 8, 10, 14, 15, 16, 17, 19, 20, 29
2	AI-powered evaluation and optimization models for music teaching quality	3, 9, 24, 22, 23, 28
3	Integration of AI with emotion and affect aspects in music education	12, 18, 25, 27
4	Multi-technology integrated teaching innovation	7, 13, 26
5	AI-enhanced learning motivation, professional skills, and creativity	2, 5, 11, 21

3.3.1 AI-powered personalized learning and recommendation systems
Against the backdrop of rapid digitalization in music teaching in higher education, AI-powered personalized learning and recommendation systems are becoming the core drivers of instructional innovation. Current research focuses on customized learning paths, optimized resource recommendations, behavioral modelling, and offering multidimensional solutions for differentiated instruction.

Firstly, deep learning-driven personalized path generation is replacing traditional uniform instructional designs. Cui and Chen (2024) developed a vocal music self-directed learning framework based on CNNs, which provides a customizable learning environment for music education and significantly enhances the students' learning ability and self-directed learning behavior. Similarly, Li (2024) designed a music education teaching system based on Intelligent Fuzzy Regression Classification (IFRC), which is used to predict learning performance and generate personalized learning paths and customized resource recommendations based on the students' characteristics and preferences.

Secondly, the intelligent evolution of recommendation systems is a key component in achieving personalized resource allocation. Traditional collaborative filtering (CF) algorithms have already been expanded and optimized in music teaching in higher education. Cao and Tao (2024) and Zhao and Razzouk (2024) introduced improved CF models, which significantly alleviated the recommendation sparsity problem and enhanced content matching accuracy and adaptability by reusing contextual information through a filtering paradigm and employing multi-label nesting and matrix dimensionality reduction techniques, respectively. Bai (2024) integrated the feature extraction capabilities of CNNs with user behavior data in the design of a music recommendation system, enhancing the personalization and adaptability of music recommendations.

Modelling learner interests has become a key strategy for enhancing the performance of recommendation algorithms. According to Hui (2023), RNNs are utilized to analyze the temporal characteristics of ethnic music, combined with Term Frequency–Inverse Document Frequency (TF-IDF) and cosine similarity to construct a user preference model, thereby enabling personalized music recommendations and improving the accuracy and adaptability of the recommendation system. S. Chen (2024) introduced a Definitive Teaching Support System, which is based on the students' interests and abilities and employs a fuzzy decision-making mechanism to identify the maximum level of adaptability achievable in personalized instruction.

In summary, the current practice of AI to promote personalized learning and recommender systems in music teaching in higher education presents a multi-layered evolutionary path from the intelligent distribution of content to predictive control of behavior. Existing research still faces the following problems: first, the adaptability of personalized systems in cross-cultural and localized environments has not been systematically evaluated. Second, there is a lack of data support for the long-term tracking of changes in students' learning paths, and third, the recommender system still has the problem of insufficient explanatory power in music learning for emotional expression. Future research needs to combine educational psychological variables, cross-modal data integration, and affective intelligence modelling to enhance the system's practicality, individual adaptability, and educational equity.

3.3.2 AI-powered evaluation and optimization models for music teaching quality

As AI becomes increasingly embedded in educational contexts, the teaching evaluation and feedback mechanism in music teaching in higher education is undergoing an intelligent transformation from experience-driven to data-driven, as well as including model optimization, multimodal fusion, and system integration. Studies have shown that the application of AI here not only greatly enhances the precision and effectiveness of instructional assessment but also offers structured assistance to continuously elevate the quality of music education via real-time feedback and personalized responses.

In terms of evaluation model optimization, the introduction of AI effectively makes up for the problems of strong subjectivity and fuzzy indicators in traditional evaluation methods. For example, Guo and Tang (2023) proposed an AGA-BP, which effectively improves the model's convergence speed and prediction accuracy, enabling a scientific evaluation of online vocal music teaching quality. Similarly, Liu (2024) confirmed that the fuzzy neural inference system outperforms the extreme learning machine and particle swarm optimization algorithm in predicting piano teaching outcomes. With its superior dynamic response capability, it is particularly well-suited for flexible instructional scenarios such as flipped classrooms, offering a more adaptive evaluation strategy for university music education.

Additionally, the development of multimodal perception technology has further expanded the dimension of music teaching evaluation. Gao (2023) constructed a multimodal evaluation system that integrates audio and motion data, utilizing Mel-scale frequency cepstral coefficients (MFCC), CNN, and OpenPose for feature extraction. Through a fully connected network, the system assesses the students' learning performance with an accuracy of 95.7%, significantly outperforming single-feature evaluation methods and enhancing the accuracy and objectivity of music teaching assessment.

