



Research on an Artificial Intelligence–Enabled Music Education System: A Case Study of China

Rendao Yu¹ Min Xu^{2,*}

¹ Instrumental Music Teaching and Research Department, Institute of Music and Dance, Jiangxi Institute of Science and Technology, Nanchang, Jiangxi, 330098, China

² Piano Department, School of Music, Jiangxi Normal University
No.99 Ziyang Avenue, Nanchang, Jiangxi 330022, China

SUMMARY: *In response to the current issues in music education, this study proposes a research framework for an AI-driven music education system. Given the application of AI technology in music education, an AI-based music education system has been designed. With the support of relevant literature, evaluation indicators for the music education system have been determined. At this level, the Analytic Hierarchy Process (AHP), Entropy Weight Method, and Fuzzy Comprehensive Evaluation Method have been employed to complete the design of the music education system evaluation scheme. Data for this study was collected through a questionnaire survey, and a quantitative analysis of the music education system was conducted. The results showed that the evaluation values of all indicators in the music education system under the AI technology framework were greater than 3 and less than 4, indicating that the construction of the music education system under the AI technology framework at this institution is in good condition. Further improvements in the integration of AI and music education can be made to enhance the level of music education at higher education institutions.*

KEYWORDS: *Analytic Hierarchy Process; Entropy Weight Method; Fuzzy Comprehensive Evaluation Method; Music Education System; Artificial Intelligence Technology*

1 Introduction

In the context of the information age of the 21st century, the rapid development of artificial intelligence (AI) is influencing our lives and work in unprecedented ways. The field of education is also undergoing this wave of change, particularly in music education [1, 2]. The introduction of AI technology has not only driven innovation in teaching methods but also provided new opportunities to improve teaching quality and efficiency. The application of these technologies is gradually shifting from the theoretical research stage to concrete practical applications, driving a series of revolutionary changes in the field of music education [3].

As a high-tech field, AI first appeared in music education in the 1960s [4]. At that time, developed countries around the world applied this technology to electronic keyboard instruments, developing electronic synthesizers with certain intelligent functions. These devices could not only store and play the sounds of various instruments but also change sounds on the fly, and they had the advantage of being compact and easy to carry [5]. During subsequent educational applications, music educators recognized and experienced the advantages and

*13811079027@126.com

<https://doi.org/10.65102/is20261044>

significance of electronic synthesizers in music education, leading to their adoption in the field of music education. The aim was to provide greater convenience for implementing collective music teaching models in music classrooms [6]. By leveraging their intelligent functions to transform the long-standing single-mode teaching approach, classroom atmospheres became more vibrant, and students' proactive learning attitudes were enhanced [7]. At the time, educators adopted an exploratory attitude toward this instrument in teaching, marking an early application of intelligent technology in the field of music education [8].

With the deep integration of technology and education, music education has also undergone new transformations. Wei, J., et al. conducted a study on the application of artificial intelligence technology in music composition education, finding that it can support personalized learning models, improve teaching systems, and enhance students' abilities and interests, thereby driving the modernization of music education [9]. Sánchez-Jara et al. noted that AI technology has a dual impact on improving music education systems, presenting both challenges and opportunities. The opportunities lie in improving teaching models through personalized learning, composition assistance tools, and interactive systems [10]. Yu, X, and others systematically summarized the application of artificial intelligence in music education, highlighting its advantages in enriching classroom resources, expanding the variety of intelligent instruments, and improving teaching techniques, thereby driving the development of the music education industry [11]. In summary, the application of artificial intelligence technology in music education has gradually become a trend. It not only enables students to learn in a more personalized and intelligent environment, but also expands teaching methods, enriches teaching forms, and improves classroom efficiency and quality.

The application of artificial intelligence in education has produced intelligent teaching systems (ITS) in its early stages [12]. The primary form of combining artificial intelligence technology with music education is the intelligent teaching system, which is also the current main research direction for relevant scholars. For example, Chen, Y, and Sun, Y utilized the Transformer model from artificial intelligence technology to construct a music composition system, finding that the use of this system could enhance students' musical technical and emotional expression abilities, as well as their satisfaction during the music education process [13]. Zhang, C developed a music composition system based on an AI model for the folk music domain, providing students with a new method for creating and learning folk songs with ethnic characteristics. This system also holds significant implications for music education and cultural heritage preservation [14]. Yin, L, and Guo, R investigated the effectiveness of an AI-based interactive learning environment (AIVA intelligent teaching system) in music education. The study found that the AIVA intelligent teaching system is more effective than traditional lecture-based teaching methods [15]. Wang, X developed a vocal education system for music majors using AI technology. Empirical research found that 82% of students preferred using this system for vocal instruction [16].

Traditional composition theory is a modular teaching system, such as harmony, texture, and musical phrase structure. Music AI not only simulates this teaching system but also possesses efficient, independent, and powerful composition computational capabilities. For example, Kwiecień, J., et al. explored the design and implementation of a hybrid AI system for automatic music generation, combining traditional methods with AI methods to generate sheet music and recordings in specific styles. For students with some compositional ability, this system can trigger their creative inspiration [17]. Ting, C, and others proposed a new automatic composition system called PIEC, which uses AI technology to generate music that mimics human intelligence and replicates the melodic features of sample pieces [18]. Hagan's, K specifically introduced the research on "musical interactivity in human-AI collaboration," showcasing numerous music works of different styles. These works demonstrate the expanding

role of AI in music composition, transcending traditional musical boundaries [19].

