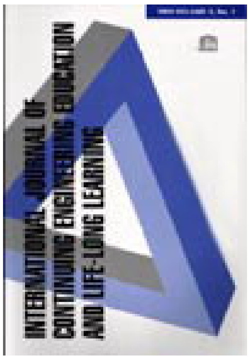

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Intelligent music teaching system and method based on human-computer interaction technology

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Abstract: An intelligent music teaching system based on human-computer interaction is proposed to address limitations in traditional music education. The system includes three modules: video-supervised teaching, instrument selection, and course selection. These form a complete intelligent teaching framework. Experimental comparisons were made between traditional and intelligent methods across three key issues in music education. Feedback from six students showed improvements in learning efficiency, engagement, and personalised instruction when using the intelligent system. Data analysis confirms the system's potential to enhance music education by offering more interactive and tailored experiences. This study demonstrates the effectiveness of integrating interactive technology into music pedagogy.

Keywords: intelligent music teaching; human-centred computing; precision rate; cost of economy.

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1 Introduction

As an important carrier of human civilisation inheritance and innovation, music education has gone beyond the simple teaching of skills and has penetrated the deep dimensions of cognitive development and cultural identity. Cognitive neuroscience has confirmed that systematic music training can reshape the structure of brain neural networks, enhance the executive control function of the prefrontal cortex, and show interdisciplinary application potential in the fields of language disorder rehabilitation and emotion regulation. However, the global music education ecosystem is facing severe structural challenges: imbalanced resource allocation, rigid teaching models, and insufficient technical adaptation constitute a triple contradiction. On the economic level, the high purchase cost and maintenance costs of physical musical instruments exclude most learners, forming a continuous economic burden; on the teaching level, the traditional apprenticeship system relies on the individual experience of teachers, making it difficult to achieve refined error detection and standardised evaluation of performance movements; on the curriculum level, the linear knowledge transfer model is seriously out of touch with the personalised needs of learners. Surveys show that most dropouts are attributed to the systematic mismatch between teaching content and individual goals.

The breakthrough in human-computer interaction (HCI) technology provides a new paradigm for solving the above dilemma. The intelligent music teaching system reconstructs the ‘teaching-learning-evaluation’ full-process education ecosystem through multimodal perception and data-driven algorithms. In terms of technical architecture, computer vision, tactile feedback, and biosignal analysis are integrated to build a closed-loop interaction model: the depth camera captures the performer’s limb movement trajectory with high precision, the pressure-sensitive sensor quantifies the dynamics of the touch force, and the electromyographic signal analysis reveals the muscle coordination pattern. The integration of the three realises the biomechanical modelling of the performance action. The innovation at the algorithm level is reflected in the coordinated application of the spatiotemporal attention mechanism and transfer learning – the improved visual model stably tracks the key points of the hand in a complex environment, and the spatiotemporal convolutional network significantly improves the sensitivity of rhythm deviation detection; the cross-instrument skill transfer framework converts the operation logic of different instruments into compatible technical strategies through the feature mapping matrix, reducing the cognitive load of multi-instrument learning.

This study takes the construction of an inclusive intelligent education system as its core goal, adopts the design science research methodology, and goes through three stages: demand analysis, prototype development, and empirical optimisation. Based on the core demand dimensions extracted from in-depth interviews with learners, a modular functional system is designed: the video supervision module transforms abstract music theory into multi-sensory embodied cognition through augmented reality and tactile feedback; the instrument simulation module uses cross-modal algorithms to achieve digital reproduction of the operating characteristics of physical instruments; the course recommendation system constructs a music knowledge graph and dynamically optimises the learning path by combining multi-dimensional feature vectors. Empirical studies have shown that the system significantly improves the efficiency of skill acquisition, and captures the physiological responses of performers through emotional computing models to achieve adaptive adjustments in teaching strategies, promoting music expression training from mechanical repetition to creative exploration. The value of this technical framework lies in reconstructing the underlying logic of music education: transforming the role of teachers from knowledge transmitters to learning guides through data flow closures, and using edge computing and cloud collaboration to ensure teaching continuity. The more profound significance lies in the fact that the system uses technology as a medium to eliminate cultural capital barriers and enable high-quality educational resources to be widely radiated. The pilot project has verified the feasibility of inclusive education, and the lightweight version can still effectively improve learning outcomes in resource-constrained environments. The current research not only provides practical solutions for the cultivation of music literacy in the digital age but also contributes original insights in the fields of human-computer collaborative education paradigm and multimodal interaction theory, marking that music education has officially entered a new era of intelligence.

2 Related work

In the field of music teaching, there are many researchers, and research directions, and methods are diverse. Wang mentioned in the article "Achievement goals, implicit theory, and internal motivation: tests of specificity across music, visual arts, and sports" in the music education research magazine that he hoped to break through the shackles of traditional music education by changing the way of music education (Wang et al., 2018). Nogaj (2020) mentioned that music education had shaped students' emotions and personalities to a certain extent in the article "Emotional quotient and coping strategies of music college students in the context of visual arts and general education" in the music education research magazine. Biasutti mentioned in the article "Effective music teachers: the impact of personal, social and cognitive dimensions on the self-efficacy of music teachers" in music science that the self-efficacy of music teachers affected the efficiency of relevant music education and teaching (Biasutti and Concina, 2018). Music teachers' self-efficacy affects the efficiency of music education and teaching because when teachers are confident in themselves, they are more likely to adopt positive and effective teaching strategies, stimulate students' interest and motivation in learning, and thus improve the quality of teaching. Rose talked about the influence of music education on children's personality shaping and emotional cognition in the article "Measuring the Influence of Music Learning on the Healthy Development of Children's Cognition, Behavior and Social Emotion" in music psychology (Rose et al., 2019). Specifically, music education can positively influence children's personality formation by improving their ability to recognise emotions, promoting the development of social skills, and enhancing their ability to express themselves. At the same time, it can also help children better manage their emotions and improve their emotional cognition. Luo (2023) studied the localisation of Orff's teaching method and its integration with early childhood music education in universities, emphasising the importance of incorporating local culture and traditions in teaching to enhance students' music learning experience. Abdumutalibovich (2022) focused on the role of authoritative systems in the historical formation of music teaching in higher education and explored their importance in education. Haitao analysed the problems and solutions in vocal teaching at Hezhou University in China, pointing out the relationship between teaching methods and student participation, and providing a reference for improving vocal education (Haitao and Hirunrux, 2023). Wang (2025) emphasised the necessity of evaluation in art and music education and explored how innovative digital technologies affected students' psychology and learning motivation, especially in the art education environment in China. Hong et al. (2022) proposed a decision support system for evaluating the functionality of machine learning and artificial intelligence in online game music education, demonstrating the potential and application of modern technology in music education. Finally, Posumah et al. (2022) analysed the teaching methods in Karawitan music learning activities and pointed out the impact of different methods on students' learning outcomes. Through the review of the above documents, the current research on music teaching is quite rich. However, it is also noted that the current research direction is mainly to improve the traditional music teaching methods, without fundamentally considering the reform of methods.

