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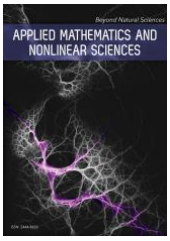

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Practical Teaching of Music Curriculum in Colleges and Universities Based on Multiple Intelligences Theory

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Abstract

Traditional piano teaching usually focuses on students' mastery of music skills and music theory, but neglects the cultivation of students' musical expression and creativity. In this paper, the multiple intelligence theory is used as the guiding theory, and the multiple hybrid teaching model of the piano course is established by combining the flipped classroom. The Fuzzy-CDF model is introduced to quantify students' piano music cognitive level, the Apriori algorithm is used to generate piano music knowledge point sequences, and multiple algorithms are used to collaborate on personalized recommendations of piano music knowledge resources for students. For the application effect of the piano music multivariate hybrid teaching model established in this paper, a teaching experiment was conducted to analyze it with H Music Academy as an example. The results show that the combined ability of song arrangement and playing and singing of the experimental class improved by 9.74 and 11.10 points respectively compared with the performance of the control class, and the average value of the difference between the pre-and post-tests of the experimental class's note recognition ability compared with that of the control class reached 5.8 points. The application of Multiple Intelligences Theory can stimulate the individual's sensitivity to timbre, pitch, and meter, fully enhance students' musical expression and creativity, and make piano learning more effective.

Keywords: Multiple intelligence theory; Fuzzy-CDF model; Apriori algorithm; Knowledge point sequence; Personalized recommendation; Piano teaching.
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1 Introduction

With the continuous development and progress of education and teaching in colleges and universities, the piano performance course in music majors is increasingly sought after and valued by college students nowadays [1]. In the actual piano teaching classroom, teachers should fully do a good job in the preparation work before class, combining theoretical knowledge and practice, the teaching work carried out should have a strong synthesis [2-3]. Teachers should pay attention to the piano classroom teaching, as well as the current social demand for talents in this area, to understand the learning needs of students, and correctly recognize that the previous more traditional and single teaching methods can not cultivate talents who can meet the current social needs [4-5].

Music education in colleges and universities is heavily dependent upon the piano, which is considered an important form of music performance art. Educationalists have found that there is an intrinsic correlation between human learning behavior and the development of intelligence, and it is not until American psychologists put forward the theory of multiple intelligences that the basic elements of human intelligence have been explored and utilized [6-7]. The intelligences related to piano teaching include musical intelligence, as well as correlation with linguistic intelligence, physical-motor intelligence, spatial intelligence, and so on. [8]. The application of the theory of multiple intelligences can stimulate individual sensitivity to timbre, pitch, and meter, make piano learning more targeted, stimulate students' enthusiasm for learning and autonomy, and guide them to actively participate in learning and exploring, with better learning results [9].

In this paper, guided by the theory of multiple intelligences, the collection of piano music teaching resources is carried out by using the informationization platform, which helps students' learning content to be richer, and combines with the flipped classroom to construct a multiple hybrid teaching mode for music courses in colleges and universities. To meet the students' learning content needs and realize the personalized recommendation of piano music resources, the Fuzzy-CDF model is used to quantify the students' cognitive level, and the Apriori algorithm is used to mine the frequent item sets of students' ungrasped knowledge points and then combined with the existing resource library, to reasonably plan the sequence of knowledge points suitable for students. After obtaining the sequence of knowledge points suitable for students, the group intelligence algorithm is used to generate personalized learning recommendations for students' piano music resources with the support of the piano music learning resource library and learners' cognitive level. For the effectiveness of the multivariate blended teaching model established in this paper, the first-year students of T City H Conservatory of Music University are taken as the research examples, and validation analyses are carried out in various aspects, such as the teaching effect, note recognition ability, multivariate competence enhancement, and personalized learning effect, etc., respectively.

2 Review of the current state of research

In the process of piano teaching, teachers need to pay attention to students' musical literacy, improve their aesthetic and aesthetic level, need teachers to pay attention to the transmission of musical connotation in teaching, encourage students to improve students' ability of music appreciation and artistic cultivation through self-appreciation, analysis, and expression. Simones, L. et al. explored the importance of gestures in the process of teacher-student communication and interaction during the process of piano music teaching and analyzed the types and frequency of gestures used during piano playing. The analysis of gestures used during piano playing revealed the types and frequencies of them. It was found that spontaneous musical gestures during piano music playing can realize the interactive communication between teachers and students, and the consistent frequency of teacher-student gestures can help students better understand the rhythm of piano music and improve their

piano expressiveness [10]. Ann Stolz, B. took the fourth movement of Schubert's major sonata as an example of the study, analyzed the author's specific experience when he was a piano teacher, and showed the importance of his efforts during the process of piano performance, and the importance of his efforts during the process of piano performance. The importance of one's efforts during the performance can help the player to better realize the piano music creation and transfer this approach to other areas in a conscious way to better sustain the piano music development [11]. Kelli, E. et al. To be able to realize the evaluation of the impact of piano playing individual notes and simple songs in an equivocal teaching methodology, four developmental children and four children with autism spectrum disorder A controlled experiment was conducted to train them in piano music stimulation. The developmental and autistic children demonstrated consistent piano playing skills using an equivalence teaching method at the end of the training [12]. Lee, C. K. et al. analyzed the factors associated with influencing the motivation of the music studio learners using 13 participants learning piano as an example of the study and analyzed the data with selective coding using the psychological needs theory as a framework. The experiment can help to better establish the piano learning environment, discover the factors of the piano learning environment that may lead to lower piano learning ability, and promote the reform of the piano music teaching style [13]. Katie et al. evaluated and analyzed a course on sight-reading skills training for advanced pianists, collected pre and post-test data for 25 pianists who participated in the course, and analyzed the data using a mixed model of the data was analyzed using a mixed model. It was found that the program had a positive impact on the reading skills of pianists and that it could be utilized to enhance the visual reading skills and piano music expression of young pianists [14].

