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Reforming and innovating music education in universities from a psychological perspective based on interactive technology

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ABSTRACT

Along with the fast developing of IT, it is more and more popular to apply the modem interaction technique to the educational domain, particularly in the college musical educational potentiality. Based on the perspectives of psychology and interactive technology, the author analyzes the latest progress of interactive technology in human-computer interaction, emotional computing, and design psychology, as well as its impact on music education in universities. It is found that the educational effectiveness of MCAI has been maintained at 92 percent and that of the others has been rising. However, there are some differences between them and the new system. Interactive technology can not only optimize the learning experience and enhance teacher-student interaction, but also provide personalized and intelligent learning support for students through emotional computing and ubiquitous computing technology, thereby enhancing learning effectiveness and artistic creativity. By building a student-centered teaching ecosystem, the deep integration of technology and art education will help promote innovation and improvement in music education in universities in the information age.

Keywords: Interactive system, artificial intelligence, Music education, Music Intelligent System

1. Introduction

Along with the fast developing of IT, particularly the wide use of interaction technique in each domain, the teaching modes and methods in higher education have also undergone profound changes. As an important component of higher education, music education has become a focus of attention for educators and scholars on how to use modern technology for reform and innovation [1]. Especially with the increasing demand for emotional experience, interactive participation, and self-directed learning among students, the limitations of traditional education models are becoming more apparent. From a psychological perspective, factors such as students' learning motivation,

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cognitive processes, emotional experiences, and social interactions all play crucial roles in music education. Psychological research has shown that learning outcomes are not only dependent on the transmission of knowledge, but also influenced by students' emotional attitudes, psychological states, and social interactions [2]. In this context, the introduction of interactive technology provides new opportunities for innovation in music education. Using Virtual Reality (VR), Augmented Reality (AR), and Interactive Multimedia Platforms, students can participate in the learning process more autonomously, experience more vivid and intuitive music perception and creation processes, and thus stimulate their higher learning interest and creativity [3].

Now in information age, higher education has come into a new developing phase. Using techniques like big data, IoT, and AI, the functions of modern multimedia devices are becoming increasingly powerful, especially the widely used tools such as Xiwo whiteboard and micro lessons in recent years, which have shown great potential in multiple fields such as education and healthcare. The introduction of AI will greatly influence the educational ideas and ways of musical education, particularly in the way of teaching, so as to better adapt to the new demand for music education in the Internet era. Therefore, the author will explore how to reform and innovate music education in universities from a psychological perspective based on interactive technology, aiming to provide new ideas and methods for the development of modern music education and promote its deeper transformation under the drive of information technology [4-5].

2. Literature Review

Computer Interaction is a subject that focuses on the design, assessment, and realization of human-oriented interactive computing systems, by designing and evaluating computer-based systems to make them most accessible to humans. Computer Interaction is an integrated subject which includes the fields of Computer Science, Psychology, Sociology, Industrial Design and Graphic Design. Since the end of 70's, people have put forward the notion of usability in human-computer interaction, and have started to research on how to evaluate and apply it. Wen et al. have created a web-based learning program for interactive learning, and have found that on-line techniques have an influence on their creativity. This experiment is carried out in a Chinese musical college, and the method of collecting data is a questionnaire. This study consists of two musical instructors and a hundred first year students who study music on the basis of the on-line curriculum. Two interviews were conducted on the subjects: pre-and after-class. The findings show a significant improvement in the creativity of the students [6]. Ouyang, L. et al. investigate the role of existing interactive speakers in enhancing early music education for children aged 3 to 5. The initial phase of the study revealed that these devices could effectively facilitate active engagement and contribute to the musical development of young learners [7]. Hu et al. proposed an interactive gesture robot with a distributed design model for music teaching. First of all, they designed the customer. The client gesture acquisition module uses a dual channel convolutional neural network (DCCNN) for gesture recognition. The convolutional layers of the constructed DCCNN contain two sizes of convolution kernels, which operate on the image. Secondly, they designed a server to recognize the collected gesture instruction data through a dual stream convolutional neural network (CNN). This network divides gesture instruction data into K segments and sparsely samples each segment into a short sequence. Extract the optical flow features of each short sequence using optical flow algorithm. Finally, the performance of the robot was tested [8].

Based on this research, the author proposes a reform and innovation of music education in universities from a psychological perspective based on interactive technology. Based on the perspectives of psychology and interactive technology, the author analyzes the latest progress of interactive technology in human-computer interaction, emotional computing, and design psychology, as well as its impact on music education in universities. By building a student-centered teaching ecosystem, the deep integration of technology and art education will help promote innovation and improvement in music education in universities in the information age.