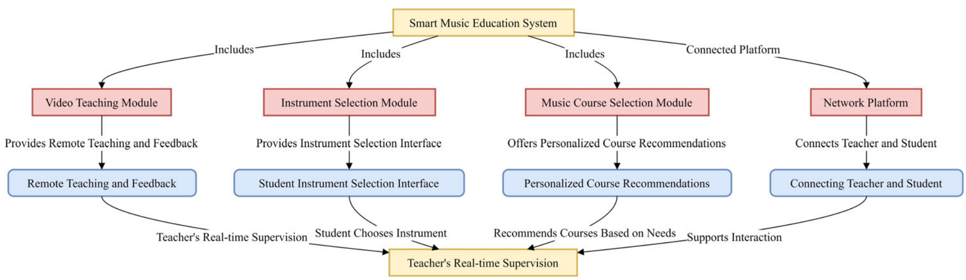
In the research of music education methods, although there are not many researchers, there are still research materials in this area. These improvements mainly focus on the innovation of teaching methods, such as introducing an interest-driven teaching model, emphasising interactivity and practicality, and using modern technology to enrich teaching resources and forms, to better adapt to the needs of different students and improve learning outcomes. Kratus (2019) mentioned in the music educator magazine "Music Education Returns to Amateurism" that the traditional education method should not be used for music education, but the interest method should be used to make music education return to interest. Freer had his understanding of music education methods in the chorus magazine "Students' Reflection on the Importance of Chorus Music in Middle School". He believed that the best music education method was the way of chorus (Freer, 2020). Cohrdes et al. (2019) said in the music psychology "Development of Preschool Children's Music Ability: the Impact of Training Plans and the Role of Environmental Factors" that the choice of music education methods had a very important guiding role for preschool children. Julia et al. (2020) pointed out in the general education research magazine "Training Non-Professional Music Teachers: Insights from Indonesian Action Research" that the selection of music education methods needed to be adjusted according to the actual training objectives. Through the review of the literature, it is found that although these documents have put forward their views on the methods of music education, there are indeed attempts to improve the methods of music education, and there is no substantive breakthrough.

This paper aims to study the application of HCI in education and learning systems. Diederich et al. (2022) conducted a comprehensive review of the design and interaction of session proxies, summarised the current status of HCI research, and provided a practical framework for designing and evaluating session proxies. Alzubi et al. (2025) explored a multimodal HCI system aimed at enhancing the effectiveness of intelligent learning systems by combining multiple interaction methods to improve learning outcomes. Han et al. (2023) developed a technology-enhanced educational metaverse framework that emphasised the importance of learner-machine collaboration to increase learner engagement and explored how HCI could facilitate this collaboration. Kosch et al. (2023) focused on measuring cognitive load in HCI and provided a review on how to evaluate users' cognitive load when interacting with the system, laying a theoretical foundation for improving user experience. Zhang (2025) proposed an HCI system utilising machine learning to enhance teacher-student interaction models, demonstrating the potential application of advanced technology in education. Finally, Ahuja et al. (2025) discussed the application of intelligent tutoring systems in helping disabled learners, combining HCI and augmented reality technology to provide innovative solutions for special education. In summary, this literature demonstrates the broad potential of HCI in educational applications, emphasising the importance of technological innovation in enhancing learning experiences and strengthening student engagement.

3 Human-computer interactive intelligent teaching system method

At present, mainstream music education has the following problems and difficulties, mainly because of the high cost of music education equipment, the inadequate supervision of music teachers, and the single choice of music courses. The research direction of this paper is the combination of music teaching system and HCI technology. Therefore, a sound and operable music teaching system needs to be established before the combination (Daubney and Fautley, 2020). To solve the difficulties of traditional music education, the system has designed the following modules: a video teaching module, an instrument selection module, and a music course selection module. The music teaching system can connect teachers and students through network data through the network platform to achieve the purpose of teaching. The intelligent music teaching system is shown in Figure 1.

Figure 1 Intelligent music teaching system (see online version for colours)



3.1 Video supervised teaching module method

This module is mainly designed for video music teaching and supervision, and its main function is video dialogue. In this paper, the conventional video motion detection method is used to carry out intelligent video algorithms on the target to capture the moving people. Motion detection refers to the extraction of moving parts from the overall video background, which is the lowest level basic function of an intelligent video system and lays the foundation for the classification, tracking, and behavioural understanding of subsequent objects. Because the camera of the teaching video is generally a fixed camera, the background picture changes very little. Therefore, it is only necessary to detect moving objects, which greatly alleviates the computational workload of intelligent video algorithms. The most direct feeling is that no matter whether in music teaching or learning, the video is not stuck and delayed, which also reflects the necessity of establishing a qualified algorithm. In essence, motion detection is a method to classify binary images, that is, to divide video images into foreground and background, that is, overall foreground and background, and target foreground and background. The following are the operation index formulas of the intelligent motion detection algorithm:

$$T/(T+F)=D \tag{1}$$

$$T/(T+P)=E \tag{2}$$

$$F/(T+F)=A \tag{3}$$

$$P/(T+P)=B \tag{4}$$

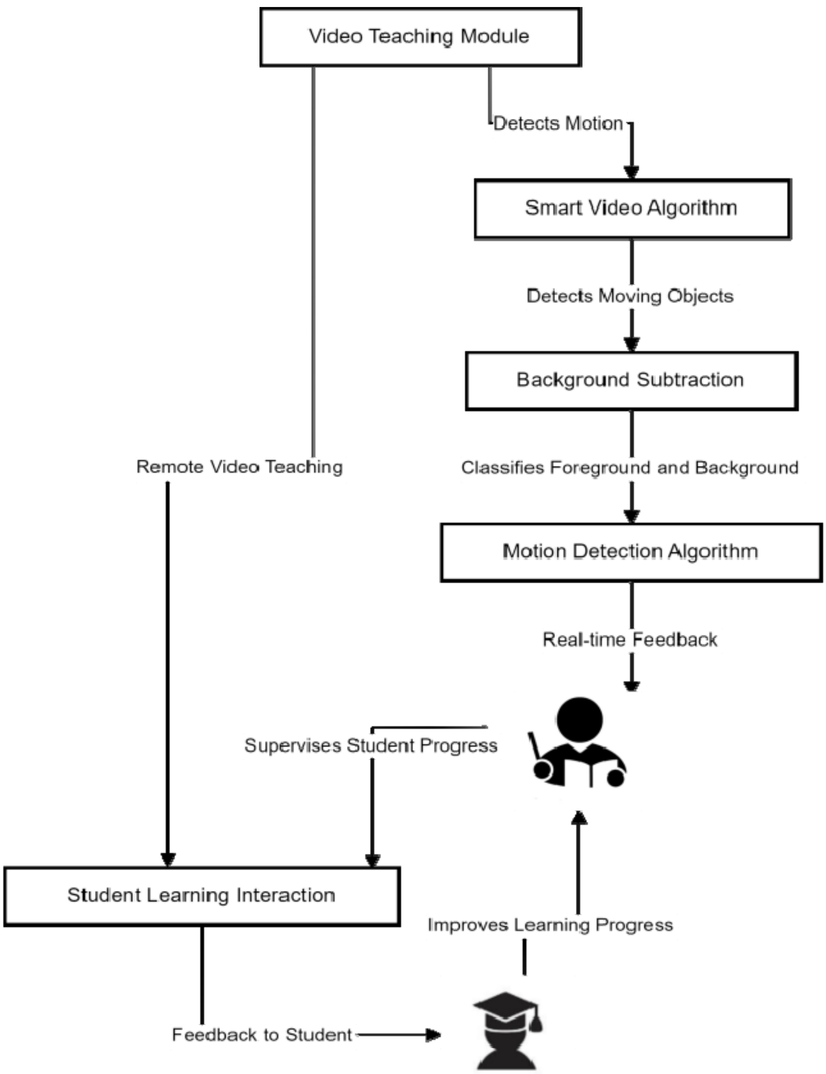
$$(N+T)/(N+T+P+F)=C \tag{5}$$

$$N/(N+P)=G \tag{6}$$

$$P/(N+P)=H \tag{7}$$

$$N/(N+F)=S \tag{8}$$

Figure 2 Video-guided teaching module



Among them, T represents the foreground pixel of the target. P represents the overall foreground pixel. F indicates the background pixel of the target. N represents the overall background pixel. A indicates the detection rate. B indicates the detection accuracy. C indicates the rate of missed inspections. D stands for false detection rate. E indicates accuracy. G indicates the background detection rate. H indicates the background missing rate. S indicates the accuracy of background detection. Through the calculation of the above motion detection algorithm, the basic function of video music teaching supervision is completed by using the efficient and fast data processing ability of the computer. The schematic diagram of this module is shown in Figure 2.

Figure 2 shows how the video teaching module uses intelligent video algorithms to detect motion and thus monitor students in real time. Through background subtraction technology, the video can classify the foreground and background in real time, providing teachers with effective teaching feedback and ensuring that teaching is not affected by delays or freezes.

3.2 Instrument selection module method

The instrument selection module is different from the traditional instrument selection because it adopts HCI technology. The instrument selection using HCI technology refers to inputting all the sounds of the existing button-type instruments into the music teaching system and extracting each button sound separately. When the user needs two or more sounds at the same time in the use process, the system also releases the input sound of each key according to the number of keys to achieve the purpose of harmony. For common instruments such as pianos, accordions, and sampling percussion pads, the system pre-records standardised sound sources for these instruments and maps notes to the touch interface based on the physical key layout. The piano keys correspond to a 12-tone arrangement; accordion buttons are grouped with chords and bass; percussion pads are arranged in a grid array to achieve simultaneous triggering and harmony of multiple notes. At present, the mainstream electronic devices on the market are mobile phones, computers, and tablets, among which most mobile phones and tablets are touchscreen models. Therefore, when designing the instrument selection module in the music teaching system, the design concept of touch screen key note signal is adopted, that is, note keys in the application system module are set. As long as the user presses and holds each note button on the screen when music teaching is needed, the corresponding instrument sound is generated.

On the personal computer (PC) side, touch screen button design is useless. At present, the mainstream computers on the market mainly use mouse and keyboard as the main input devices. Fortunately, this problem is considered at the beginning of the system design. Therefore, when using the touch key design, a key input design is also made, which is to correspond the notes of each instrument in the system to the corresponding keys on the keyboard. When the user presses the corresponding key on the keyboard, the system defaults to the note corresponding to the key, to achieve the input of the music signal. The key input design also has an additional advantage, that is, the notes on the keyboard can be modified according to the user's habit of using the keyboard so that the function can be used more quickly and skilfully. Because it uses HCI technology, all signals are transmitted through circuits. Therefore, the transmission time and processing speed can be almost ignored and can be defaulted to be the same as that of traditional instruments. The schematic diagram of the module is shown in Figure 3.