When teaching piano, what kind of ways should be taken to improve students' musical expression, so that the players can be more flexible and free in the process of playing, showing their actual ability and real state. Ying, J. analyzed the specific influence of teachers' aesthetic development on students when teaching piano, relying on the notes and rhythmic changes of the piano score, which can make the teachers and students communicate and interact with each other to promote the development of teachers' and students' aesthetic consciousness. Relying on the notes and rhythmic changes of piano music can make teachers and students communicate with each other in the process of interaction to promote the cultivation of teachers' and students' aesthetic consciousness, which can enhance students' piano playing skills and piano musical expression while promoting the development of piano music [15]. Hawkes, M. E. explored the feasibility of introducing mental skills training into regular piano music lessons, with the intention that the method could address piano music performance anxiety and enhance the performance experience and quality of performance for piano musicians. From the results of the study, the introduction of mental skills training for piano teaching can enhance students' attention and sense of calmness, and promote students' confidence and quality of piano performance [16]. Lei, S. Y. et al. argued that the current development of information technology has allowed piano music teachers to enhance their lessons through social media, which builds up virtual environments to help music teaching and learning to teach piano. Piano teaching based on social media can promote the analysis of knowledge, more effectively stimulate students' interest in learning the piano, realize the real-time interaction between teachers and students, and improve the effect of piano teaching [17]. Griffith, K. R. et al. investigated the effects of equivalency teaching in the acquisition of music reading and piano playing skills, using six female college students as an example to compare the difference between playing chords on a piano and playing chords on a keyboard. The results of the two experiments were not significantly different, i.e., they showed that equivalence teaching can effectively help adults read piano music and play chords on the piano keyboard [18]. Espeland, S. et al. characterized repertoire in music teaching and investigated the relevance of repertoire to the teaching of improvisation, which was verified through classroom observations and actual interviews. The results showed that teachers' improvisation teaching in the

music classroom can improve the overall learning efficiency of the classroom, and also enhance students' music learning power in the teacher-student communication and interaction [19].

3 Piano Music Multiple Mixed Teaching Model Construction

The teaching of piano music courses in colleges and universities should be based on the advantages of traditional teaching methods, combined with the needs of the new era of continuous reform of teaching methods, exploring cooperation and communication, immersion teaching methods, combined with the opportunity to promote methodological innovation in the construction of piano discipline culture. Problem-oriented, industry-teaching integration as a means, to educate people, optimize the teaching content and knowledge system, strengthen the cultivation of application ability, and improve the teaching quality of piano courses. This chapter takes the theory of multiple intelligences as a guide and combines the flipped classroom to design a multiple hybrid teaching model for piano music courses, which provides support for improving the teaching quality of piano courses in colleges and universities.

3.1 Multiple Intelligences Theory and Flipped Classroom

1) Multiple Intelligences Theory

Gardner believes that a person's ability can not be judged solely based on the innate existence of the "intelligence quotient", the education sector at that time judged the "intelligence quotient" standard mostly focused on the "linguistic intelligence" and "logical-mathematical intelligence", which is one-sided. The concept of 'Logical-mathematical intelligence' is one-sided. According to Gardner's theory of multiple intelligences, we know that human abilities are diversified and that we can realize the coordinated development of various intelligences through observation and cultivation, to cultivate talents. This reveals that we should be good at observing and summarizing learners' intelligences in teaching practice, and make reasonable use of the intelligences by cutting in and designing teaching activities from the perspective of what learners are good at. The structure of the Multiple Intelligences Theory is shown in Figure 1, which mainly includes linguistic intelligence, musical intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, self-cognitive intelligence, interpersonal intelligence, and museumist intelligence.

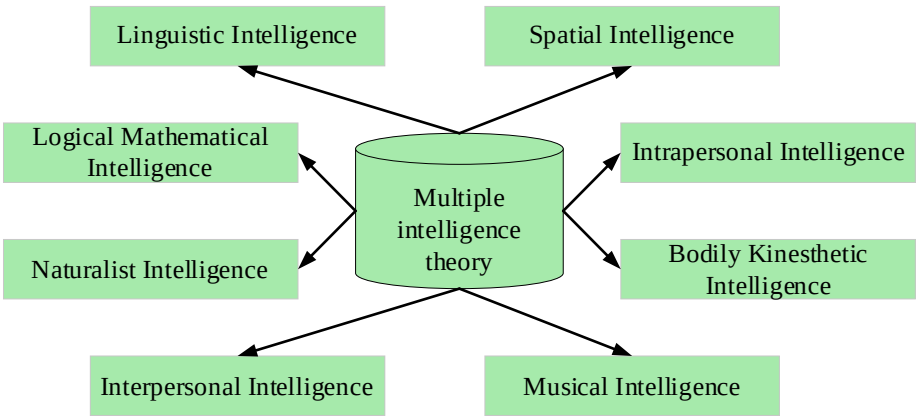

Figure 1. Theoretical structure of multiple intelligence

The theory of multiple intelligences, which encompasses eight intelligences that are both independent and interconnected, emphasizes the variety of human abilities and has had a positive impact on education and teaching. It is not only in line with Confucius' idea of "teaching students according to

their aptitude", but also similar to the six arts of Zhou Dynasty education: rites, music, archery, imperialism, calligraphy, and mathematics. Teachers can develop their potential for better classroom teaching by designing a variety of classroom activities and observing and evaluating students from multiple perspectives.