3. Research Methods

3.1. Human Computer Interaction Technology

Human-Computer Interaction (HCI) refers to the technology that enables seamless communication between humans and computers through various modes, such as voice, gestures, emotions, and other interactions. The user interface, often called the human-machine interface, acts as the platform for two-way communication, allowing users to monitor and control computer systems effectively. By leveraging HCI technology, individuals can rely less on memory, reasoning, and cognitive effort while benefiting from enhanced sensory and motor capabilities [9].

The evolution of human-computer interaction (HCI) has paralleled the advancements in computing technology, shifting its focus from machine-centric to human-centric approaches. Over time, interfaces have progressed from command-line systems to graphical user interfaces, direct manipulation interfaces, multimedia interfaces, and now toward the multi-channel multimedia interfaces that are a focal point for researchers today. Digital interfaces have increasingly supplanted physical hardware as the primary medium for interaction in intelligent information systems.

3.1.1. Development history of human-computer interaction. Human-computer interaction (HCI) technology enables users to interact with virtual environments created by smart devices in an intuitive and user-friendly way. Ideally, HCI would eliminate the need for traditional input devices like keyboards, mice, and touchscreens, fostering seamless and natural communication between humans and computers at any time and place. Although this ideal has not yet been fully realized, current technologies allow intelligent systems and mobile devices to interpret user actions such as muscle movements, gestures, and spoken language, transforming them into machine-readable information. By engaging multiple sensory modalities, these systems deliver real-time interactive feedback to users. The advancement of HCI plays a critical role in shaping user experiences and expanding the potential applications of augmented reality, serving as a foundational technology in this domain [10-11]. Figure 1 illustrates the evolutionary trajectory of human-computer interaction technology.

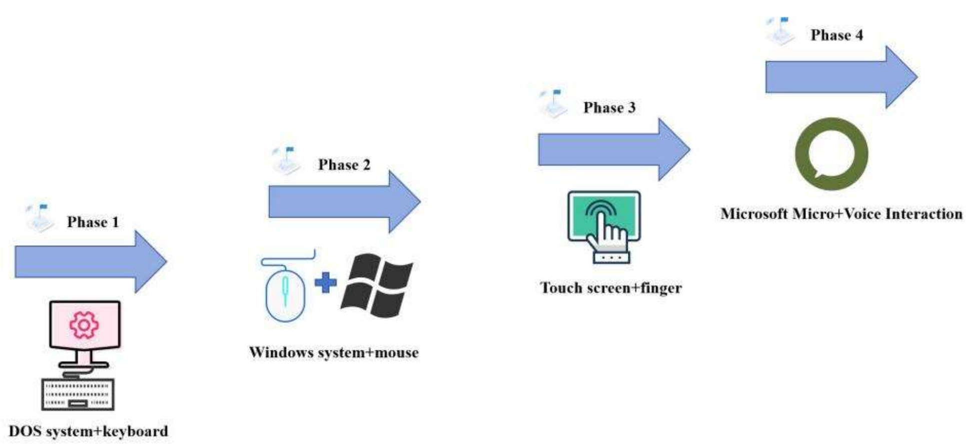

Fig. 1. Development history of human-computer interaction technology

3.1.2. Current Status of Human Computer Interaction Technology. While the PC model has changed from PC to PC, the interactive model of PC has also put a lot of constraints on PC operating and HCI. For this reason, we have put forward a new computational model called Pervasive Computing. The concept of ubiquitous computing is a vivid description of the disappearance of computers. Imagine, when humans have a good enough grasp of certain things, these things become inseparable from our lives. Gradually, we will no longer feel their existence, just like paper and notes are everywhere now. In the future, computers will also be invisible, and computing will be ubiquitous. Invisible human-computer interaction will also be ubiquitous. Just like the oxygen we breathe, which we cannot see but can experience. The invisibility of computers is reflected in their high embeddedness and mobility in technology, and the two main factors that constrain ubiquitous computing are computer interaction devices and user cognitive characteristics. The emergence and development of multi-channel technology have provided the foundation for a natural human-computer interaction environment, enabling users to feel the presence of computers at all times without being limited to computer devices such as keyboards and mice, which constrain computer interaction devices. The research on context perception provides a solution to the constraints of user cognitive characteristics [12].

Ubiquitous computing determines that computers should be more proactive in the ubiquitous computing environment, and should not rely solely on user input as the driving force for executing operations. Instead, they should intelligently perceive the user's operational intentions and expectations, perform operational tasks, and return operational results when the user has not issued operational requests or provided precise interaction request inputs. Perceived human-computer interaction refers to the use of interactive context by computers to perceive users' willingness and inclination to interact, in addition to their active input, in order to actively complete operational and computational tasks.