In addition to AI technology, researchers analyzed the feasibility of various technologies in transforming music teaching models and the advantages and disadvantages of current technologies from different technical perspectives to better promote the development of music education. de Souza, R. C., based on the unique context of the COVID-19 pandemic, argues that online education is not merely a product of the pandemic. Each technological revolution has impacted the music industry and, by extension, music education. How to leverage technological advancements to improve students' learning methods in diverse environments has become an essential skill for educators [20]. Baratè, A., et al. analyzed the advantages of 5G technology in their research, arguing that 5G technology will bring about significant changes in music education, enabling multi-level music instruction to meet the needs of diverse learners [21]. Ventura, M. D. analyzed the application of WhatsApp in music education, pointing out that new technology is not the goal but a means. Teachers can use technological tools to promote the construction of shared knowledge, interaction with information content, and the customization of learning paths and strategies, as well as active and creative learning across different disciplines [22]. In summary, we have reason to believe that as related technologies continue to advance and mature, an increasing number of teachers will begin to consider how to integrate emerging technologies such as artificial intelligence and virtual reality into music composition and sound structure. However, while artificial intelligence technology offers immense potential and opportunities for music education, it also has certain limitations. For example, how to ensure the widespread adoption and fairness of technology [23], how to avoid overreliance on technology [24], and how to strike a balance between technology and humanities [25]. These issues require educators, researchers, and technology developers to address and resolve them collectively, which is also the starting point of this study.

Taking the value of combining artificial intelligence with music education as the entry point for this study, we summarize the application of artificial intelligence technology in the music education system from three different aspects. Additionally, to improve the interaction between artificial intelligence technology and the music education system, we design a music education system based on artificial intelligence technology. Under the influence of the analytic hierarchy process, entropy weight method, fuzzy comprehensive evaluation method, and evaluation indicator system, an assessment of the AI-driven music education system is conducted, aiming to enhance the level of music education in higher education institutions and students' musical literacy.

2 Artificial Intelligence Driving the Development of Music Education

2.1 The Value of Combining Artificial Intelligence and Music Education

2.1.1 Improving students' musical abilities

Music education, as an important means of cultivating students' aesthetic and creative abilities, has achieved certain accomplishments in recent years. However, it still faces issues of regional development and imbalance in teaching resources, which have become key factors hindering the balanced development of music education. On the one hand, due to geographical location and economic conditions, students in some remote areas have almost no opportunity to access advanced music teaching equipment and facilities, nor do they receive guidance from experienced professional music teachers. This results in their music education remaining at a

relatively basic level. On the other hand, while urban areas have relatively abundant music education resources, this also presents new challenges. Students often face the dilemma of having to choose among numerous music courses and teachers, which to some extent increases their academic pressure. The development and widespread application of artificial intelligence (AI) technology have brought new opportunities for music education. Through AI-powered information platforms, students can access a wealth of diverse music education resources. Additionally, AI technology can analyze students' learning data and interests, automatically recommending suitable courses and teachers, and providing personalized learning plans. This not only stimulates students' proactive learning but also enhances their overall music proficiency.

2.1.2 Promoting the integration of music resources

The application of artificial intelligence technology is profoundly transforming the teaching models and learning methods in music education. For example, teachers and students can utilize AI-powered information platforms to quickly access the necessary music resources. Additionally, by adopting digital storage methods, these resources become easier to manage, transport, and use. This not only facilitates the dissemination and sharing of knowledge but also enhances teachers' lesson preparation efficiency and students' access to learning resources. In the future, music learning resources will be presented to students in more optimized forms. For example, through virtual reality technology, students can immerse themselves in the atmosphere of a live concert. Through intelligent analysis systems, students can receive real-time evaluations of their singing or playing, enabling them to adjust their learning progress and methods in a targeted manner. Take the “Central Music Online” learning app developed by the Central Conservatory of Music as an example. This platform integrates China's top-notch music education resources, allowing both beginners and seasoned enthusiasts to find suitable learning resources and courses to enhance their musical literacy and skills.

2.1.3 Improving teachers' teaching standards

In the field of music education, the introduction of artificial intelligence technology has not only greatly enriched the content and forms of music education but has also had a profound impact on traditional teaching methods and systems, leading to a healthy competitive landscape in the field of music education. Against this backdrop, music teachers are also facing new requirements and challenges. Some teachers may struggle to keep pace with educational reforms due to their inability to adapt to new technologies or provide up-to-date teaching content. For outstanding teachers, however, artificial intelligence technology can provide more opportunities for development and further enhance their teaching standards. Take the “Aiyue She” app and the Central Conservatory of Music's remote teaching platform as examples. These platforms offer teachers an online learning environment where they can access the latest teaching concepts, engage in professional exchanges with peers, and continuously expand their knowledge base, thereby driving the sustained development of music education.

2.2 Application of Artificial Intelligence Technology in Music Education Systems

2.2.1 Building a personalized learning platform

An AI-based music education platform can provide students with customized courses, including targeted music theory learning, instrument practice, and Q&A sessions. It can accurately analyze individual strengths and weaknesses, thereby enhancing strengths, addressing

weaknesses, and increasing the proactivity and targeting of learning. Additionally, by analyzing students' learning data through the platform, teachers can promptly understand students' learning progress and adjust teaching content, focus areas, and methods accordingly. This not only improves teaching efficiency and effectiveness but also enhances teacher-student interaction and communication. The learning platform simulates real-world music learning scenarios, providing students with diverse music practice opportunities. This immersive learning experience effectively stimulates learning interest, rapidly improves students' musical literacy, and also helps enhance their teamwork and innovation skills.

2.2.2 Intelligent Music Creation Assistance

In the digital age, AI-assisted music creation models are becoming increasingly widespread. Currently, music creation tools integrated with AI technology are being launched, providing teachers and students with user-friendly creation environments and abundant music resources. Through these platforms, users can not only view platform suggestions in real time but also modify and refine their work according to their own preferences, making their creations more personalized. Advanced technology not only provides students with new avenues for exploring music creation but also serves as a valuable teaching tool for music educators. AI-assisted music creation models enable students to master music theory, harmony techniques, and compositional structure more effectively and efficiently, thereby stimulating their creativity and imagination.