Figure 3 Instrument selection module

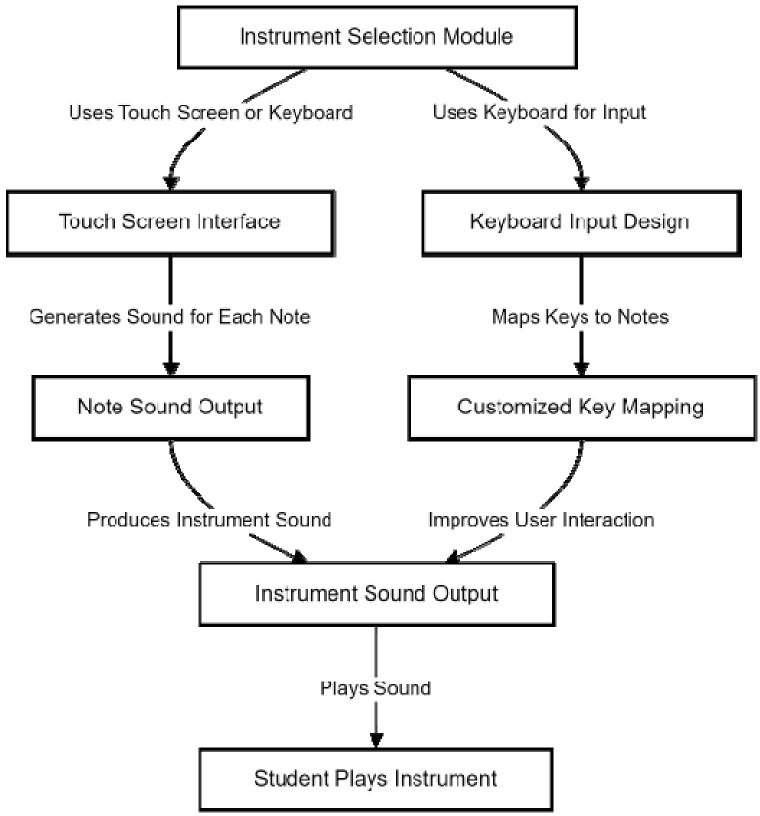


Figure 3 shows how the instrument selection module inputs notes through the touch screen or keyboard and generates corresponding instrument timbres. The touch screen and keyboard input design enable users to select and play notes as needed, enhancing the interactivity between students and the system and the accuracy of timbre playback.

3.3 Module method of music course selection

The design of the music course selection module is a collection of music teaching, which gathers a variety of music teachers and music courses. The design method of the music course selection module is to gather all kinds of excellent music teachers in the music education system. Students can independently choose their favourite music teachers through the platform provided by the music education system which also provides a variety of music instrument courses for independent selection. They can choose one or more courses to learn at the same time (Shaw and Mayo, 2022).

To reflect the advantages of a human-computer interactive music education system, two free music basic education trial courses have been set up for all teachers' music education courses. Students can choose their favourite teachers or courses. Through the audition of two basic music courses, they can judge whether they can accept the teacher's teaching methods and their acceptance ability, which is difficult to achieve in traditional music education and teaching.

The above are the functions of each module of the music education system based on HCI technology. Compared with the traditional music teaching mode, the music education system is a completely new education concept. The setting of each module of the system is a bold attempt at traditional music education. To verify whether the music education system has made a breakthrough in music education, this paper compares traditional music education with the music education system in terms of the cost of music education equipment, the supervision of music teachers' teaching, and the selection of music courses, and obtains the advantages and disadvantages of the two music education methods from the data. The schematic diagram of this module is shown in Figure 4.

Figure 4 Music course selection module

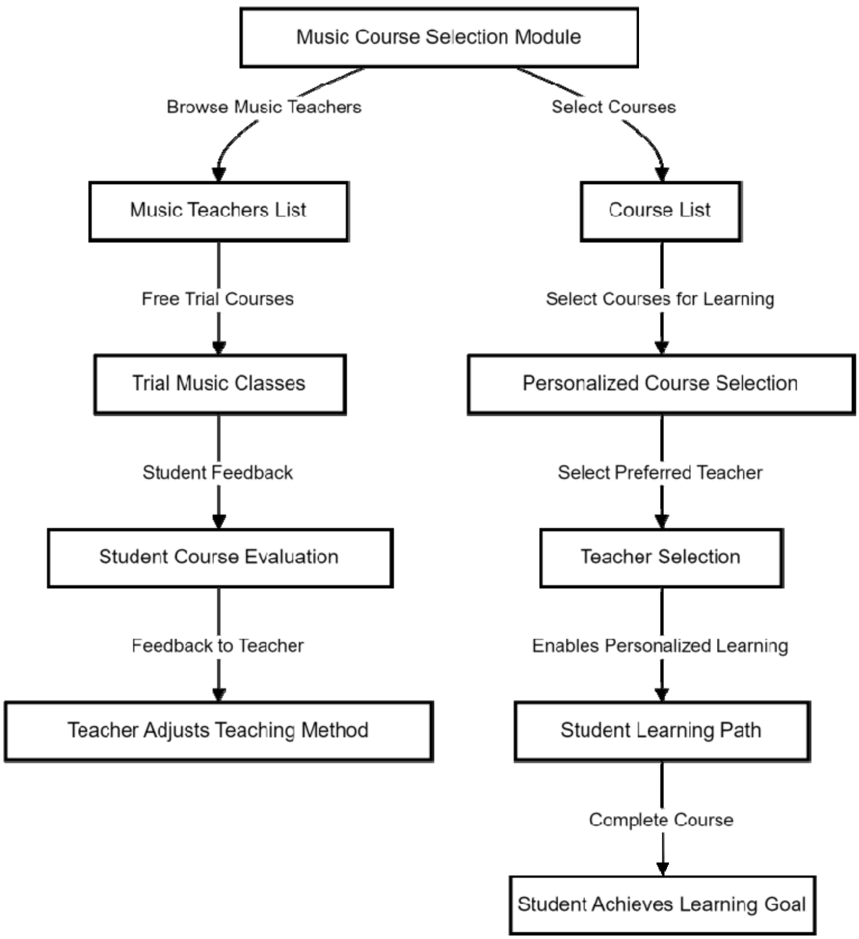


Figure 4 shows how the music course selection module provides personalised course selection. Students can browse music teachers, try out courses, and select suitable teachers and courses based on feedback. The system uses HCI technology to enable students to make flexible learning choices based on their interests and needs.

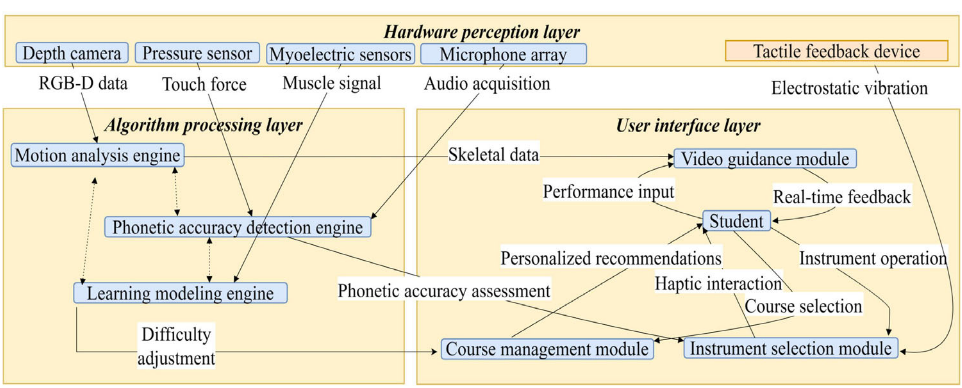
4 Application methods of HCI technology in music teaching

The application of HCI technology in music teaching can not only significantly improve the teaching effect, but also greatly enrich the students' learning experience. First, the video guidance teaching module realises real-time monitoring and feedback of students during the performance through intelligent video algorithms. This technology uses motion detection algorithms to accurately capture every movement of students, thereby providing teachers with a detailed teaching basis. For example, in piano lessons, the system can identify every key movement of students' fingers and instantly analyse their accuracy and rhythm to ensure that every practice can achieve the best results. In addition, the module also supports a two-way video call function, making remote teaching possible, breaking geographical restrictions, and making high-quality educational resources popular.