3.1.3. Emotional Machines and Emotional Interaction Theory. Emotion represents a unique aspect of human cognition, characterized by intricate processes and mechanisms. By integrating emotional capabilities into machines, researchers advance the field of artificial intelligence, particularly in applications like music education. For instance, in music education, intelligent systems can engage with students by providing guidance when challenges arise or offering feedback and explanations when mistakes are made during practice, as depicted in Figure 2.

Fig. 2. Emotional Interaction Relationship

Musical students can get into the study complex, which is often a study platform, by logging in to the customer, and then show the study outcome to the teacher. Moreover, the author makes improvements to the new teaching pattern and pattern by using the passive feedback as the basis to strengthen the students'study consciousness and competence, thus creating a complete interaction cycle. Compared with the conventional one, AI is more effective in raising students' learning efficiency by making use of development feedback and rational application of emotion [13-14].

3.2. Usability, User Experience, and Design Psychology

Design psychology is based on cognitive psychology and provides several very useful design principles. Design psychology believes that in design, the following aspects should be considered:

1) Use all kinds of constraints to make sure that the user is able to understand what is possible at all times;

2) Highlight product visibility, including system concept models, operational capabilities, and operational outcomes;

In other words, designers need to ensure that users understand the operating methods and can see the operating status of the system. These considerations in design psychology are the predecessors of several evaluation elements followed in heuristic evaluation methods for usability assessment. Thus, it can be seen that design psychology lays the theoretical foundation for usability and usability evaluation, and usability evaluation methods are the concrete implementation of design principles in design psychology. The mental model consists of the design, the user, and the presentation of the system, as illustrated in Figure 3. The design model is the concept model for the product, and the user model is the way that the user perceives the concept model of the product, which includes the operation. Communication between users and designers is achieved through system representation. Therefore, in order to accurately convey the design model to users, designers should maintain consistency between the system representation and the design model [15].

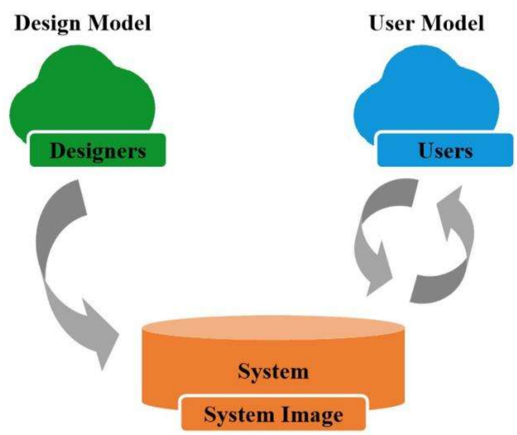

Fig. 3. Three aspects of psychological models

It can be said that in the design process, following design principles in product design basically meets the requirements of usability evaluation and user experience in all aspects. Design principles are the theoretical basis of usability and user experience. Table 1 lists which usability and user experience elements each design principle meets, and the numbers represent the degree [16].

Table 1. Design Principles, Usability, and User Experience Elements

	Design discipline	Rule1	Rule2	Rule3	Rule4	Rule5	Rule6	Rule7
Serviceability	Usefulness, and effectiveness	0	0	0	2	1	1	1
	Interaction efficiency	1	2	1	1	2	1	2
	Easy to learn, easy to remember	2	1	2	0	0	0	1
	Error frequency, and severity	1	1	2	1	1	1	0
	User satisfaction	1	0	1	2	2	2	0
User Experience	Impression	1	1	1	3	3	3	0
	Serviceability	2	0	2	0	1	1	0
	Functionality	0	1	1	1	0	0	0
	Content	1	0	0	1	1	1	0

From Table 1, we can see that the three layers of psychology of the designer, the user, and the system have significantly increased the usability and memory of the interface, as this principle cleverly utilizes the user's existing brain knowledge to reduce re memorization. Simplifying the task structure can help users focus on the operations they are interested in, enabling the system to guide users' usage tendencies, thus improving interaction efficiency and functionality significantly. The establishment of interface visibility and natural matching helps users to correctly and instantly grasp the system status, thereby reducing the frequency of errors and improving overall usability. Thoroughly considering error and operation prompts is an important method to enhance brand impression in user experience, as delicate thinking can better make users feel the humanistic care of the product. Finally, adopting universal interface design standards and specifications can be helpful in improving hard indicators of usability, such as interaction efficiency, usefulness, and ease of learning [17].

3.3. Design of College Music Education System Based on Interactive Technology

The interactive technology-based music teaching support system is composed of seven core modules, as illustrated in Figure 4.