At the level of system integration, the Music Education and Teaching based on AI (MET-AI) teaching system proposed by Wei et al. (2022) integrates indicators such as teaching performance, learning outcomes, and instructional flexibility to build an efficient and intelligent music education evaluation framework in a digital teaching environment. The empirical results demonstrate an evaluation accuracy of 95.3%, significantly outperforming traditional methods.

Current research has expanded from model-level optimization and perception-level integration to system-level integration, and has gradually formed an AI-driven intelligent assessment system for music teaching in higher education. This system not only strengthens the science and timeliness of teaching feedback but also provides a solid theoretical foundation and technical support for the precise and personalized development of music education in the future.

3.3.3 The integration of AI with emotional and affective aspects in music education

With the development of AI technology, the integrated application of emotion computing and emotion recognition in music teaching in higher education is gradually promoting the teaching paradigm from skill-centered to placing an equal emphasis on emotion and cognition. AI not only assumes the function of auxiliary recognition and feedback in music teaching but also shows new value in key links such as emotion regulation, affective expression, and feedback, as well as emotion elicitation.

According to N. Wang (2024), AI-based emotional management applications (such as Thrive) demonstrate significant effects in reducing negative cognitions, psychological vulnerability, and anxiety perception, showing particular value in alleviating music performance anxiety among university vocal students. This suggests that AI should not be regarded merely as a technological tool in music education but rather as an external extension of emotional regulation mechanisms.

In terms of affective expression and feedback, AI models have also been utilized to identify and analyze emotional characteristics in performances. For example, Huang (2024) proposed a system based on the Recurrent Neural Network–Long Short-Term Memory (RNN-LSTM) architecture which enables the capturing of temporal relationships, dynamics, and emotional style inherent in musical performances.

This emotion-centered computational approach significantly enhances the understanding of musical expressiveness and improves the effectiveness of performance feedback. H. Zhou (2023) developed a robot-based cognitive-affective interaction model that effectively analyses the students' emotional expression during singing, provides accurate feedback on their vocal techniques and emotional delivery, and thereby significantly enhances the quality of the instructional interaction and student engagement.

In terms of emotion elicitation. J. Zhang et al. (2021) found that VR training, combined with electroencephalography (EEG) data analysis and support vector machine (SVM) emotion classification technology, was more effective than traditional self-imagery methods in eliciting a range of student emotions and enhancing vocal emotional performance. Overall, the integration of AI into emotional and affective education is no longer confined to technological innovation; it has reshaped the approaches to emotional development in music education. Whether through psychological interventions, performance feedback, or interactive teaching systems, these technologies share a common goal of fostering a more human-centered, responsive, and emotionally-driven music learning ecosystem.

3.3.4 The multi-technology integrated teaching innovation

With the rapid integration of AI, immersive technology, and 6G wireless sensing technology, emerging interaction means such as VR, gesture recognition, and multimedia voice computing are gradually entering the music teaching scene in higher education, providing a brand-new path to build a more realistic, flexible, and efficient learning environment.

For example, Y. Feng (2023) constructed a virtual piano environment by integrating HTC Vive and Leap Motion as interactive hardware devices. The system's software framework incorporated Unity3D along with plug-ins such as SteamVR and Leap Motion. To ensure precise gesture detection, a Dual Channel Convolutional Neural Network (DCCNN) was utilized, achieving a static recognition accuracy of up to 98%, which greatly enhanced the students' interactive capabilities in virtual environments.

Sui and Zhu (2024) combined 6G wireless sensing technology with a Convolutional Neural Network - Multilayer Perceptron (CNN-MLP) model to develop a music intelligent interaction system based on action perception, demonstrating the potential of next-generation communication and sensing technologies in educational contexts. D. Feng (2023) focused on speech recognition tasks in multimedia music teaching, proposing a Multi-Resolution

Deep Convolutional Neural Network (MR-DCNN) model to optimize speech recognition performance and achieve excellent performance across multiple datasets.

Thus, the integration of AI and immersive technologies is driving the intelligent transformation of music education across multiple dimensions, from interaction recognition, and content processing (such as speech input recognition and emotion computation) to environment construction (such as VR immersive scenarios and 6G sensing interaction). This trend not only expands the boundaries of teaching media and spatial contexts but also provides solid technical support for improving teaching efficiency, enhancing the teacher-student interaction, and supporting differentiated teaching.

3.3.5 AI-enhanced learning motivation, professional skills, and creativity

AI has demonstrated significant potential in enhancing students' academic motivation, professional competence, and creativity. Studies have shown that the use of AI composition tools, such as DeepBach, enhances the students' academic motivation (Yuan, 2024), while KITS AI in choral arrangement effectively enhanced the students' professional skills and musical understanding (L. Zhang, 2025). In addition, the combination of deep learning and STEAM education not only improves the students' audio-visual aesthetics and confidence in learning but also stimulates interdisciplinary creativity (Zheng et al., 2024). AI-assisted learning is not only a technical support but also an important driving force to promote the transformation of music education from passive learning to active creativity.