The instrument selection module is another key part that reflects the advantages of HCI. Through the touch screen and keyboard input design concept, students can directly operate various virtual instruments on the screen to simulate a real performance experience. Whether it is piano, clarinet, or saxophone, the sound of each instrument can be achieved with a simple click or key. This design not only increases the fun of learning but also greatly reduces the high cost of traditional physical instruments. More importantly, the system can adjust the note settings according to the personalised needs of each student, making the learning process more flexible and efficient. When a student is learning a complex piece of music, the system can automatically adjust the difficulty according to his current level and gradually guide him to master the skills.

Finally, the music course selection module shows how to use HCI technology to combine a variety of music teacher resources and course options, giving students more freedom to explore different music fields. In this module, students can browse various course introductions and teacher profiles through the online platform and choose the most suitable course to study according to their interests and needs. To further enhance the user experience, the system also provides a free trial service for basic courses to help students better understand the teaching styles and methods of different teachers. At the same time, based on data analysis, the system can recommend a personalised learning path for each student to ensure that they make the greatest progress in the shortest time.

Figure 5 Architecture diagram of intelligent music teaching system (see online version for colours)



The core of an intelligent music teaching system lies in building a multimodal interactive closed-loop system, which achieves digital reconstruction of teaching scenarios through a complete chain of "perception analysis feedback". The system is based on the core technologies of 3D motion capture, tactile simulation, and synchronous analysis of audio and video, forming a three-dimensional solution covering performance training, instrument interaction, and course learning. As shown in Figure 5, its architecture consists of a hardware perception layer, an algorithm processing layer, and a user interface layer, which are dynamically coupled through real-time data streams, transforming the traditional one-way teaching mode into an immersive two-way interactive experience.

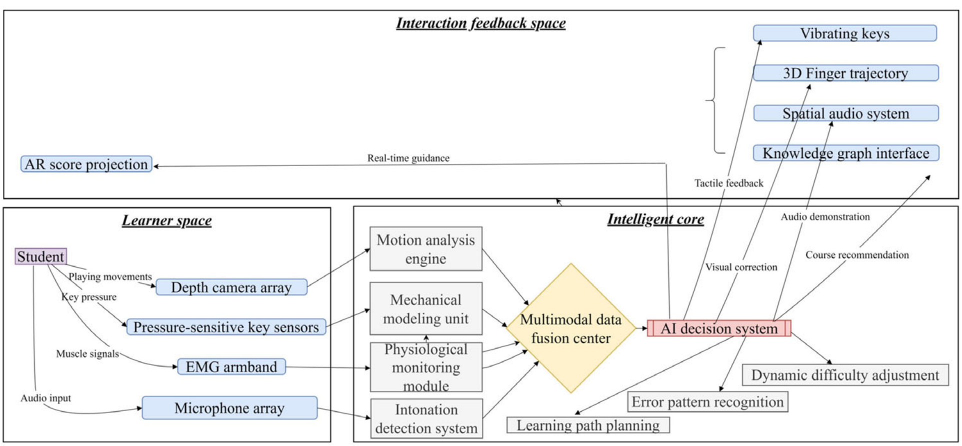
At the hardware perception level, the system deploys a deep camera array, high-precision pressure sensors, and electromyographic signal acquisition devices to construct a multidimensional biomechanical monitoring network. Taking piano teaching as an example, the pressure-sensitive film installed below the keys captures the touch force with an accuracy of 0.01N and synchronously combines with the EMG sensor installed at the wrist to monitor the activation timing of the forearm muscle group. The Azure Kinect DK depth camera at the top is 640 × 576@30fps. The resolution tracks 32 bone nodes, forming a millimetre-level precision 3D motion trajectory. These hardware devices achieve multi-source data synchronisation through timestamp alignment algorithms, establishing holographic digital twins containing spatial coordinates, mechanical parameters, and physiological signals. When students play the Moonlight Sonata, the system not only records the physical displacement of the keys but also predicts potential tendon strain risks through changes in finger joint angles, triggering intelligent warnings when the exercise intensity exceeds the safety threshold.

The algorithm processing layer adopts a hybrid machine learning architecture, which organically combines traditional signal processing with modern deep learning. The motion analysis engine is developed based on an improved MediaPipe framework and introduces a time convolutional network to enhance temporal modelling capabilities. It can solve the kinematic features of 21 hand key points. For the finger rotation technique in piano performance, the system quantifies the spatial trajectory and temporal interval of the fingers by constructing a feature matrix, and then dynamically compares it with a standard template to detect a rhythm deviation of 0.1 seconds. The pitch detection module integrates Mel frequency cepstral coefficients and a fundamental frequency tracking algorithm, which can maintain an analysis accuracy of ± 2 pitch minutes even in noisy environments. The specially designed transfer learning framework allows for skill transfer between different instruments, transforming piano fingering patterns into organ pedal control strategies through feature mapping matrices, achieving collaborative improvement of cross-instrument skills.

The user interface layer adopts a multi-channel stimulation strategy to establish an immersive teaching environment through the synergistic effects of visual, tactile, and auditory senses. When the system detects that the student's left little finger is not raised high enough, the haptic feedback device generates a 120Hz local vibration prompt, and the AR glasses overlay a semi-transparent finger trajectory guide above the music score. For rhythm-type errors, the system adopts a hierarchical correction mechanism: when the deviation is less than 15%, only visual prompts are displayed; 15%–30% deviation triggers gradient colour highlighting in the piano key area; if the error rate exceeds 30%, the audio demonstration clip starts playing automatically. This progressive feedback strategy not only avoids the frustration of beginners but also ensures timely correction of errors. In remote teaching mode, the bidirectional video channel adopts WebRTC low latency transmission protocol, combined with motion compensation algorithm to eliminate the influence of network jitter, so that teachers and students from different places can synchronously conduct four-handed joint training.