2) Flipped Classroom Teaching Mode

The elements and processes of flipped classroom teaching have undergone significant changes compared to traditional classrooms due to the support of new-generation information technology. The ideal teaching process structure of a flipped classroom is "8+8 mode", and its teaching process is shown in Figure 2. It mainly includes 8 steps for teachers to "teach", i.e., learning statistics, resource release, teaching design, topic introduction, new task assignment, lecture and comment, personalized push, and homework correction, and 8 steps for students to "learn", i.e., preview and homework, pre-course discussion, presentation and sharing, and cooperative exploration. Discussion, presentation and sharing, cooperative inquiry, classroom test, consolidation and enhancement, completion of homework, summarization, and reflection, and the interactive relationship between them, which together form a complete teaching process before, during, and after class.

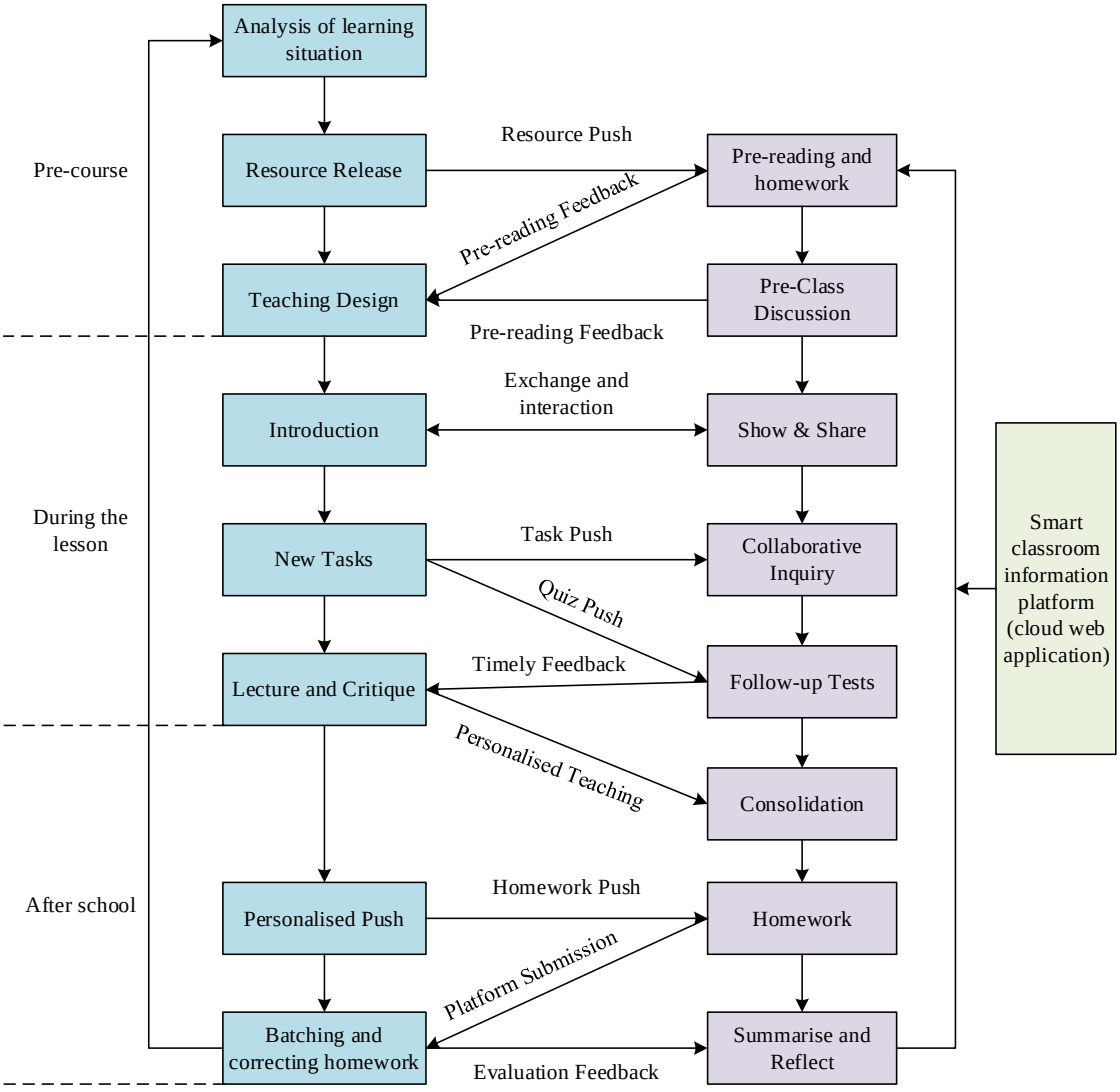

Figure 2. Flipped classroom teaching model

The flipped classroom teaching process structure is based on the information technology platform, is the product of the deep integration of information technology and education and teaching in the Internet era, is mainly a theoretical model, the wisdom of the classroom teaching in the theory of an important guiding significance. However, in the reality of teaching activities, the teacher's "teaching" and the student's "learning" are, integrated, the teacher's every teaching behavior needs to be completed under the active cooperation of the students, and every learning activity of the students needs to be completed under the guidance of the teacher. The teacher's every teaching behavior needs to be completed with the active cooperation of the students, and every learning activity of the students needs to be completed under the guidance of the teacher.