3.4 The Future Research Agenda of AI Usage in Music Teaching in Higher Education

The application of AI in this field is gradually transforming from tool-assisted to in-depth integration, and it shows remarkable value in the dimensions of personalized learning, skill training, emotion regulation, and assessment feedback. To promote the sustainable development of this field, future research should deepen the system from the two paths of theoretical construction and practical innovation.

3.4.1 Theoretical level research agenda

a) Refining an AI-based music instruction model with multimodal perception and interactive capabilities

Music learning is characterized by highly integrated sensory and emotional interactions, encompassing a multidimensional experience that includes auditory, visual, kinesthetic, and affective components. Existing studies have developed multimodal sensing environments based on IoT technologies. However, these are still primarily centered on audio and motion data, with limited integration of real-time physiological and behavioral signals (Gao, 2023).

Future AI-powered music education models should incorporate a wider range of multimodal data—such as electroencephalography (EEG), audio inputs, facial expressions, and movement trajectories—to accurately capture learners' cognitive, emotional, and behavioral states. By leveraging advanced AI technologies including deep learning, computer vision, and emotion recognition, such systems can dynamically respond to the students' cognitive biases, emotional fluctuations, and performance postures, and offer personalized, data-driven feedback and guidance. At the theoretical level, a dynamic audio–visual–sensorimotor model should be developed, grounded in multimodal learning theory and affective computing, to better support the complex interactions involved in music learning.

b) Deepening the study of AI-based personalized learning mechanisms

In AI-enabled environments, personalized learning emphasizes a student-centered approach by modelling learning behaviors and interests to generate differentiated resources and pathways, thereby meeting learners' diverse needs in musical perception, learning pace, and interests (Bai, 2024; S. Chen, 2024). AI technologies offer critical capabilities to support differentiated instruction and dynamic adaptation in higher education music learning (Hui, 2023; Zhao & Razzouk, 2024).

Building on existing collaborative filtering and fuzzy inference systems (Cao & Tao, 2024; S. Chen, 2024), future research could explore how AI can analyze students' learning records, performance data, and skill profiles to recommend a particular practice repertoire, accompaniment materials, and compositional tasks aligned with their style and proficiency level. AI can also optimize learning paths by adjusting the content difficulty based on learner feedback and progress. Through voice recognition, emotion analysis, and behavioral prediction, intelligent systems can detect the students' emotional shifts and learning bottlenecks, assist teachers in adjusting instructional strategies, and enhance learning motivation and musical expressiveness, thus gradually establishing a personalized music learning mechanism that is data-driven, emotionally aware, and dynamically adaptive.

c) Optimizing AI-driven evaluation and feedback mechanisms

Formative feedback plays a pivotal role in achieving effective educational assessment outcomes (Schmulian & Coetzee, 2019), while the integration of technology into assessment practices can significantly improve students' learning performance throughout the evaluation and feedback process (Deeley, 2018). AI provides a wide space for the reconstruction of educational assessment and feedback mechanisms.

Currently, there are HMM algorithms and fuzzy neural systems applied to music skill recognition (Chen & Zheng, 2023; Liu, 2024) but there are still problems of delayed feedback and a single assessment dimension, making it difficult to comprehensively reflect the learning outcomes. Future research can focus on how AI can automatically analyze key parameters (such as intonation, rhythm, and emotional expression) in the students' performance, composition, and improvisation, generating multimodal and personalized feedback information to assist teachers in precise teaching interventions.

Additionally, the AI system also captures the students' emotional and cognitive states during music learning through voice recognition, emotion recognition, and natural language processing technologies, providing educators with multi-dimensional insights into learning performance. With the intelligent assessment platform and process tracking system, it is expected to realize the transformation from traditional static grading to dynamic, data-driven process evaluation, and promote music teaching in higher education towards a more accurate and feedback-oriented teaching mode.

d) Developing AI literacy and ethics in music teaching in higher education
With the widespread use of AI in education, ethical issues are becoming increasingly complex. AI-generated works often rely on existing styles, lacking innovation, which can lead to homogenization and a negative effect on musical diversity and creativity (Xiaoya, 2025). Excessive reliance may also weaken the students' independent thinking skills and diminish their attention to the aesthetic and emotional essence of music. At the same time, in the process of applying AI to learning, various difficulties are still emerging, particularly those related to ethics, data privacy, and reliance on technology (Ampo, Ayuban, et al., 2025; W. Zhou & Kim, 2024).

To cope with this trend, future research should construct an AI ethical practice framework in music education, clarify the boundaries between AI-assisted creation and the students' independent thinking, and regulate authorship and intellectual property rights in content generation. In addition, educators should guide students to develop AI literacy, cultivating a sound ethical perspective on AI, forming responsible usage habits, preventing misuse, and ensuring that the development of AI adheres to ethical standards and aligns with societal values.