2.2.3 Automatic assessment and feedback effectiveness

Using advanced audio analysis technology, the AI-powered automatic assessment and feedback system can accurately capture the details of students' performances, precisely analyze their performance levels, provide timely evaluations of their progress, and offer improvement suggestions based on the quality of their performances. This helps students master skills more effectively and optimize their learning outcomes. This instant feedback mechanism helps students improve their understanding of their own performances, quickly identify mistakes, and accelerate their learning process. Additionally, the system supports long-term tracking and analysis of students' performance data, enabling teachers to gain a comprehensive understanding of each student's learning status, including their strengths, weaknesses, and learning habits. This provides more precise guidance and support for assessing students' learning progress and outcomes, as well as refining teaching plans. This data-driven teaching approach not only makes instructional activities more targeted but also provides a basis for optimizing the allocation of educational resources.

2.3 Building an AI-based music education system

As a unique educational discipline, music courses play an irreplaceable role in both formal and informal learning environments within schools. As China strives to achieve a moderately prosperous society, the public's aspirations for spiritual enrichment continue to rise, and the nation's demand for talent grows increasingly stringent. Music not only cultivates emotional refinement but also promotes the comprehensive development of talent in the new era. As described above, the author has discovered that the application of artificial intelligence technology in the music education system can be achieved by designing a music education system based on artificial intelligence technology, enabling students to receive a musical education in a relaxed and enjoyable classroom environment.

2.3.1 Optimizing the allocation of public music course resources

With the development of artificial intelligence technology, smart devices have been widely applied in music education at universities, such as smart instruments and application software, playing a significant role in modern university music education. "Smart instruments are musical instruments that integrate computer, sensor, and controller technologies. They can connect and interact with smart devices to provide more intelligent and personalized music performance and creation experiences. "Smart instruments, equipped with built-in sensors and controllers, can achieve more precise control and processing of musical effects, helping students master musical techniques with ease. They can also use built-in programs to reinterpret traditional music, thereby stimulating students' innovative thinking. Currently, the primary smart instruments used in university music education include smart pianos, smart guitars, and smart drum sets, offering students a more diverse and personalized music learning experience.

2.3.2 Optimizing the music education assessment system

The teaching evaluation mechanism plays a crucial role in assessing the effectiveness of higher education, enabling evaluations of students' learning progress and teachers' instructional outcomes. Based on these evaluation results, course curricula can be optimized to further enhance students' learning efficiency. In traditional music education evaluation systems, assessments primarily focused on students' classroom performance and academic achievements, relying on the subjective judgments of instructors and students themselves, often lacking objectivity and comprehensiveness. The application of artificial intelligence, however, can provide more reliable support for music education. Through technologies such as image recognition, sheet music speech recognition, and gesture and facial expression recognition, real-time data on students' performance in music theory courses, vocal or instrumental performance, and music composition can be collected and analyzed. This helps teachers assess students' learning outcomes, learning status, and learning abilities more quickly and objectively, accurately identify their strengths and weaknesses, thereby enhancing teachers' ability for instructional reflection and summarization, and enabling the development of more rational and personalized teaching arrangements and schedules to improve music education quality. Additionally, artificial intelligence technologies related to music evaluation mechanisms require ongoing in-depth research and algorithm optimization. Regarding how to overcome challenges in natural language understanding within music learning, collaboration between music education experts and professionals in the artificial intelligence field is essential to explore and innovate. Through regular evaluations, public music education can be promoted and developed, with evaluation driving improvement.

3 Designing an evaluation scheme for the music education system

In order to further understand the practical application effectiveness of AI-driven music education systems, an evaluation plan for music education systems in the context of AI was developed based on relevant literature and theoretical support from the analytic hierarchy process and entropy weight method. The specific design details are as follows:

3.1 Building an evaluation indicator system

When evaluating music education systems in the context of artificial intelligence, a comprehensive assessment should be conducted from four aspects: the school's music education

system, curriculum system, teaching staff, and extracurricular music activities. Ultimately, an evaluation index system for music education in the context of artificial intelligence was constructed. The evaluation index system is shown in Table 1, which consists of four first-level indicators and 15 second-level indicators.

Table 1: Evaluation index system

Theme	First-level indicator	Symbol	Secondary indicators	Symbol
Artificial intelligence drives the music education system	Music education system	A1	The proportion of music courses	A11
			The establishment of special funds for art	A12
			Talent introduction	A13
			Professional title evaluation	A14
	Music curriculum system	A2	Basic theory of music	A21
			Musical skills	A22
			Musical quality	A23
			Imagination	A24
			Creativity	A25
	Construction of the teaching staff	A3	Teacher's Morality	A31
			Teachers' musical literacy	A32
			Teacher size	A33
			Teaching staff	A34
	Extracurricular music activities	A4	The development of art activities	A41
			The participation of students in social practice	A42

3.2 Calculation of indicator weights

3.2.1 Hierarchical Analysis Method

The Analytic Hierarchy Process (AHP) involves a thorough analysis of a system or object with a complex, multi-level structure, breaking it down layer by layer to ultimately form a multi-level, multi-dimensional goal structure diagram. This structure can be divided into three layers from shallow to deep: the goal layer, the criterion layer, and the alternative layer [26]. The final solution layer includes several interconnected and interacting factors. Through pairwise comparisons, the relative importance of elements across all layers is quantified using mathematical methods such as linear algebra, and a final overall ranking of relative importance is determined. This is a decision analysis method that organically combines qualitative analysis by decision-makers with quantitative calculations. The method is highly systematic, flexible in application, and efficient and practical in project management.

(1) Determine the research object

The use of the hierarchical analysis method should have a clear objective. First, a systematic analysis of the objective must be conducted to determine the depth of evaluation required for the research object. The scope of the research object is then defined based on national and industry laws, regulations, and other constraints.

(2) Construct a multi-level hierarchical structural model

After determining the research object, through systematic analysis, identify the primary influencing factors of the research object and conduct a layer-by-layer analysis from coarse to fine and from superficial to deep, forming a multi-level hierarchical structure, typically divided into the objective layer, criterion layer, and scheme layer.