3.2 Multiple Blended Teaching Models for Piano Courses

The flipped classroom teaching process as a whole makes the teacher's "teaching" and the student's "learning" produce a certain mismatch, and can't promote the enhancement of the students' learning ability, so this paper combines the theory of multiple intelligences and the relevant characteristics of the flipped classroom teaching mode. This paper combines the theory of multiple intelligences and the relevant features of the flipped classroom teaching mode and establishes a multiple hybrid teaching mode for piano music courses in colleges. The specific process of the multiple hybrid teaching mode is shown in Figure 3, which is mainly based on the information technology platform to carry out the production of the corresponding piano course teaching video, and based on the information technology platform for the collection of teaching resources, but also can effectively realize the recommendation of students' personalized learning resources to help students learn more rich content.

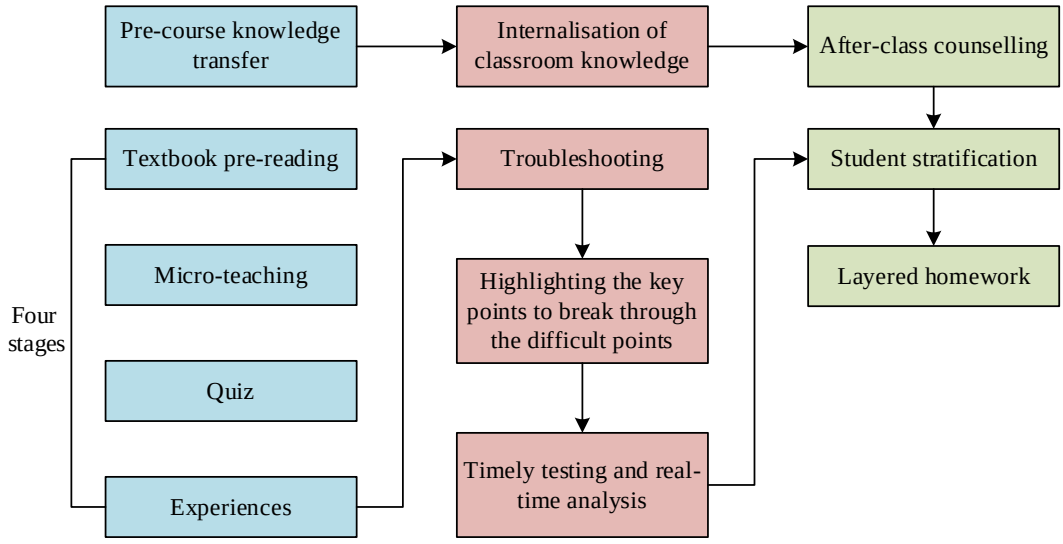

Figure 3. Multiple and mixed teaching mode of piano course

Through the three different phases before, during and after class to help students internalize their knowledge of piano music, teachers also need to carry out timely and appropriate group discussions for students' problems to solve students' confusion, and to promote students' piano music knowledge and skills enhancement.

4 Personalized Recommendation Method for Piano Music Resources

Diversified piano teaching with diversified hybrid teaching mode refers to the teaching mode in which teachers use diversified concepts, diversified means, diversified evaluation, and diversified curricula to teach students' performance skills, and at the same time guide students to appreciate piano art masterpieces, create music, and perform ensembles, which is characterized by comprehensiveness and flexibility, and can improve the level of piano performance teaching. Effectively broadening the scope of students' piano music knowledge learning and providing personalized recommendations for teaching resources can be achieved with the use of multiple hybrid teaching modes based on the information technology platform.

4.1 Cognitive level based on Fuzzy-CDF

Cognitive diagnostic models enable (Fuzzy-CDF) to describe the structure of potential roles between the learner's level of knowledge, the characteristics of the test questions, and the learner's results of answering the test questions using a mathematical model. In reality, according to the algorithm for solving the model, it is possible to assess the knowledge level of the learner under the condition that the results of the learner's answers to the test questions and some of the characteristics of the test questions are known. Based on the evaluation results, personalized educational resources can be recommended to learners to save time and money.

The four-layer structure of the Fuzzy-CDF model from top to bottom is the level of students' potential knowledge and ability θ affects the students' knowledge level of the knowledge points assessed in the test questions α, and the students' knowledge level in the knowledge points α determines the students' knowledge mastery of the test questions η. Considering both carelessness and guessing, which are the two main manifestations of students' answering process, the modeling obtains the results of the students' answers, which in turn predicts the students' answer score R [20].

A student's knowledge level α is equivalent to the degree of affiliation on the corresponding fuzzy set μ. Each knowledge point k in a quiz question has a fuzzy set that uniquely corresponds to it (J, μ_k). Where J is the set that represents the students, and μ_k is a function of the degree of affiliation of the students' set J on the fuzzy set corresponding to the level of knowledge and competence. the formula for calculating the students' level of knowledge points α draws on the logistic Steele model used in Item Response Theory. Namely:

$$\alpha_{ij} = \frac{1}{1+\exp\left(-1.7\lambda_{1k}\left(\theta_i - \lambda_{0k}\right)\right)} \tag{1}$$

θ_i denotes the higher-order ability profile of the learner i, λ_{1k} denotes the differentiation of the knowledge points k and λ_{ok} denotes the difficulty of the knowledge points k. The level of mastery of the students' test questions η_{ji} is defined:

$$\eta_{ji} = \min\left(\mu_{k1}(j), \mu_{k2}(j), \cdots, \mu_{kN}(j)\right) \tag{2}$$

Where $\mu_{k1}(j)$ and $\mu_{k2}(j)$ are the fuzzy set affiliations of student j on knowledge point 1 and knowledge point 2 examined in test question i, and a total of N knowledge points were examined in question i.