Future research should adopt an interdisciplinary approach, combining music education, educational technology, and legal and ethical perspectives to explore how to appropriately guide the use of AI in various aspects of music education, such as composition, performance, and classroom interaction. In this way, while benefiting from the convenience brought in by AI, educational equity, originality, and ethical standards can still be upheld. This agenda also aligns with the United Nations Sustainable Development Goal 4, which emphasizes inclusive and equitable quality education (Ampo, Rullen, et al., 2025).

3.4.2 Practical level research agenda
a) Design AI-based tools or systems adapted to diverse instructional contexts
Existing studies have shown that AI can conduct multidimensional assessments of students through deep learning, image recognition, and voice characterization (Cui & Chen, 2024; Zheng et al., 2024) but there is still a lack of integrated systems that combine real-time feedback, individualized adaptation, and emotional guidance.

Future research should further develop AI tools or systems tailored to different teaching scenarios in music teaching in higher education. For example, pitch and rhythm correction tools based on CNN/RNN models can be designed, combined with SVM or emotion recognition modules, to build a comprehensive intelligent training platform covering the full cycle of singing–listening–evaluating–

adjusting to systematically enhance student skill development and emotional expression.

In addition, for ethnic music and intangible cultural heritage education, a localized AI platform should be developed based on RNNs (Hui, 2023), establishing music feature extraction, style matching, and an automatic generation model. As well as integrating multilingual corpora and traditional instrument sample resources, the platform can generate culturally contextualized teaching content, thereby supporting the educational reproduction and intergenerational transmission of intangible musical heritage.

b) To address the issues of cold start and algorithmic bias in data generalization and personalized recommendations

In personalized recommendation and intelligent path generation systems, one of the main challenges is the cold-start problem and data sparsity (Bai, 2024; Zhao & Razzouk, 2024). Zhao and Razzouk (2024) proposed an improved collaborative filtering algorithm based on matrix dimensionality reduction, which alleviates the data sparsity problem and improves recommendation accuracy to some extent. However, the authors also note that the model still faces limitations in cold-start handling and scalability. In scenarios lacking historical user behavior data or with uneven sample distributions, recommendation performance is also prone to degradation due to insufficient data (Bai, 2024).

To solve the above problems, future research should examine methods for utilizing non-annotated educational data, coping with cold-start challenges and system scalability limitations in recommendation models, investigating frameworks based on unsupervised pretraining techniques for representation learning, and further revealing hidden reasoning patterns and knowledge linkages within learning content (Zhao & Razzouk, 2024). In addition, strategies such as integrating transfer learning and meta-learning can be explored to improve the model's generalization ability in small-sample contexts. Helping the system build user profiles through teacher input or initial questionnaires can mitigate the adaptation delay caused by the cold-start problem, thus improving the accuracy and responsiveness of the recommendation strategies during the early stages of instruction.

c) Promoting multi-group adaptation: a triple perspective of student-faculty-administrator system optimization

The existing research focuses on the design of student-centered AI teaching systems, with less systematic attention paid to the teachers' needs when it comes to instructional collaboration and administrators' demands for teaching quality monitoring.

In the future, an adaptive system architecture for multi-role users should be constructed and differentiated interfaces and permission management mechanisms should be developed, enabling teachers to optimize instructional strategies based on student behavioral data. This is as well as allowing administrators to conduct course evaluations and decision-making based on the visualized teaching data generated by the platform. In addition, the system should enhance information flow and collaboration mechanisms among multiple roles, enabling teachers to promptly adjust their teaching plans based on real time student data, allowing administrators to monitor teaching operations in real time, thus achieving a closed-loop linkage from instructional implementation to quality monitoring.

4. Discussion

The findings show that the use of AI research in this field exhibits multiple trends of rapid growth, deepening technology integration, expanding application scenarios, and transforming educational paradigms, echoing the global issue of higher education responding to the challenges of digitization and promoting educational innovation.

Based on the analysis of 29 articles, this study provides a macro-level perspective on the development of AI-powered music teaching in higher education. Firstly, the overall research output has shown a notable upward trend, reflecting the continued interest and research enthusiasm of the academic community in relation to this topic. Research participation in this field based on country is uneven, with countries like China exhibiting robust scholarly vitality. The research also demonstrates clear characteristics of interdisciplinary integration. These trends collectively indicate that the field is experiencing strong development momentum and rich potential for multidimensional exploration, driven by technological advances and educational innovation.

Secondly, AI has been extensively utilized in a range of music-related subjects, including choral arts, vocal instruction, and piano teaching, indicating its strong adaptability within the field of music education (Yu et al., 2023). The types of applications mainly include deep learning, machine learning, reinforcement learning, as well as the development and implementation of diverse AI tools. This suggests that music education is evolving toward multidisciplinary integration and intelligent instruction (Konovalova et al., 2025).