(3) Construct a pairwise comparison judgment matrix

After constructing a multi-level indicator system, it is necessary to rely on the experience and knowledge of experts to compare each level of indicators in pairs, judge the relative importance of each sub-indicator under the same indicator, and thereby establish a judgment matrix. Taking the criterion-level indicators $B_1 - B_n$ as an example, let a_{ij} represent the ratio of the influence of elements B_i and B_j on objective A. The pairwise comparison judgment matrix is shown in Table 2.

Table 2: Pairwise comparison judgment matrix

A	B_1	B_2	...	B_n
B_1	a_{11}	a_{12}	...	a_{1n}
B_2	a_{21}	a_{22}	...	a_{2n}
...
B_n	a_{n1}	a_{n2}	...	a_{nn}

Based on the table, we can construct a judgment matrix for a_{ij} :

$$A = (a_{ij})_{m \times n} = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{pmatrix} \quad (i = 1, 2, 3 \cdots m, j = 1, 2, 3 \cdots n) \quad (1)$$

The elements in a satisfy the following conditions:

- (a) $a_{ij} > 0$.
- (b) $a_{ij} = \frac{1}{a_{ji}}, i \neq j$.
- (c) $a_{ii} = 1, i = 1, 2 \dots n$.

a_{ij} represents the numerical value of the relative importance of two factors. Typically, Saaty's 1-9 scale method is used to make pairwise judgments on the criteria layer indicators. Different scales correspond to different degrees of relative importance, with larger ratios indicating higher importance of i . This step enables qualitative judgments to be quantified.

(4) Solving the weight vector

After obtaining the judgment matrix, the weights of each indicator are calculated based on the constructed judgment matrix. There are two methods for calculating weights: the square root method and the sum method. The steps for the square root method are as follows:

- (a) Calculate the $\frac{1}{m}$ th power of the product of each row to obtain an m -dimensional vector. That is:

$$\bar{a}_i = \sqrt[m]{\prod_{j=1}^m a_{ij}} \quad (2)$$

- (b) Standardize the vector to obtain the weight vector. That is:

$$\omega_i = \frac{\bar{\omega}_i}{\sum_{j=1}^m \bar{\omega}_j} \quad (3)$$

The weight vector $W = (W_1, W_2, \dots, W_n)^T$. The summation method first standardizes each column of the decision matrix, sums the standardized elements row by row, and finally standardizes the summation results. The resulting weight vector is most consistent with the weight vector obtained by the square root method.

(5) Solving for the maximum eigenvalue and consistency test

After obtaining the weight vector using the above method, its maximum eigenvalue can be calculated as shown in Equation (4):

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \frac{(AW)_i}{W_i} \quad (4)$$

Among them, n is the number of dimensions, i.e., the order of the judgment matrix. Thus, the consistency index C.I value can be further calculated through the maximum eigenvalue λ_{\max} , as shown in Equation (5):

$$C.I = \frac{\lambda_{\max} - n}{n - 1} \quad (5)$$

The purpose of consistency testing is to verify whether the constructed judgment matrix contains logical issues. For example, when comparing the relative importance of three elements A, B, and C, if the importance of A relative to B is 5 and the importance of A relative to C is 0.25, then the importance of B relative to C should be lower than that of C. However, if the importance of B relative to C is set to 3 when constructing the judgment matrix, this is logically inconsistent. Therefore, consistency testing is necessary. However, as shown in the above formula, the larger n is, the greater the error in the C.I. value. Therefore, the random consistency ratio C.R. is introduced in the consistency check to reduce the impact of errors, as shown in equation (6):

$$C.R = \frac{C.I}{R.I} \quad (6)$$

3.2.2 Entropy Weighting Method

(1) Dimensionless processing of indicators

Since different indicators have different units, before performing entropy weight calculations, the indicator data must first be dimensionless to eliminate the effects of different units and make the data comparable [27]. This method converts all values to the range of 0–1. To ensure that the data results are meaningful, the dimensionless indicators must also be shifted by a minimum unit value to meet the calculation conditions of the entropy weight method.

For positive indicators, the larger the indicator value, the better. The processing method is as shown in Equation (7):

$$\chi'_{ij} = \frac{x_{ij} - m_j}{M_j - m_j} \quad (7)$$

For reverse indicators, the smaller the indicator value, the better. The processing method is as shown in Equation (8):

$$\chi'_{ij} = \frac{M_j - x_{ij}}{M_j - m_j} \quad (8)$$

Among them, M_j is the maximum value of X_{ij} and m_j is the minimum value of X_{ij} .

(2) Principle of entropy weighting method

Entropy is a measure of the disorder of a system. The smaller the entropy value of an indicator, the greater the amount of information carried by the data, and the greater the influence of the indicator in the evaluation, so the weight should be greater. Conversely, the larger the entropy value of an indicator, the less information it contains, and the smaller its influence in the evaluation, so the weight should be smaller. Therefore, when applying this method, weights for each indicator can be calculated using entropy based on the uniformity of the indicator data. By weighting all indicators using their entropy weights, a more objective evaluation result can be obtained.

(3) Application Steps of the Entropy Weighting Method

After normalizing the indicator values, calculate the proportion of the i th condition under the j th indicator:

$$p_{ij} = \frac{x'_{ij}}{\sum_{i=1}^n x'_{ij}} \quad (9)$$

Calculate the entropy value of the j th indicator:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^n p_{ij} \ln p_{ij}, 0 \leq e_j \leq 1 \quad (10)$$

Calculate the coefficient of variation:

$$g_j = 1 - e_j \quad (11)$$

Calculate the entropy weight w_j of the j th indicator:

$$w_j = \frac{g_j}{\sum_{j=1}^m g_j}, j = 1, 2, 3, \dots, m \quad (12)$$

3.3 Fuzzy comprehensive evaluation

3.3.1 Principles of Fuzzy Comprehensive Evaluation Method

In multi-attribute comprehensive evaluation, the quality of many things cannot be described by deterministic sets. Due to differences in knowledge and experience, people have different views on a particular thing, making it difficult to give a precise definition. Therefore, in order to describe fuzzy concepts relatively accurately and scientifically, fuzzy mathematics can be used

to quantify fuzzy concepts, facilitating processing and calculation.