The virtual instrument interaction system breaks through the limitations of physical devices and reproduces the operational texture of real instruments through electrostatic friction tactile technology. When students simulate violin bow movement on the touch screen, the surface coating generates a controllable friction coefficient through voltage changes, and with a vibration frequency of 250Hz, accurately reproduces the tactile characteristics of the bow and strings. The pressure tone mapping model dynamically adjusts harmonic components based on touch intensity, presenting a soft and weak sound effect when lightly touched, and stimulating full and strong resonance when heavily pressed. The system's built-in adaptive learning algorithm continuously analyses students' performance data, uses the LSTM network to predict skill development curves, and dynamically adjusts the difficulty parameters of practice tracks. When practicing Chopin's Etudes, if the accuracy of three consecutive phrases exceeds 85%, the system automatically introduces decorative variations to enhance the challenge. If the error rate remains above 60%, the phrase is broken down into one-handed practice mode, and the speed requirement is reduced.

Figure 6 Architecture diagram of intelligent music teaching system (see online version for colours)



The intelligent course recommendation system has constructed a music knowledge graph, which semantically associates more than 3,700 classic songs, 120 performance techniques, and 58 composer style features. By using a hybrid recommendation algorithm, the system can accurately match students' learning needs. After students complete the first movement of Beethoven's 'Pathetique Sonata', the system recommends Czerny 599 related etudes based on the analysis of mispronunciation distribution, while linking Brahms' interludes as a style extension. The quantitative model for course difficulty comprehensively considers four dimensions: skill complexity (T), rhythm density (R), speed requirement (S), and expressiveness requirement (E), and generates dynamic difficulty coefficients. A smooth transition in the learning path is ensured. To reduce selection anxiety, the system provides a course preview function based on neural style transfer. Students can input personal performance clips and generate real-time comparisons of improvement effects under different teacher guidance.

Based on the human-machine interaction process of the intelligent music teaching system, a teaching diagram is constructed, as shown in Figure 6. Figure 6 is mainly divided into three layers: the physical perception layer (learner space), the intelligent processing layer (intelligent centre), and the interactive feedback layer. The AR score projection is achieved by overlaying dynamic fingering markers on top of real instruments and using piezoelectric ceramic plates to provide graded tactile cues for vibration feedback keys. 3D trajectory guidance uses holographic projection to display standard action paths. The spatial audio system is equipped with 5.1 channel speakers to achieve directional perception demonstration, combined with a knowledge graph interface for 3D visualisation of music element association networks. The central hexagonal AI system integrates the following functional modules: LSTM-driven dynamic difficulty adjustment; error pattern recognition based on DTW algorithm; combining knowledge graph-based learning path planning; and multimodal data fusion engine.

5 Experimental comparison between traditional music teaching and music teaching system

At present, although traditional music education and teaching have formed a relatively complete system in all aspects of education after the precipitation of time and its development, the current music education model still has some long-standing problems, that have not been effectively solved in the past years. For example, the high cost of purchasing musical instruments, insufficient teacher supervision, and single course selection have become chronic diseases in traditional music education. Despite many attempts to improve them, the results are limited, and these problems have not been fundamentally solved (Khasanova, 2020). To verify the effect of the intelligent music education system based on HCI technology in practical applications, this paper randomly invited 6 undergraduate music students from a well-known music college (3 of them were sophomores; 2 were juniors; 1 was a senior) to conduct a questionnaire survey on the problems existing in current traditional music education. The survey mainly focused on three aspects: the cost of music education equipment, the supervision of music teachers, and the selection of music courses. By comparing the feedback data of these students using the traditional music teaching model and the intelligent music teaching system, relevant data on these three issues was obtained.

5.1 Cost comparison of musical instruments

In traditional music education, students need to prepare musical instruments by themselves before learning, and there are only two ways for students to obtain musical instruments: self-purchase or lease (Bell and Bell, 2018). Whether it is self paid purchase or lease, the price cost is huge. There are also grades of physical instruments. The more advanced musical instruments, the better their timbre quality and physical feel. On the contrary, instruments with lower prices can only hover around the tone standard line. Some inferior products even have inaccurate timbre, and it is difficult to feel satisfied with the physical feel (Woody, 2021). According to the questionnaire survey on the cost of various musical instruments for 6 music students, the following data was obtained. The survey data table of the cost of physical musical instruments is shown in Table 1.

Table 1 Investigation data sheet of physical musical instruments

Unit(thousand yuan)	*First*	*Second*	*Third*	*Fourth*	*Fifth*	*Sixth*
Piano	21	30	26	24	26	22
Clarionet	1	3	1	1	2	1
Saxophone	8	9	9	8	8	7

It can be seen from Table 1 that the amount spent on physical instruments was generally high. The more expensive the instruments are, the more money they spend. The results showed that the average cost of the six students on traditional physical instruments was 34,500 yuan. As a result, six music students were also surveyed on the cost of a music teaching system based on HCI technology to obtain the following data. Table 2 shows the survey data on the hardware cost of the music teaching system.

Table 2 Investigation data of hardware cost of music teaching system

Unit (thousand yuan)	*First*	*Second*	*Third*	*Fourth*	*Fifth*	*Sixth*
Cellphone	2	0	0	2	1	1
Computer	0	4	0	0	0	0
Ipad	0	0	3	0	2	3

For the sake of data integrity, the average cost of the hardware of the music teaching system of the six students was also counted. The results showed that the average cost of the hardware of the six students was 3,000 yuan.