The Bernoulli distribution in probability and statistics is used to model the students' scores for their responses on the test questions, and according to equation (2) and taking into account the two cases of carelessness and guessing that exist in students' responses, the prediction formula for students' scores is:

$$P\left(R_{ji}=1|\eta_{ji},s_i,g_i\right)=\left(1-s_i\right)\eta_{ji}+g_i\left(1-\eta_{ji}\right) \tag{3}$$

where R_{ji} is the result of student j's score on question i, η_{ji} is student j's mastery of test question i, S_i is the carelessness factor for answering test question i, and g_i is the guessing factor for answering test question i.

4.2 Apriori algorithm to generate a sequence of knowledge points

The primary purpose of the Apriori algorithm is to uncover association rules between items by mining frequent itemsets in data. Its basic principle is based on the concept of ex-itemsets, that is, when searching for frequent itemsets, first select frequent itemsets from an itemset, and then get higher dimensional itemsets by combining these frequent itemsets, until it is impossible to generate new frequent itemsets. In this paper, we use Apriori algorithm to mine the learning results of learners in the information technology platform to find out the frequent itemsets of the learners' ungraspable knowledge points, and then combine them with the existing resource library to reasonably plan the sequence of knowledge points suitable for the learners.

The constructed resource library and the learner's current cognitive level are instrumental in producing the sequence of knowledge points. Let set $kg=\{k_1,k_2,...,k_n\}$ be a collection of n knowledge points in the resource library and arranged according to the relationship between the knowledge points, and set $cg=\{c_1,c_2,...,c_n\}$ be a collection of cognitive levels of a learner, which is specifically obtained by inputting the learner's answers into the Fuzzy-CDF model.

For the set of ungrasped knowledge points for each learner, a threshold value of μ is set, and the cognitive level below the value of μ is the ungrasped knowledge points. Set $ng=\{n_1,n_2,...,n_n\}$ represents the set of ungrasped knowledge points, then:

$$\begin{cases}0\le m\le n\\ ng\subset kg\end{cases} \tag{4}$$

For a learner whose target knowledge point is B, he/she wants to get the association rule $A\Rightarrow B$ between knowledge point A and it, i.e., the learner's failure to master knowledge point A will result in failure to master the target knowledge point. where $A\subset kg, B\subset kg$ or $B\subset kg$, but $A\cap B=\varnothing$.

In the process of searching the current knowledge point to the target knowledge point, the correlation between the knowledge point and the antecedent knowledge point is calculated for each knowledge point encountered, and the knowledge point with the largest correlation is selected to continue the search, and the learner's knowledge point sequence is finally obtained. The expression for the calculation of relevance is:

$$R(v)=(1-\theta)+\theta\times\sum_{u_i\in in(v)}\frac{similarity_{uv}\times R(u)}{\sum_{u_k\in out(u)}} \tag{5}$$

where $R(u), R(v)$ denotes the relevance of knowledge point u, v, θ is the correlation coefficient, $\sum u_i \in in(v)$ is the number of edges connecting u, v, $\sum u_k \in out(u)$ is the number of all knowledge points connected to u, and $similarity_{uv}$ is the similarity of knowledge point u, v.

4.3 Personalized Piano Music Learning Resources Recommendation

For the personalized recommendation of piano music learning resources in the multivariate hybrid teaching mode, this paper uses the binary particle swarm algorithm for resource recommendation, initializes the population using the chaotic strategy, and optimizes the worst and optimal particles in each iteration, thus improving the quality of the population and enlarging the global exploration ability of the population. The sequence of knowledge points given in the previous section is solved using the binary particle swarm algorithm for its optimal solution, to recommend the relevant piano music knowledge resources that students have not learned.

1) Chaotic initialization strategy

The viscous binary particle swarm algorithm's initial population is randomly generated, resulting in poor and low-quality distribution. To improve the quality of the population, the NFSBPSO algorithm uses Logistic mapping for chaotic initialization, i.e.:

$$x_{t+1} = \mu x_t (1 - x_t), x_t \in (0,1) \tag{6}$$

Where, μ denotes the degree of chaos, the larger the value of μ, the higher the degree of chaos, and experimentally it is concluded that the system is in the best chaotic state when $\mu = 4$. In the mapping process, if $x_t \geq 0.5$, $x_t = 1$, if $x_t < 0.5$, $x_t = 0$.

2) Worst Particle Update Strategy

The particle swarm algorithm, has always adhered to the "survival of the fittest" law, to improve the quality of the worst particles, in the iterative process of its update operation. To increase the diversity of the population and improve their searchability, the worst particle update strategy would be to improve the least adapted particles in the population. The formula for improving fitness particles that are the worst is called:

$$x\_worst(t) = \arg\max\left(fit\left(x_1(t)\right), fit\left(x_2(t)\right) \cdots fit\left(x_N(t)\right)\right) \tag{7}$$

$$\text{Eworst}(t) = x_i(t) + \text{rand}\left(x_j(t) + x_k(t)\right)(i \neq j \neq k \in 1, \cdots, N) \tag{8}$$

$$x\_worst(t) = \begin{cases} Eworst(t) & if \ \left(fit\ (\ Eworst\ ) < fit\ \left(x\_worst\ \right)\right) \\ x\_worst\ (t) & otherwise \end{cases} \tag{9}$$

Where x_worst denotes the position of the worst adapted particle among the N particles, and $Eworst$ in Eq. (8) denotes the updated particle, that is, three different particles are randomly selected for updating after the completion of each iteration. Eq. (9) indicates that if the fitness value of the updated particle is less than the worst particle, the worst particle is updated to $Eworst$, and vice versa the worst particle is kept.