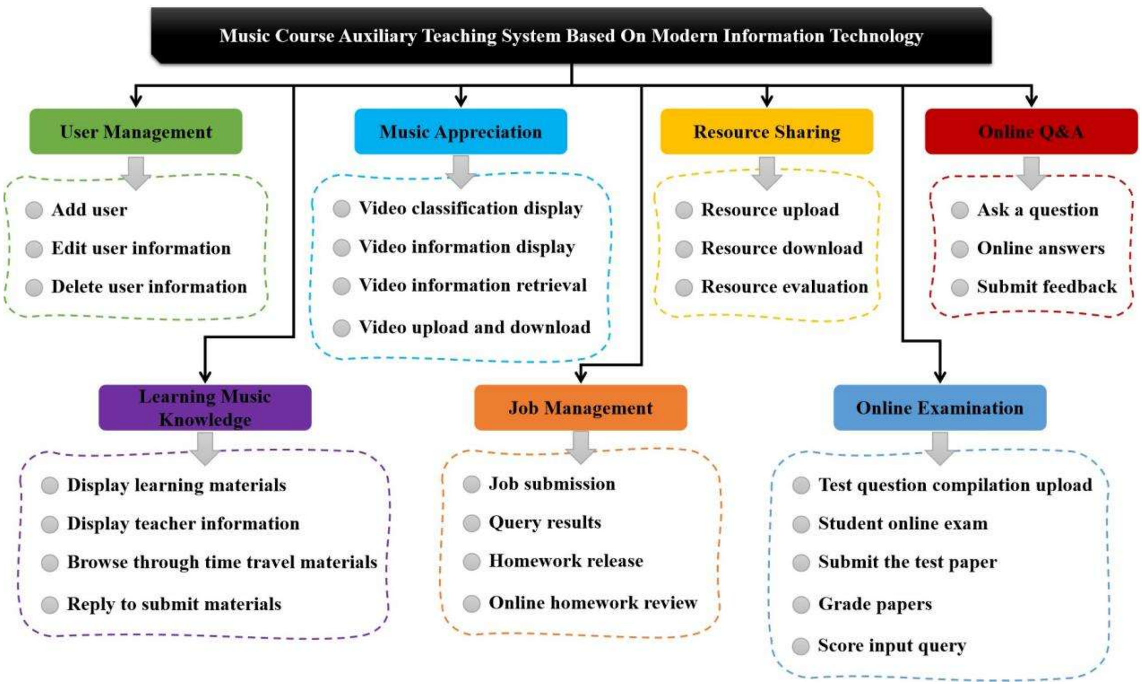

Fig. 4. Functional Module Diagram of Music Teaching System

3.3.1. Database Design. In the critical stage of database design, E-R graph is particularly important as a powerful aggregation model. It includes three core elements: Entity, Attribute, and Relationship. Through such a model, we can clearly see how data is organized together and be able to perform effective queries and operations on the data. However, having only a good E-R graph is not enough to build a fully functional relational database system. To achieve this goal, it is necessary to transform the graphical E-R diagram into a more descriptive and operational relationship pattern. This conversion process requires careful design to ensure that each entity, attribute, and their relationships can be accurately mapped to the database [18]. The E-R chart of musical study model is illustrated in Figure 5.

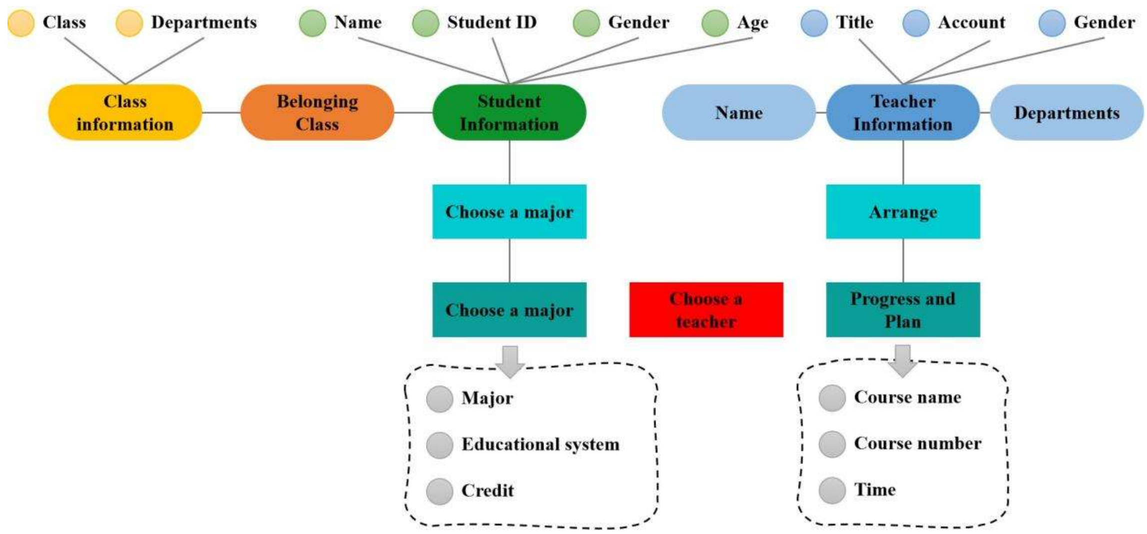

Fig. 5. E-R diagram of database

3.3.2. Login Module Design. The registration module of the system is a primary interface of the system, which requires the user to validate it in order to utilize the other features of the system. This system can be used to communicate with the user efficiently, and allocate the appropriate operating interface according to the user's role. The detailed procedure for logging into the system is illustrated in Figure 6.