3.3.2 Application steps of the fuzzy comprehensive evaluation method

(1) Establish a comprehensive evaluation factor set.

The factor set is a general set composed of various factors that affect the evaluation object, usually denoted by U , $U = (u_1, u_2, u_3, \dots, u_i), i = 1, 2, 3, \dots, m$, where u_i represents the i -th factor influencing the evaluation object, i.e., the evaluation indicator, and these evaluation indicators have varying degrees of fuzziness.

(2) Establish a comprehensive evaluation set

The evaluation set is a collection of various possible outcomes that evaluators may make regarding the evaluation object, denoted by V , $V = (v_1, v_2, v_3, \dots, v_n)$ where V_j represents the j th evaluation result, which can be expressed using different grades, comments, or numbers.

(3) Conduct single-factor fuzzy evaluation to obtain the evaluation matrix

If the membership degree of the i th element in the factor set U to the first element in the evaluation set V is r_{i1} for the i -th element in the factor set U to the first element in the evaluation set V , then the single-factor evaluation result for the i -th element can be represented as a fuzzy set $R_i = (r_{i1}, r_{i2}, r_{i3}, \dots, r_{in})$, and the fuzzy comprehensive evaluation matrix R_{mm} is formed by arranging the m single-factor evaluation sets R_1, R_2, \dots, R_m as rows.

(4) Determine the factor weight vector

Assign weights to each factor u_i ; the fuzzy sets of factor weights are represented by vector A , $A = (a_1, a_2, \dots, a_n)$.

(5) Perform fuzzy synthesis and decision-making

After determining the single-factor evaluation matrix R and the factor weight vector A , the fuzzy vector A on U is transformed into the fuzzy vector B on V through fuzzy transformation, i.e., $B = A_{1m} \cdot R_{mm}$. The maximum membership degree of the evaluation set corresponding to this factor is determined based on the calculation results, which serves as the final evaluation result for this indicator.

4 Evaluation and Analysis of Music Education Systems in the Context of Artificial Intelligence

4.1 Calculating indicator weights

4.1.1 Subjective weights of indicators based on the analytic hierarchy process

Based on the principles of the Analytic Hierarchy Process (AHP) described above, a hierarchical structure was established, a judgment matrix was created, the relative weights of each factor under a single criterion were determined, and a random consistency test was conducted. Considering the large volume of data to be processed, Matrix Lab—MATLAB software was used to improve efficiency and ensure accuracy. Matrix operations were performed, and the judgment matrices for each indicator are shown in Tables 3–7. Based on the data in the tables, the judgment matrix established in this study meets the consistency test criteria (A : 0.0952, A_1 : 0.0427, A_2 : 0.0846, A_3 : 0.0598, A_4 : 0.0936, $CR < 0.1$), and can be used for subsequent weight calculations in the music education system. The subjective relative weight values for each indicator are 0.1310 (A_1), 0.0961 (A_2), 0.2851 (A_3), 0.4878 (A_4), 0.0986 (A_{11}), 0.1474 (A_{12}), 0.2663 (A_{13}), 0.4878 (A_{14}), 0.0675 (A_{21}), 0.1023 (A_{22}), 0.1627

(A23), 0.2766 (A24), 0.3908 (A25), 0.1309 (A31), 0.1557 (A32), 0.2477 (A33), 0.4657 (A34), 0.2499 (A41), 0.7501 (A42).

Table 3: Judgment matrix(A)

Symbol	A1	A2	A3	A4	Weight	CR
A1	1	2	0.333	0.25	0.1310	0.0952
A2	0.5	1	0.2	0.5	0.0961	
A3	3	5	1	0.25	0.2851	
A4	4	2	4	1	0.4878	

Table 4: Judgment matrix(A1)

Symbol	A11	A12	A13	A14	Weight	CR
A11	1	0.5	0.5	0.2	0.0986	0.0427
A12	2	1	0.25	0.5	0.1474	
A13	2	4	1	0.333	0.2663	
A14	5	2	3	1	0.4878	

Table 5: Judgment matrix(A2)

Symbol	A21	A22	A23	A24	A25	Weight	CR
A21	1	0.5	0.333	0.25	0.333	0.0675	0.0846
A22	2	1	0.333	0.5	0.333	0.1023	
A23	3	3	1	0.25	0.5	0.1627	
A24	4	2	4	1	0.5	0.2766	
A25	3	3	2	5	1	0.3908	

Table 6: Judgment matrix(A3)

Symbol	A31	A32	A33	A34	Weight	CR
A31	1	0.5	0.5	0.5	0.1309	0.0598
A32	2	1	0.25	0.5	0.1557	
A33	2	4	1	0.2	0.2477	
A34	2	2	5	1	0.4657	

Table 7: Judgment matrix(A4)

Symbol	A31	A32	Weight	CR
A41	1	0.333	0.2499	0.0936
A42	3	1	0.7501	

Through the above judgment matrix, the relative weights of each evaluation indicator can be obtained. A hierarchical total ranking must also be performed to obtain the absolute weight values of each evaluation indicator. Based on this, the Rank function in Excel is used to sort the subjective absolute weights of the evaluation indicators. The sorting results are shown in Table 8. The results show that A42 (0.3659) > A34 (0.1328) > A41 (0.1219) > A33 (0.0706) > A14 (0.0639) > A32 (0.0444) > A25 (0.0379) > A31 (0.0373) > A13 (0.0349) > A24 (0.0264) > A12 (0.0193) > A23 (0.0154) > A11 (0.0129) > A22 (0.0099) > A21 (0.0065), This clearly demonstrates the absolute subjective weighting order of the various evaluation indicators and also provides data support for subsequent evaluation indicator combination weighting results and fuzzy comprehensive evaluation result calculations.