3) Optimal particle perturbation strategy

In the particle swarm algorithm, the global optimal solution of the population affects all the particles to move in the direction of the optimal solution, which leads to the aggregation phenomenon in the later stage. So in this paper, according to the aggregation degree of the population, the position of the global optimal solution is perturbed, so as to expand the global search ability of the population.

The formula used to determine the degree of aggregation of the population can be summarized as:

$$avg_x(j) = \frac{1}{N}\sum_{i=1}^{N} x[i][j] \tag{10}$$

$$avg_r r = \frac{1}{N}\sum_{i=1}^{N} \left| x_i - \text{avg}\_x \right| \tag{11}$$

Where avg_x denotes the center position of N particles and avg_r denotes the average distance from N particles to avg_x in the population. If the value of avg_r is large, it means that the distribution of particles is more scattered and the diversity of the population is higher, then the interference with the global optimal solution is less. If the value of avg_r is small, it means that the particles are more tightly distributed, resulting in a population that is already in a local optimum or less diverse, and the interference with the global optimal solution is larger.

The perturbation strategy used in this paper is shown in Eqs. (12) and (13), and the size of the perturbation produced to the global optimal solution is determined by the exponential function in Eq. While it is shown above that the size of the perturbation is negatively correlated with avg_r, the exponential function is negatively correlated with avg_r. Then:

$$\text{Nbest}(t) = \left(1 + \text{sign}(\text{rand} - 0.5)\exp\left(-avg\_r\right)\right) \times \text{Gbest}(t) \tag{12}$$

$$Gbest(t) = \begin{cases} Nbest(t) & if\ \ (fit(Nbest(t)) < fit(Gbest(t))) \\ Gbest(t) & otherwise \end{cases} \tag{13}$$

Where $Nbest(t)$ represents the particle after being disturbed, if the fitness value of $Nbest(t)$ is lower than the fitness value before being disturbed, the particle after being disturbed is the globally optimal particle; otherwise, no update is performed.

The learners' piano music resource learning in the informatization platform is collected, and the data is input into the Fuzzy-CDF model to obtain the cognitive level of the learners after certain processing, and the set of ungraspable knowledge points is obtained through the set threshold. The sequence of knowledge points can be generated by combining the association rule algorithm Apriori and the constructed knowledge graph. Finally, with the support of the piano music learning resource library and learners' cognitive level, the group intelligence algorithm is used to generate personalized learning recommendations of piano music resources for students.

5 Analysis of the effect of multiple mixed teaching of piano music

Analysis of the effect of multiple mixed teaching methods on piano music. Under this new teaching form, teachers should adopt diversified teaching contents and teaching methods, guiding students to

utilize the development of independent thinking, the enhancement of the subject position of the flipped classroom, and the practical deepening of the pair classroom to achieve the goal of improving students' music level. Relying on the diversified mixed teaching mode constructed in the previous chapter, this chapter designs a relevant teaching experiment to verify the effectiveness of the teaching mode given in this paper and also to provide a reference for promoting the innovation of piano music classroom teaching mode in colleges and universities.

5.1 Study Population and Data Collection

The research object of this paper is to take two classes of students in the first year of the University of H Conservatory of Music in T City in 2023 as the research example, one of the classes is an experimental class, using multiple mixed teaching modes constructed in this paper to teach piano music, and the other class as a control class, using the traditional piano music teaching method to teach. There are 60 students in each of the two classes, and there is no difference between the two classes in terms of piano music knowledge, playing level, and playing skills, so they can be used as a sample for the control test to carry out the teaching experiment. The experiment was conducted from February to July 2023 for one semester, and questionnaires were used before and after the teaching experiment to test the changes in the piano skill levels of the students in the two classes before and after the teaching.

A questionnaire was employed to collect data on the changes in students' piano skill levels. 120 questionnaires were given out 120 were recovered, and all were valid. To ensure the credibility of the data obtained from the questionnaire, the two classes of students who filled out the questionnaire conducted a return survey, and the two sets of data were tested for reliability, and the reliability coefficient obtained was 0.902. This paper's questionnaire is highly reliable, and the data obtained can accurately reflect the student's real-world situation.

5.2 Analysis of the effects of the hybrid teaching model

5.2.1 Comparative analysis of teaching effectiveness

Teaching piano music courses with a diversified mixed teaching mode, comparing the learning effects of the experimental and control classes after the teaching experiment can clarify the promotion effect of this teaching mode on the teaching of piano music courses. In this paper, students were tested in different aspects, such as keyboard harmony (A), song arrangement (B), combination of playing and singing (C), music theory knowledge (D), listening ability (E), rhythmic memory (F), melodic memory (G), etc., and the results are shown in Figure 4.

From the comparative results of the test, the experimental class as a whole was stronger in each ability than the control class, and the average score of each achievement of the experimental class was 92.33, while the average score of each achievement of the control class was only 82.12, and the average score of the experimental class was increased by 10.21 compared to that of the control class. Among them, melodic memory showed the greatest increase, with 18.78% in the experimental class compared with the control class, and auditory discrimination, which showed the smallest increase, was also enhanced by 9.21%. This shows that the use of multiple mixed teaching modes can help students better master piano music skills, diversified piano music teaching materials can be more diverse for students to learn music knowledge, enriching the scope of student learning, and different piano music videos can help students better master the piano music playing and singing rhythms. In the teaching process, the interaction between teachers and students and group discussion make students encounter

relevant problems that can be solved promptly, to promote the absorption and transformation of music theory knowledge.