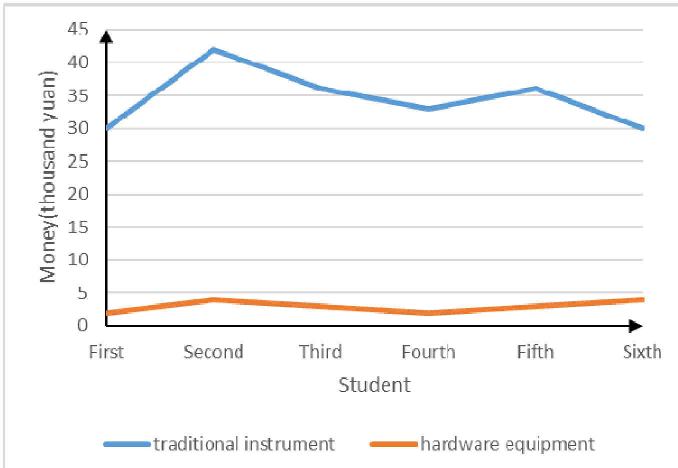
In the case that the effects of traditional music education methods and HCI music education methods are identical, it can be roughly understood from the data that, compared with traditional music instruments, the cost of the music education system was mainly spent on electronic hardware, and the cost was far lower than that of traditional music instruments. This showed that the cost of the music education system was better than that of traditional musical instruments when the effect of music teaching and learning was identical.

According to the data obtained from the instrument cost experiment, this paper had a clear and intuitive data understanding of the cost of traditional physical music instruments and the cost of the music education system. By comparing the cost of traditional physical musical instruments with that of the music education system, a comparison chart of the average cost of musical instruments was obtained as shown in Figure 7.

It can be seen from the analysis and comparison chart that the average cost of the six music students on traditional music instruments was generally high, with a minimum of 30,000 yuan, a maximum of 42,000 yuan, and a difference of 12,000 yuan. The average cost for the six students was 34,500 yuan. That is to say, on average, every family spent more than 30,000 yuan on the purchase of traditional physical instruments, which undoubtedly added a lot of financial burden to every family.

The economic cost of using the music teaching system was much smaller. The highest economic cost of the hardware equipment of the music teaching system was 4,000 yuan, while the lowest cost was only 2,000 yuan. The difference was only 2,000 yuan. The average cost of six students was 3,000 yuan, which meant that each student spent no more than 3,000 yuan on average. This was 10 times less than the average cost of traditional instruments. Therefore, no matter for students or their families, this has greatly reduced the education cost of music education.

Figure 7 Comparison of average spending on musical instruments (see online version for colours)



5.2 *Comparison of music teaching supervision*

In music teaching, the standards for evaluating teaching quality can be analysed from multiple dimensions, including the standard speed of music performance, the compliance rate of music performance, and the degree of teacher supervision of students' music education. Specifically, the standard speed of music performance refers to the ability of students to complete the performance within a specified time, usually evaluated by measuring the speed and accuracy of the performance. The achievement rate of music performance refers to the proportion of students who reach a specific level during the performance, which can reflect the effectiveness of teachers in the teaching process and the learning outcomes of students (Elpus and Abril, 2019). In addition, the level of teacher supervision can also be evaluated by observing indicators such as student participation, feedback frequency, and the quality of exercises in the classroom. When music teachers supervise effectively, the standard rate of students' music performance should show an obvious upward trend. On the contrary, if the music teacher does not carry out effective supervision of students, the standard rate of students' music performance should be kept at the same level or have a downward trend (Savage, 2019). In this paper, six students played the same piece of music three times in two different ways. One was a traditional face-to-face one-to-one teaching mode, and the other was an online instruction using an intelligent music teaching system based on HCI technology. By comparing the results of the two methods, the effects of different teaching modes on the students' music performance achievement rate were analysed. The data table of the standard rate of traditional music performance is shown in Table 3. The standard rate data of music performance of the music teaching system is shown in Table 4.

Table 3 Datasheet of performance standard rate of traditional music

Unit (%)	*First*	*Second*	*Third*	*Fourth*	*Fifth*	*Sixth*
First time	50	60	66	58	70	62
Second time	55	62	64	56	66	58
Third time	51	58	62	60	62	66

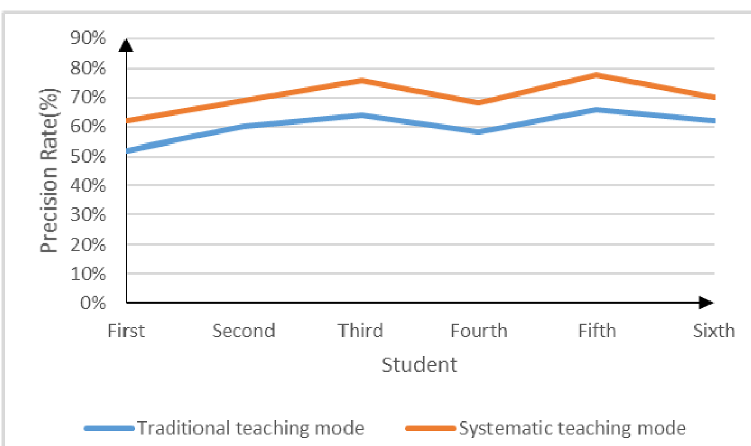
Table 4 Datasheet of standard rate of music performance of music teaching system

Unit (%)	*First*	*Second*	*Third*	*Fourth*	*Fifth*	*Sixth*
First time	50	60	66	58	70	62
Second time	60	68	75	67	78	67
Third time	76	79	87	79	86	80

According to the data in Table 3 and Table 4, it can be roughly seen that the data of the standard rate of traditional music performance was volatile, rising, and falling. This showed that students did not receive the attention and supervision of music teachers when they were learning music. Therefore, in terms of their performance of music, they failed to find and point out the errors in time. Only by their feelings and judgments, can the accuracy of this fluctuation occur.

According to the data obtained in the music teaching supervision experiment, it is known that the quality of music teaching supervision is mainly reflected in the accuracy of students' music performance. The higher the accuracy rate, the better the supervision quality. The lower the accuracy rate, the worse the supervision is. By comparing the accuracy of music performance of students in two different teaching methods, the standard rate of music performance is shown in Figure 8.

Figure 8 Comparison of standard rate of music performance (see online version for colours)



It can be seen from the comparison chart of the standard rate of music performance that the highest standard rate of music performance conducted by traditional supervision was 66%, while the lowest standard rate was 52%. The highest standard rate of music performance in the way of music teaching system supervision was 78%, and the lowest was 62%. Through the trend of the broken line chart of the two supervision methods, it can be seen intuitively that the accuracy of using the music teaching system was generally above the accuracy of traditional supervision. This also fully showed that the supervision ability to use the supervision method of the music teaching system was far more than that of using the traditional supervision method, which reflected the improvement and breakthrough of the music education system in the supervision of music teaching.