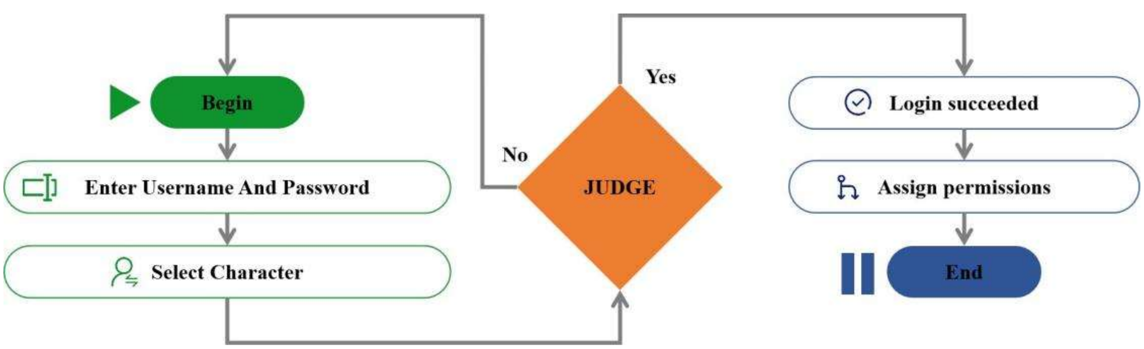

Fig. 6. System login process

3.3.3. Design of Knowledge Learning Module. The module of learning music knowledge is a comprehensive learning platform aimed at providing learners with comprehensive and in-depth music education resources. The specific process of the knowledge learning module is shown in Figure 7.

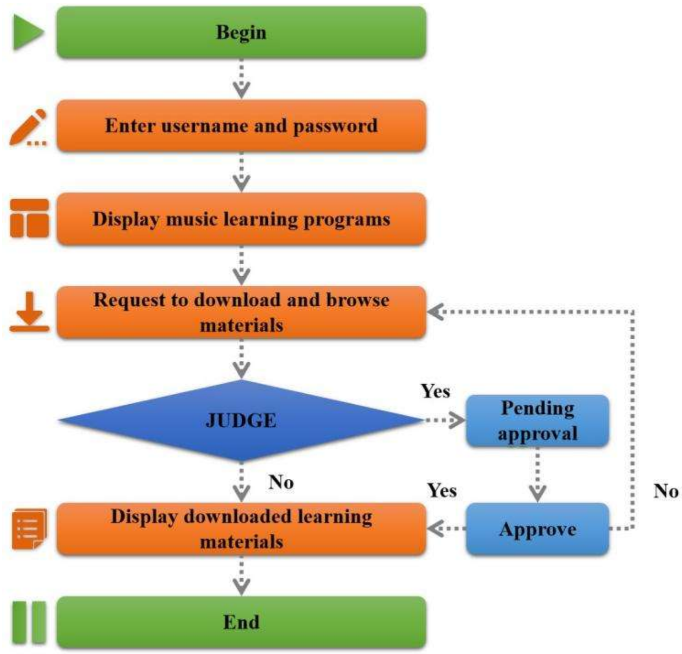

Fig. 7. Knowledge Learning Process

3.3.4. Appreciation Module Design. Firstly, the managers will preempt the relevant data, for example, video, sound, literature, and so on, and then re-organize them based on their appreciation content and categories, and hand them over to a specified place for storing information. Then, they rapidly search for and carry out high-level search based on defined filtering requests for music appreciation data that are stored in the database [19].

3.3.5. Design of homework management module. The homework management module within the modern information technology-based music teaching support system comprises six key processes, as shown in Figure 8.