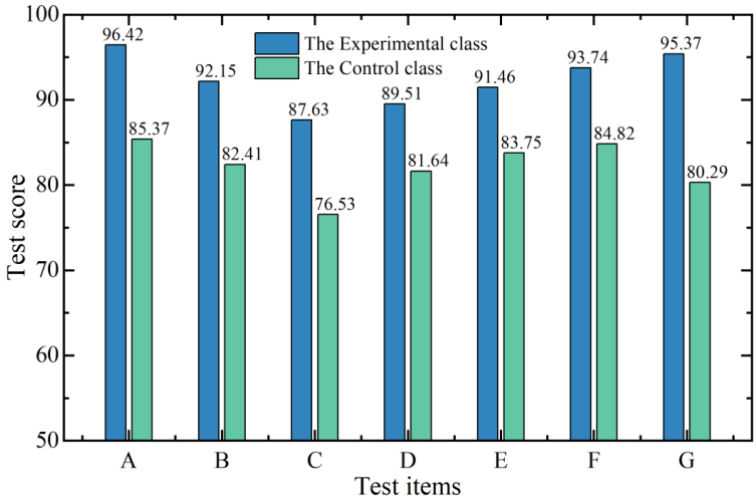

Figure 4. The effect analysis of the mixed teaching mode

5.2.2 Comparison of note recognition ability

To further verify the effectiveness of the multivariate mixed teaching model established in this paper, 10 people were selected from the experimental class and the control class respectively for the comparison of note recognition ability, and the Piano Sight-reading and Rhythm Training Tutorial was chosen as the training material, which will be referred to as the Tutorial later. After the training materials were determined, 20 pieces of data were randomly selected from the training content, played at a tempo of 55, with no advance viewing time, and played only once, to record the number of note recognitions all pairs of teams in the two classes. Table 1 demonstrates the results of the note recognition control for both classes.

From the comparison results of note recognition ability, the experimental class will conduct blind playing and point reading training when teaching piano music with the multiple blended teaching mode, which can better help students to improve their listening and recognition ability, and the difference between the mean value of note recognition ability of the ten experimental students before and after the experiment is 8.4, while the difference between the mean value of note recognition ability of the ten control students before and after the experiment is only 2.6. This shows that the mixed teaching mode can enhance students' note recognition ability, and the diversified learning content also enriches students' knowledge of music theory, enabling them to learn more piano music scores in the classroom, which makes students internalize the knowledge of music scores in their hearts and improves students' piano music imitation ability.

Table 1. Comparison of the note recognition ability

Experimental class				Control class			
No.	Post-test	Pre-test	D-value	No.	Post-test	Pre-test	D-value
E1	8	18	10	C1	7	9	2
E2	7	16	9	C2	6	9	3
E3	4	15	11	C3	5	8	3
E4	7	17	10	C4	8	12	4
E5	9	16	7	C5	9	13	4
E6	10	19	9	C6	9	11	2
E7	9	16	7	C7	8	10	2
E8	7	15	8	C8	7	9	2
E9	9	14	5	C9	8	10	2
E10	7	15	8	C10	6	8	2
Means	7.7	16.1	8.4	Means	7.3	9.9	2.6

5.3 Analysis of the Effectiveness of Personalized Piano Learning

5.3.1 Multiple competence enhancement test

The blended teaching model of piano music relying on the multiple intelligences theory can not only effectively enhance students' piano music knowledge and skill level, but also effectively target the comprehensive development of their multiple abilities. Based on the theory of multiple intelligences, it mainly includes eight aspects: linguistic intelligence (A), musical intelligence (B), logical-mathematical intelligence (C), spatial intelligence (D), physical-kinesthetic intelligence (E), self-awareness intelligence (F), interpersonal intelligence (G), and museological intelligence (H). A T-test was conducted to analyze how personalized learning of piano music correlates with multiple intelligences in the multivariate blended teaching model of piano music curriculum through independent samples. Table 2 displays the results of the one-way independent sample test.

From the results of the independent sample test, the significance test results of the eight multiple abilities are all significant at the 1% level, and among them, the t-value test result of musical intelligence is the highest at 5.426, and the 95% confidence interval of the difference is [0.351,0.654], which does not contain 0. This indicates that the blended teaching mode of the piano music course that is based on the theory of multiple intelligences can enhance the student's pitch of piano music, melody, rhythm, and other elements of sensitivity ability, and promote students' mastery of piano music skills. In addition, the t-value of self-cognitive intelligence reaches 5.319, and its 95% confidence interval is between 0.248 and 0.867. This shows that the multiple mixed teaching modes of piano music can fully integrate students' feelings into piano music so that students can clarify the emotions of piano music, internalize piano knowledge in their feelings, and thus understand and guide their piano playing behavior.

Table 2. Results of the univariate independent sample test

Variable	t value	Sig.(2-tailed)	Means	Standard error	CI 95%	
					Lower limit	Superior limit
A	4.095	0.001***	0.737	0.1143	0.349	0.713
B	5.426	0.000***	0.784	0.1299	0.351	0.654
C	5.147	0.005***	0.672	0.1255	0.294	0.729
D	5.041	0.006***	0.518	0.1257	0.317	0.718
E	5.185	0.002***	0.576	0.1222	0.359	0.877
F	5.319	0.001***	0.529	0.1126	0.248	0.867
G	4.623	0.003***	0.631	0.1107	0.394	0.664
H	3.458	0.000***	0.625	0.1204	0.425	0.882

5.3.2 Analysis of the Effectiveness of Personalized Learning

1) Comparison of personalized learning effect

To test the difference between the personalized learning effect carried out in the multiple blended teaching environments of piano music and the traditional teaching environment, the difference analysis is carried out for the teaching knowledge, teaching skills, teaching process, teaching methods, and emotional attitudes as a way to demonstrate the personalized learning effect of the multiple blended teaching modes. In Table 3, the results of the differential analysis of personalized learning effects for the experimental class (EC) and the control class (CC) in different teaching modes are displayed.