In addition, the use of AI in music teaching in higher education presents five core research themes: personalized learning and recommender systems, intelligent technology-driven optimization and evaluation, the integration of AI with emotion and affect, multi-technology integrated teaching innovation, and AI-enhanced learning motivation, professional skills, and creativity. These themes reflect the evolutionary trend of AI technology from instrumental support to educational ecological reconstruction.

For example, deep learning models such as CNN, RNN, and HMM are widely used in vocal learning, movement recognition, and emotional feedback, which not only improve teaching efficiency and accuracy but also trigger changes in teaching concepts and practice paths (Cui & Chen, 2024; D. Feng, 2023; Gao, 2023). Meanwhile, the integration of emerging technologies such as VR, IoT, and emotional computing has further expanded the media forms and interaction methods of music education (Gao, 2023; Sui & Zhu, 2024; H. Zhou, 2023).

To promote the deep integration of AI and music education, theoretical exploration should emphasize the alignment of AI with fields such as educational psychology, cognitive science, and ethical norms. On the one hand, an intelligent teaching model with multimodal perception and real-time interaction capabilities should be constructed to accommodate the complex sensory and emotional interaction characteristics of music learning. On the other, AI-driven personalized learning mechanisms and formative evaluation approaches should be systematically explored, and a data-based dynamic feedback system should be developed. With the growing penetration of AI in pedagogical decision-making and creative support, establishing an AI literacy education system and an ethical practice framework for art education will become an essential and unavoidable issue (W. Zhou & Kim, 2024).

At the practical level, future research should focus on the contextualized development of AI educational products, the continuous optimization of algorithmic performance, and the construction of multi-role collaborative systems to promote the intelligent and systematic advancement of music teaching in higher education. Overall, the development of the future direction should emphasize the coordination and alignment of technology with educational goals, forming a joint force in multimodal intelligent construction, personalized optimization, process evaluation, and ethical norms to support the high quality and sustainable development of music education in the context of intelligence.

5. Implications of the Study

5.1 AI-Driven Transformations in Music Education Practice

AI is shifting from a marginal auxiliary tool to a key force deeply integrated into the entire teaching process. Its application spans various curriculum areas. By leveraging technologies such as deep learning, emotion recognition, IoT perception, and motion capture, AI has significantly enhanced teaching efficiency and student engagement. Building on this, AI is driving transformation in music teaching in higher education in three main areas.

First, there is the reconstruction of the teaching paradigm from teacher-centered to human-machine co-creation. Second is the development of personalized learning paths and multimodal feedback mechanisms, making the teaching process more intelligent and precise. Third is the extension of educational philosophy, prompting reflection on educational equity, creative ethics, and the essence of art amid technological interventions. Future music teaching in higher education should seek to establish a dynamic balance between technological integration, cognitive development, and cultural value guardianship, promoting the synergistic optimization of teaching concepts and practice systems, and realizing the dual enhancement of educational quality and humanism.

5.2 Implications for Future AI Research in Music Teaching in Higher Education

Although the application of AI in music teaching in higher education has achieved initial success, the existing studies still exhibit several limitations. First, theoretical construction remains underdeveloped, with most research focused on instrumental applications while lacking a systematic interpretation of the deeper relationship between technology and education. Second, insufficient attention has been given to the humanities, cultural appropriateness, and ethical considerations, which risks overlooking the core values of music education. Third, the research samples and scenarios are relatively homogeneous and should be expanded to include multicultural contexts and various types of institution to enhance broader applicability. Fourth, as teachers play a key role in technology integration (Eyles, 2018), greater attention should be directed in future studies toward teachers' attitudes, beliefs, competencies, and instructional practices, which constitute the key dimensions of effective teaching and learning.

In the future, the integration of AI and music education should emphasize interdisciplinary collaboration and technological innovation while remaining grounded in the humanistic essence and cultural mission of arts education, thus promoting the mutual advancement of educational practice and theoretical research. Overall, while the use of AI has significantly transformed traditional music teaching methods, its application remains in an early stage and still requires in-depth exploration to realize meaningful innovation and transformation in music teaching in higher education.

6. Conclusion

This study employs an SLR to review the development trends, application subjects, types, research themes, and future research agendas of AI in higher music education over the past decade. The current research primarily focuses on university teaching and learning scenarios, with methods favoring experimental design and data modelling, and content emphasizing improvements in teaching effectiveness and learning experiences through AI-enabled technologies. The number of publications has risen sharply since 2023, with China being the main contributor.

The journal distribution shows a clear trend for multidisciplinary integration, underscoring AI's potential to enhance music education quality and support personalized learning. Applications span vocal, instrumental, choral, polyphonic composition, and popular music, reflecting AI's interdisciplinary and pervasive influence. At the technological level, the adoption of deep learning, machine learning, reinforcement learning, and AI tools (e.g., ChatGPT-4, Thrive) has driven innovations in personalized learning, intelligent recommendations, teaching evaluations, emotion recognition, and multi-technology integration.