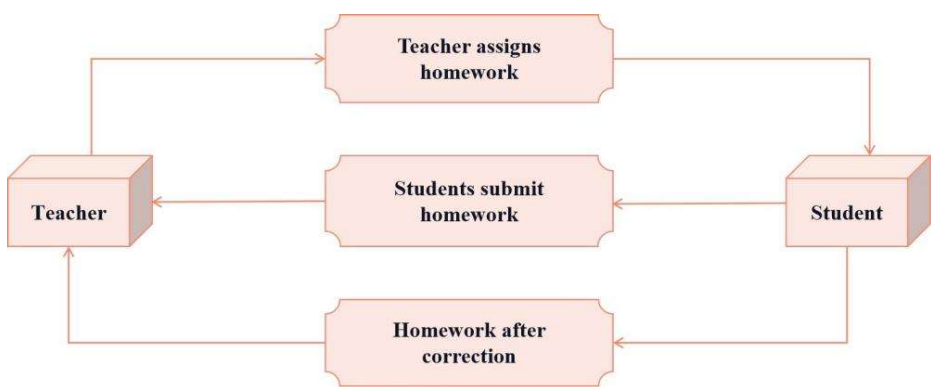

Fig. 8. Homework Management Process

3.4. Analysis and Implementation of Music Intelligent System

The application of artificial intelligence algorithm RBF algorithm in interactive music education intelligent system has achieved the construction of its core algorithm model. In this paper, we present a RBF neural network, which consists of self-adapting neurons. In the first layer, the individual case information elements are classified into several indicators and entered into the NN. The second layer is the membership function, which is represented by Equation (1):

$$\mu_{ij}(x_i) = \exp\left[\frac{(x_i - c_{ij})^2}{\sigma_j^2}\right] \\ i = 1,2,\cdots r; j = 1,2,\cdots,u \tag{1}$$

The third layer is about the quantity of fuzzy rules, which is to minimize the amount of the learned rules by using the model of learning, in order to achieve maximum efficiency. Among them, in formula (2), perform mathematical calculations on the output of rule j:

$$\phi_j = \exp\left[-\frac{\sum_{i=1}^{r}(x_i - c_{ij})^2}{\sigma_j^2}\right] = \exp\left[-\frac{\|X - C_j\|^2}{\sigma_j^2}\right], \\ j = 1,2,\cdots,u \tag{2}$$

In the formula, $cj = (c_{1j}, \ldots, c_{rj})$ represents the center of the jth RBF unit. The feature of RBF NN is that it is more active as it gets nearer to the centre, and this is in line with the influence of interaction. Level 4 is normalized, and its nodes are identical to those of fuzzy rules. The output of its jth node Nj is represented by formula (3):

$$\Psi_j = \frac{\phi_j}{\sum_{k=1}^{N}\phi_k} j = 1,2,\cdots,u \tag{3}$$

The fifth level is the output level, and it can be used to evaluate all kinds of musical performance. This method is based on TS Fuzzy Model of RBF. The output of this method is represented by Formula (4):

$$y(x) = \frac{\sum_{i=1}^{u}\left[(a_{i0} + a_{i1}x_1 + \cdots + a_{1r}x_r)\exp\left(-\frac{\|x - c_i\|^2}{\sigma_i^2}\right)\right]}{\sum_{i=1}^{u}\exp\left(-\frac{\|x - c_i\|^2}{\sigma_i^2}\right)} \tag{4}$$

Wk represents the connection method of the kth rule, which is the sum of the weight products of the output variables, as shown in equation (5):

$$y(x) = \sum_{k=1}^{u} w_k \cdot \Psi_k \tag{5}$$

In the case of large-scale datasets, based on the previous music data, an RBF network learning model is established, and on this basis, the developed software platform is used to evaluate it, ultimately forming a perfect learning model [20]. As shown in Figure 9.