Table 8: Sorting result

Theme	First-level indicator	Weight	Secondary indicators	Relative weight	Absolute weight	Rank
Artificial intelligence drives the music education system	A1	0.1310	A11	0.0986	0.0129	13
			A12	0.1474	0.0193	11
			A13	0.2663	0.0349	9
			A14	0.4878	0.0639	5
	A2	0.0961	A21	0.0675	0.0065	15
			A22	0.1023	0.0099	14
			A23	0.1627	0.0154	12
			A24	0.2766	0.0264	10
	A3	0.2851	A31	0.1309	0.0373	8
			A32	0.1557	0.0444	6
			A33	0.2477	0.0706	4
			A34	0.4657	0.1328	2
	A4	0.4878	A41	0.2499	0.1219	3
			A42	0.7501	0.3659	1

4.1.2 Objective weighting of indicators based on entropy weighting method

(1) Constructing a judgment matrix

This paper uses a six-point Likert scale to represent the effectiveness of artificial intelligence technology in music education systems. Thirty experts engaged in music education and related fields were invited to participate in interviews and asked to fill out a questionnaire on the effectiveness of artificial intelligence technology in music education systems. After collecting the questionnaires, the data was summarized to produce a summary table of the effectiveness of artificial intelligence technology in music education systems, as shown in Table 9.

Table 9: Data summary

Expert	A1	A2	A3	A4
1	5	2	4	4
2	2	3	5	5
3	6	5	4	4
4	2	3	5	5
5	5	4	2	2
6	5	5	6	5
7	1	5	1	2
8	5	2	1	2
9	6	5	3	1
10	5	6	1	6
11	3	3	5	6
12	5	4	6	4
13	4	5	5	4
14	2	5	5	3
15	2	2	2	6
16	2	3	5	5
17	4	6	1	1
18	2	3	5	2
19	3	5	5	4
20	5	4	6	5
21	5	3	2	6
22	2	1	6	1
23	5	4	4	6
24	2	6	4	2
25	3	3	5	4
26	6	1	4	2
27	3	5	1	3
28	2	1	5	6
29	6	1	2	5
30	2	2	3	2

(2) Normalize the data.

According to the normalization formula in the entropy weight model, use Excel software to standardize the above matrix to obtain the standardized P matrix. The standardized matrix is shown in Table 10.

Table 10: Standardized matrix

Expert	A1	A2	A3	A4
1	0.0866	0.0000	0.0396	0.0494
2	0.0000	0.0282	0.0594	0.0741
3	0.0866	0.0424	0.0000	0.0000
4	0.0000	0.0282	0.0594	0.0741
5	0.0866	0.0565	0.0000	0.0000
6	0.0000	0.0000	0.0594	0.0000
7	0.0000	0.0847	0.0000	0.0185
8	0.0866	0.0212	0.0000	0.0185
9	0.0866	0.0678	0.0238	0.0000
10	0.0693	0.0847	0.0000	0.0741
11	0.0000	0.0000	0.0396	0.0741
12	0.0433	0.0000	0.0594	0.0000
13	0.0000	0.0847	0.0594	0.0000
14	0.0000	0.0847	0.0594	0.0247
15	0.0000	0.0000	0.0000	0.0741
16	0.0000	0.0282	0.0594	0.0741
17	0.0519	0.0847	0.0000	0.0000
18	0.0000	0.0282	0.0594	0.0000
19	0.0000	0.0847	0.0594	0.0370
20	0.0433	0.0000	0.0594	0.0370
21	0.0649	0.0212	0.0000	0.0741
22	0.0173	0.0000	0.0594	0.0000
23	0.0433	0.0000	0.0000	0.0741
24	0.0000	0.0847	0.0297	0.0000
25	0.0000	0.0000	0.0594	0.0370
26	0.0866	0.0000	0.0356	0.0148
27	0.0433	0.0847	0.0000	0.0370
28	0.0173	0.0000	0.0475	0.0741
29	0.0866	0.0000	0.0119	0.0593
30	0.0000	0.0000	0.0594	0.0000

(3) Calculate the entropy values of each indicator.

According to the entropy calculation formula, the entropy value vectors of each indicator are as follows:

$$e_j = [0.8753 \quad 0.7942 \quad 0.9637 \quad 0.8544]^T$$

(4) Calculate the weights of each indicator.

Based on the weight calculation formula, obtain the weight vector:

$$w_j = [0.2434 \quad 0.4016 \quad 0.0708 \quad 0.2842]^T$$

Similarly, based on the above steps, the weight vector calculation results for the second-level indicators relative to the first-level objectives are as follows:

$$w_{A1} = [0.2745 \quad 0.3216 \quad 0.2658 \quad 0.1381]^T$$

$$w_{A2} = [0.1643 \quad 0.1504 \quad 0.2817 \quad 0.1942 \quad 0.2094]^T$$

$$w_{A3} = [0.2378 \quad 0.2989 \quad 0.1875 \quad 0.2758]^T$$

$$w_{A4} = [0.2622 \quad 0.7378]^T$$

The results above are summarized in Table 11.

Table 11: Summary result

Theme	First-level indicator	Weight	Secondary indicators	Relative weight	Absolute weight	Rank
Artificial intelligence drives the music education system	A1	0.2434	A11	0.2745	0.0668	8
			A12	0.3216	0.0783	4
			A13	0.2658	0.0647	9
			A14	0.1381	0.0336	11
	A2	0.4016	A21	0.1643	0.0675	7
			A22	0.1504	0.0618	10
			A23	0.2817	0.1157	2
			A24	0.1942	0.0706	5
			A25	0.2094	0.086	3
	A3	0.0708	A31	0.2378	0.0168	14
			A32	0.2989	0.0212	12
			A33	0.1875	0.0133	15
			A34	0.2758	0.0195	13
	A4	0.2842	A41	0.2622	0.0745	6
A42			0.7378	0.2097	1	

4.1.3 Combination Weight Calculation

Through the above calculations, the subjective weights and objective weights of the evaluation indicators were obtained. Based on this, a weighted summation method was used (combined weight = 0.5 × subjective weight + 0.5 × objective weight) to obtain the combined weights of the evaluation indicators. The results of the combined weights of the evaluation indicators are shown in Table 12. The results show that the combined weights for the first-level evaluation indicators are 0.1872, 0.2489, 0.1780, and 0.3860, respectively. Additionally, the combined weights for the second-level evaluation indicators are as shown in Table 12 and will not be repeated here.