From the t-test results, the teaching activities of different modes show significant differences at the 0.01 level in the dimensions of learners' teaching knowledge, teaching skills, teaching process, teaching methods, and affective attitudes, with the significance Sig. values less than 0.01, and it is found through the comparison of the means that the means of the experimental class under the multivariate blended mode of teaching are greater than the means of the traditional teaching class, and the dimensions of the mean value are 10.21% higher than the mean value of the traditional teaching class. It can be seen that compared with the traditional teaching mode, the blended teaching mode of piano music based on the multiple intelligences theory combined with the information technology platform is more capable of promoting students' personalized learning. This is because the blended teaching mode starts from the problematic situation, guides students to carry out independent and cooperative inquiry learning, and pays attention to the independent development of students in the learning process, which can stimulate positive emotional participation of students, better contribute to the achievement of the teaching objectives, and better enhance the piano music skill level of students.

Table 3. Differential analysis of personalized learning effects

Dimension	Class	Means	Std.	T value	Sig.
Teaching knowledge	EC	3.613	0.573	0.096***	0.001
	CC	3.407	0.532		
Teaching skill	EC	3.596	0.574	0.027***	0.000
	CC	3.212	0.798		
Teaching process	EC	3.978	0.609	0.048***	0.002
	CC	3.309	0.695		
Teaching method	EC	3.887	0.447	0.035***	0.001
	CC	3.608	0.415		
Emotional attitude	EC	3.501	0.632	0.064***	0.000
	CC	3.318	0.655		

2) Analysis of the correlation between personalized learning needs and learning objectives

For piano music teaching, students' learning needs and the teaching goals of piano music education should be consistent, which makes it necessary for students to contact their own learning needs when formulating their personalized learning goals, combined with the personalized learning resources recommendation method given in the previous section, to promote the development of students' personalized learning goals. A correlation analysis was performed between learners' content needs and personalized learning objectives, and the Pearson correlation coefficient was utilized to evaluate the strength of the correlation. Students' content needs in multiple blended teaching mainly include the knowledge difficulty, knowledge breadth, knowledge depth, and learning activities of piano music, which were analyzed in correlation with the personalized learning objectives, and the results of the Pearson correlation analysis are shown in Table 4.

The Sig values of the dimensions of content needs and personalized learning objectives, in general, are all less than 0.01, all of which show significance at the 1% level, and the R values of the dimensions of learning content needs are all in the range of 0.7 to 0.9. The correlation between learning activities and personalized learning objectives is closely connected, as it indicates. The distinction demonstrates that learners' content needs and personalized learning goals are significant at the 0.01 level, and the R-values are all positive, suggesting a positive correlation between them. Relying on the personalized learning objectives of the multifaceted blended teaching model, which can fit the content of students' learning needs, not only can make full use of the network to provide learners with learning content and learning resources in different forms, at different levels, and different levels of difficulty. It can also set and push teaching content and learning tasks and assignments suitable for different levels of students according to their levels, which is conducive to improving learners' self-efficacy, confidence in learning, and interest in learning by completing learning tasks suitable for their levels.

Table 4. Correlation of learning needs and learning objectives

Dimension		Knowledge difficulty	Knowledge breadth	Knowledge depth	Learning activities
Teaching knowledge	Correlation	0.902***	0.849***	0.735***	0.812***
	Sig.(2-taild)	0.001	0.002	0.001	0.000
Teaching skill	Correlation	0.827***	0.721***	0.733***	0.711***
	Sig.(2-taild)	0.003	0.001	0.000	0.005
Teaching process	Correlation	0.825***	0.844***	0.729***	0.762***
	Sig.(2-taild)	0.002	0.001	0.003	0.000
Teaching method	Correlation	0.717***	0.846***	0.863***	0.887***
	Sig.(2-taild)	0.001	0.002	0.003	0.001
Emotional attitude	Correlation	0.803***	0.826***	0.739***	0.842***
	Sig.(2-taild)	0.002	0.001	0.000	0.005

6 Conclusion

Based on the theory of multiple intelligences and flipped classrooms, this paper establishes a multivariate blended teaching mode for piano music courses by combining the information technology platform, and personalized recommendation of piano music resources is carried out under the multivariate blended teaching mode according to the learning needs of students. Experiments were conducted to verify that the multivariate blended teaching method presented in this paper has a teaching effect, and the following conclusions were drawn:

1) In terms of the teaching effect of the piano music course, the average score of the experimental class in all grades after the experiment is 92.33 points, and the average score of the experimental class is 10.21 points higher than that of the control class. By using multiple teaching modes, students can improve their piano music skills, and by using different piano music resource videos, they can improve their piano playing rhythm.

2) In the comparison results of note recognition ability, the difference between the mean value of note recognition ability of students in the experimental class before and after the experiment is 8.4, while the difference between the mean value of note recognition ability of the control class before and after the experiment is only 2.6, which shows that the experimental class is better than the control class in note recognition ability. The multiple blended teaching modes can enhance students' listening abilities and help them master more piano music notes.

3) In the personalized learning effect, the result of the test of students' musical intelligence based on the multiple blended teaching modes is 5.426, the 95% confidence interval of the difference is [0.351,0.654], and the mean value of the personalized learning effect in all dimensions is improved by 10.21% compared with that of the traditional teaching class. The multifaceted blended teaching mode is capable of meeting students' individual learning content needs and enhancing their diverse abilities, as reflected by this.

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