Core research themes include AI-powered personalized learning and recommendation systems, evaluation and optimization models for music teaching quality, the integration of AI with emotion and affect aspects in music education, multi-technology integrated teaching innovation, and AI-enhanced learning motivation, professional skills, and creativity. Future research should focus theoretically on constructing multimodal perception and dynamic interaction models, deepening personalized learning and feedback mechanisms, and strengthening ethical frameworks. In practice, the focus should be on developing AI tools for diverse teaching scenarios, addressing cold-start and algorithmic bias challenges, and promoting collaborative optimization across students, teachers, and administrators.

Overall, AI is accelerating the personalized, intelligent, and emotional transformation of university music education, offering strong support for innovative models and the reconstruction of learning ecosystems. Challenges remain regarding cross-cultural adaptability, long-term effectiveness, and ethical governance. Continued interdisciplinary collaboration and international comparative studies are essential for the sustainable development of this field.

7. Limitations of This Study and Future Research Perspectives

It should be acknowledged that the literature inclusion criteria and database search strategy adopted in this study may have led to the omission of some relevant studies, particularly due to the limited coverage of the non-English literature. Future research could further broaden the inclusion scope, enhance the language diversity, and integrate cross-domain databases to improve the comprehensiveness and representativeness of the findings. Adopting methodological approaches that combine meta-analysis with quantitative modelling may offer a more nuanced evidence base for research on AI and music teaching in higher education.

8. Conflict of Interest

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11. References

Ampo, W. M. G., Ayuban, A. R., Avellaneda, S. L. A., & Go, D. T. (2025). Exploring teachers' lived experiences in integrating ChatGPT in classroom practices. *International Journal of Education and Emerging Practices*, *1*(1), 17–28. https://doi.org/10.63236/injeep.1.1.2

Ampo, W. M. G., Rullen, M. S. M., Deguit, E. O., Perocho, R. V. & Romero, P. J. B. (2025). From traditional school to virtual classroom: Students lived experiences on blended learning implementation. *International Journal of Education and Emerging Practices, 1*(2), 1–15. https://doi.org/10.63236/injeep.1.2.1

Bai, H. (2024). Convolutional neural network and recommendation algorithm for the new model of college music education. *Entertainment Computing*, *48*, 100612. https://doi.org/10.1016/j.entcom.2023.100612

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Cao, H., & Tao, X. (2024). Research on the reform and innovation of college music teaching based on collaborative filtering algorithm. *International Journal of High-Speed Electronics and Systems*, 2540037. https://doi.org/10.1142/S0129156425400373

Chen, S. (2024). The application of big data and fuzzy decision support systems in the innovation of personalized music teaching in universities. *International Journal of Computational Intelligence Systems*, *17*(1), 215. https://doi.org/10.1007/s44196-024-00623-4

Chen, Y. (2025). Innovation of music teaching methods in universities based on fuzzy decision support systems and deep learning. *International Journal of Fuzzy Systems*. https://doi.org/10.1007/s40815-024-01925-7

Chen, Y., & Zheng, H. (2023). The application of HMM algorithm-based music notes feature recognition teaching in universities. *Intelligent Systems with Applications*, *20*, 200277. https://doi.org/10.1016/j.iswa.2023.200277

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

Deacon, B., Laufer, M., & Schäfer, L. O. (2023). Infusing educational technologies in the heart of the university—A systematic literature review from an organisational perspective. *British Journal of Educational Technology*, *54*(2), 441-466. https://doi.org/10.1111/bjet.13277

Deeley, S. J. (2018). Using technology to facilitate effective assessment for learning and feedback in higher education. *Assessment & evaluation in higher education*, *43*(3), 439-448. https://doi.org/10.1080/02602938.2017.1356906

Eyles, A. M. (2018). Teachers' perspectives about implementing ICT in music education. *Australian Journal of Teacher Education (Online)*, *43*(5), 110-131. https://doi.org/10.14221/ajte.2018v43n5.8

Feng, D. (2023). On the gains and losses of multimedia-assisted instruction technology in college music teaching practice. *International Journal of Web-Based Learning and Teaching Technologies*, *18*(2), 1–16. https://doi.org/10.4018/IJWLTT.330646

Feng, Y. (2023). Design and research of music teaching system based on virtual reality system in the context of education informatization. *PLOS One*, *18*(10), e0285331. https://doi.org/10.1371/journal.pone.0285331

Gao, Y. (2023). Application of multimodal perception scenario construction based on IoT technology in university music teaching. *PeerJ Computer Science*, *9*, e1602. https://doi.org/10.7717/peerj-cs.1602