Table 12: The results of the combined weights of evaluation indicators

First-level indicator	Subjective weight	Objective weight	Combined weight	Secondary indicators	Subjective weight	Objective weight	Combined weight
A1	0.1310	0.2434	0.1872	A11	0.0129	0.0668	0.0399
				A12	0.0193	0.0783	0.0488
				A13	0.0349	0.0647	0.0498
				A14	0.0639	0.0336	0.0488
A2	0.0961	0.4016	0.2489	A21	0.0065	0.0675	0.0370
				A22	0.0099	0.0618	0.0359
				A23	0.0154	0.1157	0.0656
				A24	0.0264	0.0706	0.0485
				A25	0.0379	0.086	0.0620
A3	0.2851	0.0708	0.1780	A31	0.0373	0.0168	0.0271
				A32	0.0444	0.0212	0.0328
				A33	0.0706	0.0133	0.0420
				A34	0.1328	0.0195	0.0762
A4	0.4878	0.2842	0.3860	A41	0.1219	0.0745	0.0982
				A42	0.3659	0.2097	0.2878

4.2 Fuzzy comprehensive evaluation results

4.2.1 Data Acquisition

Based on the target audience of the indicators, this study designed two survey questionnaires: one for teachers and one for students. The teacher version consists of 15 questions, and the student version also consists of 15 questions. Taking managers, full-time teachers, counselors and students of an undergraduate college as the sampling objects, questionnaires were distributed through the "questionnaire star", and a total of 200 valid questionnaires for teachers and 300 valid questionnaires for students were collected, totaling 500 questions. After sorting, the initial quantitative values of the evaluation index of the music education system of an undergraduate college are shown in Table 13.

Table 13: Initial quantification value

Secondary indicators	Evaluation frequency				
	Excellent	Good	General	Poor	Very bad
A11	63	219	67	87	64
A12	110	124	82	114	70
A13	108	158	64	64	106
A14	64	185	85	76	90
A21	66	159	95	74	106
A22	96	180	70	75	79
A23	118	127	71	109	75
A24	119	115	96	62	108
A25	79	160	68	75	118
A31	103	124	114	71	88
A32	61	174	90	104	71
A33	93	130	84	78	115
A34	110	78	90	108	114
A41	75	165	83	95	82
A42	115	99	77	94	115

According to the evaluation frequency weighting, this study normalized the initial quantitative data to form the evaluation results of the indicator factors. The normalization

results are shown in Table 14.

Table 14: Normalization processing result

Secondary indicators	Evaluation frequency				
	Excellent	Good	General	Poor	Very bad
A11	0.126	0.438	0.134	0.174	0.128
A12	0.22	0.248	0.164	0.228	0.14
A13	0.216	0.316	0.128	0.128	0.212
A14	0.128	0.37	0.17	0.152	0.18
A21	0.132	0.318	0.19	0.148	0.212
A22	0.192	0.36	0.14	0.15	0.158
A23	0.236	0.254	0.142	0.218	0.15
A24	0.238	0.23	0.192	0.124	0.216
A25	0.158	0.32	0.136	0.15	0.236
A31	0.206	0.248	0.228	0.142	0.176
A32	0.122	0.348	0.18	0.208	0.142
A33	0.186	0.26	0.168	0.156	0.23
A34	0.22	0.156	0.18	0.216	0.228
A41	0.15	0.33	0.166	0.19	0.164
A42	0.23	0.198	0.154	0.188	0.23

4.2.2 Comprehensive evaluation results and analysis

Assign values of 5, 4, 3, 2, and 1 to each element in the evaluation grade set V {Excellent, Good, Average, Poor, Very Poor} in descending order. Under the influence of the aforementioned fuzzy comprehensive evaluation method, the evaluation results of the music education system under the perspective of artificial intelligence technology at a certain undergraduate institution are obtained, as shown in Table 15. As shown in Table 15, the current evaluation values of the music education system under the artificial intelligence technology framework at a certain undergraduate institution are not very high, generally around 3. This indicates that there is significant room for improvement in the music education system under the artificial intelligence technology framework at this institution. Further analysis reveals that the university has already established the necessary foundation for music education and achieved certain educational outcomes. The key focus moving forward should be to implement music education in more efficient and effective ways. In particular, university leadership should place greater emphasis on the music education system under the AI technology framework, establish specialized advisory bodies, and increase funding for related initiatives.

Table 15: Evaluation result

Theme	First-level indicator	Evaluation value	Secondary indicators	Evaluation value
Artificial intelligence drives the music education system	A1	3.4130	A11	3.4221
			A12	3.2119
			A13	3.2101
			A14	3.8077
	A2	3.5739	A21	3.4929
			A22	3.9502
			A23	3.4356
			A24	3.4812
	A3	3.6573	A25	3.5096
			A31	3.0385
			A32	3.8684
			A33	3.7835
	A4	3.116	A34	3.9386
			A41	3.1156
			A42	3.1164

5 Conclusion

This paper constructs an artificial intelligence-based music education system based on the application of artificial intelligence technology in the music education system. To test the practical application value of this system, an evaluation scheme for the music education system was developed using the analytic hierarchy process, entropy weight method, and fuzzy comprehensive evaluation method. Under the guidance of this scheme, the artificial intelligence-based music education system was evaluated. Calculations revealed that the evaluation value of the music education system under the AI technology framework at a certain undergraduate institution falls within the range of 3 to 4, indicating that the evaluation grade of the music education system under the AI technology framework at this institution is “good.” Further efforts are needed to strengthen the integration of AI and music education to achieve the goal of enhancing the music education system and students' musical literacy at higher education institutions.