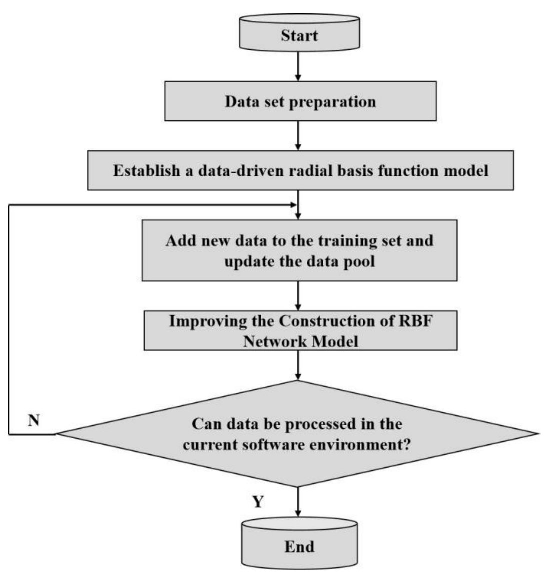

Fig. 9. Program Design Diagram

4. Results Analysis

4.1. System Verification

4.1.1. Experimental Preparation. Each user level, including teachers, students, and administrators, has their own unique identity permissions, which are implemented through fine division within the system. This grading strategy allows educational institutions to allocate different permissions based on their respective teaching plans and management needs, making the entire system more flexible and efficient. In the construction of the music intelligent system, technicians pay special attention to integrating the intelligent teaching mode and the assessment mechanism of learning skills into the teaching management process. Through artificial intelligence technology, the system can effectively identify and classify various teaching subjects such as teachers, students, courseware, and auxiliary tools, and develop corresponding teaching strategies based on teaching content and objectives. In addition, the system can comprehensively integrate teaching methods, including organization, management, evaluation, assessment, and strategy development, to ensure the orderly development of teaching activities. In this way, various roles can find the required services in the intelligent system, achieving personalized teaching experience. To improve the practicability and availability of this system, it consists of assistant training, self-study and performance training. The auxiliary training section provides a series of standardized training procedures and guidance to help students better master music skills; The self-learning module encourages students to actively explore music knowledge and improve learning efficiency through self testing and reflection; The performance training module focuses on practical operations, enhancing students' practical abilities by simulating real performance scenarios. These three modules complement each other and together form a comprehensive music learning and training system. The logic diagram of the system shows the interactive relationship between each module, as shown in Figure 10.

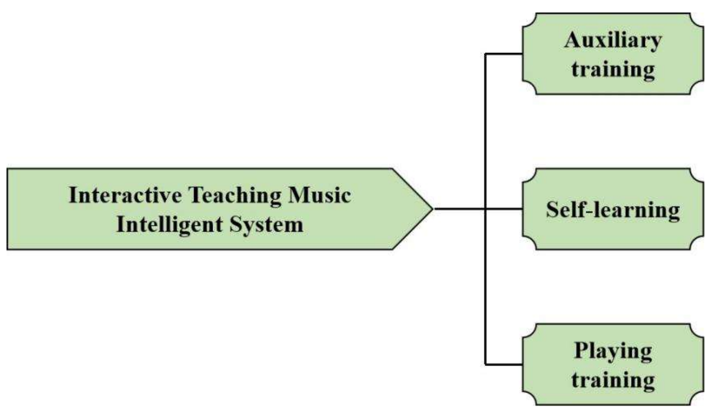

Fig. 10. Functional Structure Diagram

The powerful support of the backend database is indispensable when building various functional modules. In addition, SQL Server provides a comprehensive data solution framework, making the analysis and querying of massive data simple and fast. The Musical Intelligence System's network topology consists of two parts: software and hardware. A DB Server will have 4 GB storage, 500 GB RAM, and 2 CPU Gigabit LAN in a server environment. As for the software, we choose the system and the application software, and we select Veritas as the backup. The data base of the platform is composed of musical study question library, which contains the piano playing problem, the score problem, the evaluation problem and the musical knowledge problem. The data list of the data base contains a variety of information, for example, a piece of music, a piece of music, a multi-media document, and an answer message, as illustrated in Table 2.

Table 2. Database Information List

Field name	Field Content Explanation	data type	Category restrictions	notes
Test_Type_ID	Type number	Number(4)	NotNull	Interactive type
Test_Type_Name	Type name	Varchar2(40)		
Test_Title	Score title	Varchar2(1000)	NotNull	Title Description
Knowledge_ID	Knowledge Point Number	Number(2)	NotNull	
Knowledge_Name	Knowledge Point Name	Varchar2(40)	NotNull	Knowledge points in music history, etc
Grammar_ID	Practice number	Number(2)	NotNull	Primary key
Grammar_Name	Exercise Name	Varchar2(40)	NotNull	Chopin's Etudes, etc
Territory_ID	Instrument number	Number(2)	NotNull	
Territory_Name	Instrument name	Varchar2(40)	NotNull	Piano, guitar, etc
Test_Text	Main text of knowledge points	Varchar2(4000)		
Level_ID	Belonging level	Number(2)	NotNull	
Diff_Quot	Degree of Difficulty	Number(2)	NotNull	12345
Create_Name	Submit User	Varchar2(20)		
Book_No	Music score source	Number(10)		
Test_Image	Corresponding image	Varchar2(200)		Image file name
Imedia_Text	Multimedia files	Varchar2(200)	NotNull	File name and directory
Choice_Text	Option Text	Varchar2(1000)	NotNull	
Key_Text	Performance Text	Varchar2(2000)	NotNull	Standard Text
Key_Remark	Music category description	Varchar2(1000)		

4.1.2. Test results. At a certain normal university, an innovative music education technology is being introduced and gradually popularized. Named Music Intelligence System, this instrument is designed to improve students'study experience by using AI arithmetic and interaction model. To prove its validity, the University has chosen participants from Music Academy 2022 to conduct an annual use test. The first time a user enters a musical intelligence system, he or she will discover a simple and straightforward interface. At the bottom of the system login interface, various course types and their names can be seen, including subject lectures, vocal singing, sight singing and ear training, as well as core courses such as basic music theory. In addition, the system also provides practical activity bars such as the main menu, navigation bar, system introduction, and calendar to help students better plan their study time and content. In artificial intelligence based music intelligence systems, four courses have been offered: firstly, subject lectures, which cover the latest developments in music and in-depth analysis of music theory; Finally, the basic music theory course teaches students the fundamental knowledge of music theory, laying a solid foundation for further music practice.