Table 5 Questionnaire on traditional course selection

	First	*Second*	*Third*	*Fourth*	*Fifth*	*Sixth*
Piano lessons	√	×	×	×	×	×
Gourd lesson	×	√	×	×	×	×
Recorder lesson	×	×	√	√	×	√
Saxophone lesson	×	×	√	×	×	×
Flute lesson	×	×	×	×	√	×

Table 6 Questionnaire on course selection of music education system

	First	*Second*	*Third*	*Fourth*	*Fifth*	*Sixth*
Piano lessons	√	×	√	×	√	×
Gourd lesson	√	√	√	√	√	√
Recorder lesson	√	×	√	√	×	√
Saxophone lesson	×	√	√	×	×	×
Flute lesson	×	×	×	×	√	×

5.3 Comparison of music course selection

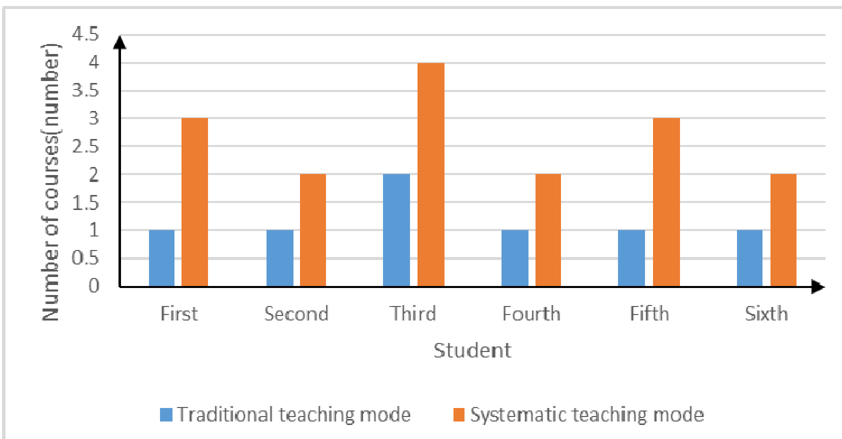
Traditional music course selection is mainly based on offline self-selection and usually relies on offline private tutoring or attending training courses to learn. Due to various reasons such as geographical location, time arrangements, and resource constraints, the number of courses that students can choose when selecting courses is very limited. Specifically, students can often only choose one or two courses, which greatly limit the breadth and depth of their learning. In contrast, the intelligent music education system based on HCI technology provides a richer range of course options. Students can freely choose multiple courses according to their interests and needs, which significantly improve learning efficiency and flexibility. However, with the development of time and the rise of science and technology, this situation is expected to be improved. The music education system used in this paper is an intelligent teaching system based on HCI technology. By using the power of science and technology, the traditional teaching mode that can only carry out offline teaching has been changed, and a new online teaching mode has been provided. The advantage of this model is that students do not need to spend a lot of time and energy on some unnecessary things in the course selection and spend the time saved in the music course study, to improve the efficiency of music learning. This paper classifies the relevant music courses, including piano lessons, Hulusi lessons, recorder lessons, saxophone lessons, and flute lessons. The following is a questionnaire on the traditional course selection and music education system course selection of 6 music majors. The conventional course selection questionnaire is shown in Table 5. The questionnaire for the selection of courses in the music education system is shown in Table 6: (√ for selection in the table, × for non-selection)

According to the survey results of the traditional curriculum selection questionnaire and the music education system curriculum selection questionnaire, it can be seen that the number of courses selected by students has generally increased with the use of the music curriculum education system. This shows that the music education system has increased students' right to choose music courses to a certain extent.

According to the survey data on the course selection of six music students obtained in the music course selection experiment, six students have limited courses to choose from under the traditional teaching method, which is affected by many factors. The choice of online courses is generally increasing.

Through the analysis of the data, the comparison chart of the number of courses selected by 6 students is shown in Figure 9.

Figure 9 Comparison of the number of courses selected (see online version for colours)



It can be seen from the comparison chart of the number of courses selected that in the traditional teaching course selection, the maximum course selection was 2, and the minimum course selection was 1. The difference was 1. The six survey students generally chose one course, which showed that the available courses were very limited in the time when the six students could effectively learn music. The main reason for this result is that there are many factors leading to a large waste of learning time.

After using the music teaching system of HCI, the convenience of HCI and the speed of the online system saved a lot of learning time for students. Therefore, regarding course selection, the maximum number of courses selected by 6 students in the music education system was 4, and the minimum number was 2. The difference was 2. Through the comparative analysis of the data, it can be seen that after the improvement of the music education system, the curriculum choices of the six students have doubled at least and doubled at most. This also fully reflects and explains that the use of online teaching mode is far superior to the traditional offline teaching mode in terms of time and efficiency.

6 Conclusions

The full text mainly focused on the application of HCI technology to focus on the discussion, experiment, and analysis of intelligent music education system mode and traditional education mode on the economic cost of musical instruments, music teaching supervision, and music curriculum selection and finally came to a conclusion.

The traditional music teaching mode has the problems of high economic cost of musical instruments, inadequate supervision of music teaching, and few choices of music courses. The highest cost of musical instruments was 42,000 yuan, and the lowest was 30,000 yuan. The difference was 12,000 yuan, and the average cost was 34,500 yuan. The highest standard rate of music supervision was 66%, and the lowest was 52%. The maximum number of music courses was 2, and the minimum was 1. After the improvement of the music teaching system, under the same effect, the economic cost of musical instruments changed into the cost of hardware equipment, and the cost was far lower than the traditional cost. The highest cost was 4,000 yuan, and the lowest was 2,000 yuan. The difference was 2,000 yuan, and the average cost was 3,000 yuan. The highest standard rate of music supervision was 78%, and the lowest was 62%. The maximum number of music courses was 4, and the minimum was 2.

From the experimental data and analysis results, the intelligent music education system using HCI technology has greatly alleviated and improved the problems of traditional music teaching methods in all aspects. This also proves that the intelligent music education system using HCI technology in this paper is a practical research direction, which can open up a new research field and development direction for existing music education. However, there are still several limitations, among which the small sample size of the experiment may limit the universality of the results and require larger-scale validation. The system's simulation of physical interactions such as tactile feedback is insufficient, which may affect the realistic experience of instrument operation. Future research can expand multimodal interaction technology to enhance operational immersion develop lightweight cross-platform versions that are compatible with low-performance devices and optimise offline functionality.

Declarations

The authors declare that there are no conflicts of interest regarding the publication of this article.

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