References

- [1] Yang, H., & Ge, W. (2025, June). Research on the Application of Artificial Intelligence in the Evaluation of Music Education-Taking the Four Dimensional Integration Evaluation System as an Example. In 2025 4th International Conference on Educational Innovation and Multimedia Technology (EIMT 2025) (pp. 539-548). Atlantis Press.
- [2] Dey, M. T., Patra, S., & Mitra, S. (2025). Enhancing music education with innovative tools and techniques: the role of artificial intelligence in musical works. In *Enhancing Music Education With Innovative Tools and Techniques* (pp. 19-50). IGI Global Scientific Publishing.
- [3] Ooi, K. B., Tan, G. W. H., Al-Emran, M., Al-Sharafi, M. A., Capatina, A., Chakraborty,

- A., ... & Wong, L. W. (2025). The potential of generative artificial intelligence across disciplines: Perspectives and future directions. *Journal of Computer Information Systems*, 65(1), 76-107.
- [4] Coppi, A. (2024, June). Creativity and Digital Music Education in the AI Era. In *Conference on Artificial Creativity: Looking at the Future of Digital Culture* (pp. 153-167). Cham: Springer Nature Switzerland.
- [5] Wang, X., & Fitri bin Haris, M. (2025, March). AI-Driven Violin Performance Evaluation: A Deep Learning Approach for Automated Assessment and Personalized Feedback in Music Education. In *Proceedings of the 2025 International Conference on Generative Artificial Intelligence and Digital Media* (pp. 126-132).
- [6] Yin, Y. (2025). Research on Technological Innovation and Application of Music Education Transformation Under the Background of Technology. *Journal of Educational Theory and Practice*, 2(2).
- [7] Petkova, D. (2025). Cross-modal Priming of a Music Education Event in a Digital Environment. *International Journal of Cognitive Research in Science, Engineering and Education*, 13(1), 75-81.
- [8] Frytsiuk, V., Kshyvak, I., Baranovska, I., Teplova, O., Novosadova, A., & Khilya, A. (2025, June). Digital Ecosystems for Music Teacher Training: ICT, Social Media, and Online Learning Environments. In *ENVIRONMENT. TECHNOLOGY. RESOURCES. Proceedings of the International Scientific and Practical Conference* (Vol. 2, pp. 137-144).
- [9] Wei, J., Karuppiyah, M., & Prathik, A. (2022). College music education and teaching based on AI techniques. *Computers and Electrical Engineering*, 100, 107851.
- [10] Merchán Sánchez-Jara, J. F., 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.
- [11] Yu, X., Ma, N., Zheng, L., Wang, L., & Wang, K. (2023). Developments and applications of artificial intelligence in music education. *Technologies*, 11(2), 42.
- [12] Lin, F., & Chen, F. (2025). Intelligent music education system: utilizing algorithms for personalized learning experience. *International Journal of High Speed Electronics and Systems*, 2540253.
- [13] Chen, Y., & Sun, Y. (2024). The usage of artificial intelligence technology in music education system under deep learning. *Ieee Access*.
- [14] Zhang, C. (2025). The analysis of Chinese National ballad composition education based on artificial intelligence and deep learning. *Scientific Reports*, 15(1), 9215.
- [15] Yin, L., & 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), e12858.

- [16] Wang, X. (2022). Design of vocal music teaching system platform for music majors based on artificial intelligence. *Wireless Communications and Mobile Computing*, 2022(1), 5503834.
- [17] Kwiecień, J., Skrzyński, P., Chmiel, W., Dąbrowski, A., Szadkowski, B., & Pluta, M. (2024). Technical, Musical, and Legal Aspects of an AI-Aided Algorithmic Music Production System. *Applied Sciences*, 14(9), 3541.
- [18] Ting, C. K., Wu, C. L., & Liu, C. H. (2015). A novel automatic composition system using evolutionary algorithm and phrase imitation. *IEEE Systems Journal*, 11(3), 1284-1295.
- [19] Hagan's, K. (2017). Sound Anthology: Program Notes. *Computer Music Journal*, 41(1), 106-113.
- [20] de Souza, R. C. (2020). In the Era of Computers, Internet and Multimedia, are we still Teaching Composers to become Chapel-Masters?. *Revista Vórtex*, 8(1), 1-14.
- [21] Baratè, A., Haus, G., Ludovico, L. A., Pagani, E., & Scarabottolo, N. (2019). 5G technology for music education: a feasibility study. *IADIS International Journal on Computer Science & Information Systems*, 14(1), 31-52.
- [22] Ventura, M. D. (2016, November). Creating inspiring learning environments by means of digital technologies: A case study of the effectiveness of WhatsApp in music education. In *E-Learning, E-Education, and Online Training: Third International Conference, eLEOT 2016, Dublin, Ireland, August 31–September 2, 2016, Revised Selected Papers* (pp. 36-45). Cham: Springer International Publishing.
- [23] Huang, J., & Li, X. (2023). Promoting the Popularization of Artificial Intelligence Education. In *Constructing Regional Smart Education Ecosystems in China* (pp. 125-132). Singapore: Springer Nature Singapore.
- [24] Karamuk, E. (2025). The Automation Trap: Unpacking the Consequences of Over-Reliance on AI in Education and Its Hidden Costs. In *Pitfalls of AI Integration in Education: Skill Obsolescence, Misuse, and Bias* (pp. 151-174). IGI Global Scientific Publishing.
- [25] Zhang, H., & Zeng, Y. (2022). The education for sustainable development, online technology and teleological rationality: A game between instrumental value and humanistic value. *Sustainability*, 14(4), 2101.
- [26] Xiao Han, Fuyang Chen, Ijaz Ullah & Mohammad Faisal. (2023). **RETRACTED ARTICLE:** An evaluation of AI-based college music teaching using AHP and MOORA. *Soft Computing*, 28(suppl 2), 1-1.
- [27] Xiaoying Bai & Yulong Wan. (2025). Evaluation method of innovation and entrepreneurship education quality in colleges and universities based on entropy weight method. *International Journal of Innovation and Sustainable Development*, 19(1), 81-93.