With the continuous evolution of the music discipline, music intelligent systems can regularly push new themes based on seasons or specific festivals, in order to enrich course content and expand students' horizons. These topics typically include academic lectures within the professional field, as well as Q&A and exchange activities related to music related knowledge. The Q&A module mainly interacts through chat and interactive evaluation to ensure that students can receive the necessary support and feedback in a timely manner. In terms of vocal performance learning, intelligent systems analyze the learning content in detail through text and multimedia forms. From the introduction of basic singing techniques to specific teaching videos, and then to the appreciation of representative works of different singing techniques, the entire learning process has been carefully constructed into a scientific and comprehensive knowledge system. This structured learning path makes the content easier to understand and remember, greatly improving learning efficiency and interest. As for the learning of music theory knowledge, the music theory testing theme module of this intelligent system adopts an interactive teaching strategy and designs an online platform containing a knowledge question bank. This question bank can randomly generate various questions to evaluate students' mastery of the knowledge they have learned. In response to the specific requirements of the course, the system will also program and develop the testing module to achieve online music theory exams, allowing students to practice and take exams anytime and anywhere, thus truly achieving an efficient and convenient learning experience.

4.2. Teaching Efficiency

To evaluate the performance and teaching effectiveness of the university music education reform and innovation system based on interactive technology, a comparative experimental analysis was conducted. The experiment utilized the MATLAB platform on a Windows XP system with 16GB RAM. The system's teaching efficiency was assessed by examining its impact on learning outcomes. Three groups of university students with comparable backgrounds and levels of music knowledge were selected as participants. A single instructor employed identical teaching materials to deliver music education through various interactive technology systems. The effectiveness of each system was measured by assessing students' understanding of course concepts. The results, presented in Figure 11, highlight the differences in enhancing students' music learning outcomes and knowledge retention across the systems.

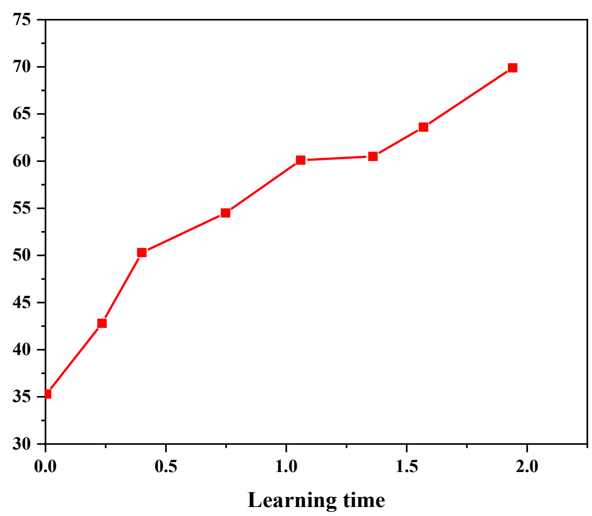

Fig. 11. Teaching Efficiency of Different Teaching Systems

Based on Figure 11, we can find out that with the variation of the time of study, the performance of the teachers' teaching effectiveness is different. Among them, the educational effectiveness of the Interactional Educational Reformation System was maintained at 92 percent or higher, and the others had an increasing tendency, but it was not as good as the one put forward by the writer.

5. Conclusion

With the continuous development of information technology and the transformation of educational needs, college music education urgently needs to achieve innovative transformation of teaching modes and methods through the deep application of interactive technology. The author explores the latest developments of modern interactive technology in human-computer interaction, emotional computing, and design psychology from the perspectives of psychology and interactive technology, as well as its impact on music education. Research has shown that interactive technology can provide new impetus and technological support for the reform of music education in universities by optimizing the learning experience, enhancing teacher-student interaction, and improving learning efficiency. From emotional interaction to the application of ubiquitous computing, from user experience to the integration of psychological models, interactive technology not only enhances students' learning interest and creativity, but also effectively solves the problems of unidirectionality and limitations in traditional education models. At the same time, the introduction of emotional machines and emotional computing has made music education more humane and intelligent, providing students with more targeted and personalized learning support. By building a student-centered teaching ecosystem, achieving deep integration of technology and art education, and promoting music education to a higher level in the information age.

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