Guo, Y., & Tang, Y. (2023). The assessment model of online vocal music teaching quality under the optimized DL model. *Intelligent Systems with Applications*, *20*, 200276. https://doi.org/10.1016/j.iswa.2023.200276

Huang, L. (2024). Learning Experience of University Music Course Based on Emotional Computing. *Journal of Electrical Systems* *20*(1), 313–325. https://doi.org/10.52783/jes.684

Hui, F. (2023). Transforming educational approaches by integrating ethnic music and ecosystems through RNN-based extraction. *Soft Computing*, *27*(24), 19143–19158. https://doi.org/10.1007/s00500-023-09329-9

Khojageldiyeva, M. E. q., Himmatova, N. P., & Panjiyeva, N. K. Q. (2022). The role of club activities in the development of students' musical abilities in general education schools. *Journal of Pedagogical Inventions and Practices, 10*, 13-15. https://zienjournals.com/index.php/jpip/article/view/2122

Konovalova, I., Breslavets, H., Riabukha, N., Polska, I., Shchepakin, V., & Roshchenko, O. (2025). The evolution of world music pedagogy in the information society. *BRAI*N. *Broad Research in Artificial Intelligence and Neuroscience, 16*(1 Sup1), 99-116. http://dx.doi.org/10.70594/brain/16.S1/9

Li, S. (2024). Intelligent Construction of University Music Education Teaching System Based on Artificial Intelligence Technology. *Journal of Electrical Systems*, *20*(3s), 530–539. https://doi.org/10.52783/jes.1326

Lin, P. H. (2024). Optimization of college music teaching mode based on embedded neural network. *International Journal of High-Speed Electronics and Systems*, 2540112. https://doi.org/10.1142/S0129156425401123

Liu, Y. (2024). Evaluation of Interactive College Piano Teaching's Effect Based on Artificial Intelligence Technology. *International Journal of Web-Based Learning and Teaching Technologies*, *19*(1), 1–16. https://doi.org/10.4018/IJWLTT.335079

Luo, H., Li, G., Feng, Q., Yang, Y., & Zuo, M. (2021). Virtual reality in K-12 and higher education: A systematic review of the literature from 2000 to 2019. *Journal of Computer Assisted Learning, 37*(3), 887–901. https://doi.org/10.1111/jcal.12538

Lv, H. Z. (2023). Innovative music education: Using an AI-based flipped classroom. *Education and Information Technologies*, *28*(11), 15301–15316. https://doi.org/10.1007/s10639-023-11835-0

McCarthy, J. (2007). From here to human-level AI. *Artificial Intelligence, 171*(18), 1174–1182. https://doi.org/10.1016/j.artint.2007.10.009

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Bmj*, *339.* https://doi.org/10.1136/bmj.b2535

Ng, D. T. K., Su, J., Leung, J. K. L., & Chu, S. K. W. (2024). Artificial intelligence (AI) literacy education in secondary schools: a review. *Interactive Learning Environments*, *32*(10), 6204-6224. https://doi.org/10.1080/10494820.2023.2255228

Özenç-Ira, G., & Gültekin, M. (2023). Making interdisciplinary connections through music: A systematic review of studies in general schooling context in Turkey. *International Journal of Music Education*, *41*(4), 631-650. https://doi.org/10.1177/02557614221137867

Pati, D., & Lorusso, L. N. (2017). How to write a systematic review of literature. *HERD: Health Environments Research & Design Journal, 11*(1), 15–30. https://doi.org/10.1177/1937586717747384

Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social sciences: A practical guide*. Blackwell Publishing. https://doi.org/10.1002/9780470754887

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & education*, *147*, 103778. https://doi.org/10.1016/j.compedu.2019.103778

Sánchez-Jara, J. F. M., González Gutiérrez, S., Cruz Rodríguez, J., & Syroyid Syroyid, B. (2024). Artificial Intelligence-Assisted Music Education: A Critical Synthesis of Challenges and Opportunities. *Education Sciences*, *14*(11), 1171. https://doi.org/10.3390/educsci14111171

Schmulian, A., & Coetzee, S. A. (2019). Students' experience of team assessment with immediate feedback in a large accounting class. *Assessment & Evaluation in Higher Education*, *44*(4), 516-532. https://doi.org/10.1080/02602938.2018.1522295

Shen, S., & Wu, K. (2023). Solfeggio teaching method based on MIDI technology in the background of digital music teaching. *International Journal of Web-Based Learning and Teaching Technologies*, *18*(1), 1–18. https://doi.org/10.4018/IJWLTT.331085

Sui, X., & Zhu, Y. (2024). Implementing VR action and music intelligent interaction based on 6G wireless sensing technology. *Wireless Personal Communications*. https://doi.org/10.1007/s11277-024-11221-0

Wang, N. (2024). The role of psychotherapy apps during teaching solo vocals: The specifics of students' psychological preparation for performing in front of an audience. *Acta Psychologica*, *249*, 104417. https://doi.org/10.1016/j.actpsy.2024.104417

Wang, P. (2025). Leveraging AI and machine learning to personalise music education. *European Journal of Education*, *60*(1), e12916. https://doi.org/10.1111/ejed.12916

Wang, Y. (2024). Influence of the development of internet big data on college students' music education. *International Journal of Information Systems and Supply Chain Management*, *17*(1), 1–17. https://doi.org/10.4018/IJISSCM.343260

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

Xiaoya, Z. (2025). Analysing the role and impact of AIGC on the process of music creation and dissemination. *Al-Noor Journal for Digital Media Studies*, *1*(1), 151-162. https://doi.org/10.69513/jnfdms.v1.i1.en11

Yang, Y., & Welch, G. (2023). A systematic literature review of Chinese music education studies during 2007 to 2019. *International Journal of Music Education*, *41*(2), 175-198. https://doi.org/10.1177/02557614221096150

Yu, X., Ma, N., Zheng, L., Wang, L., & Wang, K. (2023). Developments and applications of artificial intelligence in music education. *Technologies*, *11*(2), 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

Zhang, J., Xu, Z., Zhou, Y., Wang, P., Fu, P., Xu, X., & Zhang, D. (2021). An empirical comparative study on the two methods of eliciting singers' emotions in singing: Self-imagination and VR training. *Frontiers in Neuroscience*, *15*, 693468. https://doi.org/10.3389/fnins.2021.693468

Zhang, L. (2025). Compositional tools based on artificial intelligence for choral artistic education: Enhancing creative skills in choral arrangements. *Thinking Skills and Creativity*, *56*, 101768. https://doi.org/10.1016/j.tsc.2025.101768

Zhao, B., & Razzouk, R. (2024). The Growth of Contemporary Music Subject and the Reform of Music Teaching in Universities. *International Journal of Web-Based Learning and Teaching Technologies*, *19*(1), 1–15. https://doi.org/10.4018/IJWLTT.338362

Zheng, J., Zhang, Y., & Zhang, S. (2024). Audio-visual aesthetic teaching methods in college students' vocal music teaching by deep learning. *Scientific Reports*, *14*(1), 29386. https://doi.org/10.1038/s41598-024-80640-7

Zhou, H. (2023). Innovation of college pop music teaching in traditional music culture based on robot cognitive-emotional interaction model. *3C TIC: Cuadernos De Desarrollo Aplicados a Las TIC*, *12*(1), 200–220. https://doi.org/10.17993/3ctic.2023.121.200-220

Zhou, W., & Kim, Y. (2024). Innovative music education: An empirical assessment of ChatGPT-4's impact on student learning experiences. *Education and Information Technologies*, *29*(16), 20855–20881. https://doi.org/10.1007/s10639-024-12705-z

Appendix 1

Appendix 1: The results of the quality appraisal

Article No.	Methodological rigor-1	Methodological rigor-2	Relevance-1	Relevance-2	Transparency-1	Transparency-2	Final judgment
1	High	High	High	High	High	Medium	High
2	Medium	Medium	High	High	Medium	Medium	Medium
3	High	High	High	High	High	High	High
4	Medium	Medium	High	Medium	Medium	Medium	Medium
5	High	Medium	High	High	High	High	High
6	Medium	Medium	High	High	Medium	Medium	Medium
7	High	High	High	High	High	High	High
8	High	Medium	High	High	Medium	High	Medium
9	High	Medium	High	High	High	High	High
10	Medium	Medium	High	High	Medium	High	Medium
11	High	Medium	High	High	Medium	Medium	Medium
12	Medium	Medium	High	High	Medium	Medium	Medium
13	Medium	Low	High	Medium	Medium	Medium	Medium
14	High	Medium	High	High	High	Medium	Medium
15	High	Medium	High	High	High	Medium	Medium
16	Medium	Medium	High	High	Medium	Medium	Medium
17	Medium	Medium	High	High	Medium	Medium	Medium
18	Medium	Medium	Medium	Medium	High	High	Medium
19	Medium	Medium	Medium	Medium	High	High	Medium
20	Medium	Medium	High	High	Medium	Medium	Medium
21	Medium	Medium	High	High	Medium	Medium	Medium
22	High	High	High	High	High	Medium	High
23	Medium	Medium	High	High	Medium	Medium	Medium
24	Medium	Medium	High	High	Medium	Medium	Medium
25	High	Medium	High	High	High	High	High
26	Medium	Medium	Medium	Medium	Medium	Medium	Medium
27	Medium	Medium	High	High	Medium	Medium	Medium
28	High	Medium	High	High	Medium	Medium	Medium
29	High	Medium	High	High	High	Medium	Medium