



# Design of Mobile Teaching Platform for Vocal Piano Accompaniment Course Based on Feature Comparison

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**Abstract.** With the rapid development of the Internet, the current education system courses often use mobile teaching platforms to improve teaching effects. However, due to the large and unclear feature extraction range, the established mobile teaching platform database information is confused, and the stored data resources are not comprehensive. Poor operation stability, etc. In order to improve the mobile teaching effect of vocal piano accompaniment courses, the text designs a mobile teaching platform for vocal piano accompaniment courses based on feature comparison. By constructing a mobile teaching platform framework for vocal piano accompaniment courses, we will improve and update the mobile teaching platform resource database and expand the content of resources. Design the course teaching evaluation module, use feature comparison technology to extract the fundamental frequency parameters of vocal piano accompaniment and Mel cepstrum parameters, create a scoring mechanism to compare vocal piano accompaniment, to evaluate the teaching effect of vocal piano accompaniment course, and complete the course teaching evaluation module design. Experimental results show that in the actual application process of the mobile teaching platform in this paper, the delay time is 1.9 s, the response speed is fast, the memory occupancy rate is only 35%, and the stability is high, which can effectively improve the actual teaching effect.

**Keywords:** Feature comparison · Vocal music · Piano accompaniment course · Mobile teaching platform

## 1 Introduction

Along with technological innovation, various mobile devices have quietly entered our lives and changed the way we learn. As the most representative electronic product in the contemporary era, smart phones have undoubtedly become the most widely used electronic tools in students' lives [1]. The development of the mobile Internet and new media technology has made the speed of information dissemination faster and wider,

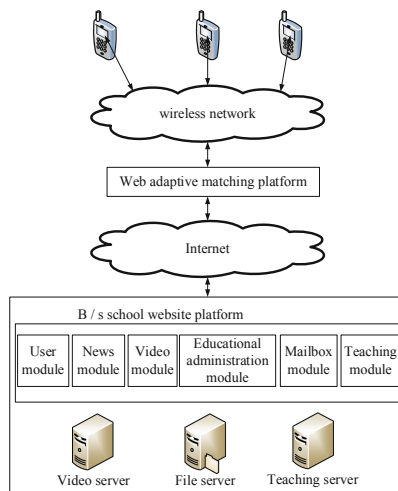
and has provided a lot of convenience for teachers' teaching and students' learning. For the teaching of vocal piano accompaniment courses in colleges and universities, it can be said that opportunities and challenges coexist in the era of new media. On the one hand, the educational content of paper textbooks has the characteristics of authority, authenticity and rigor, which are the main reference basis for teachers' teaching. On the other hand, there are disadvantages in terms of interactivity, poor image quality, and slow update of educational content [2]. Therefore, with the advantages of new media and mobile Internet, the presentation forms and teaching methods of piano knowledge are enriched.

After years of development, the country's mobile teaching has been greatly developed, and various mobile teaching platforms have also been established, such as Chaoxing Xuetong, Little Ant Teaching Platform and so on. Literature [3] adopts research methods such as literature research method, questionnaire survey method, experimental research, interview method, and constructivist learning theory, informal learning theory, cognitive load theory, and Maslow's demand theory as the theoretical basis. It also analyzed the feasibility of vocal piano accompaniment course teaching based on the WeChat public platform, and built a vocal piano accompaniment course teaching platform "Mousse Music Class". On the basis of modern information technology, Liu Jia [4] deeply studied the design of the cloud platform for learning online music courses on mobile terminals. Through the cloud platform as the carrier of the online music course learning environment atmosphere, users can access the network, servers, applications and other resources in real time, so that students can enjoy online and offline course on-demand, online live broadcast, course content push and other related service functions. It helps to meet the students' individualized and diverse music course learning needs, and also helps music teachers to successfully complete music teaching tasks. Chen Hao and Wu Yuqi [5] designed a music feature recognition system design based on the Internet of Things technology in order to improve the ability of music feature recognition. The sound sensor is used to collect the original music signal, the digital signal processor is used to analyze the music signal, and the music signal is processed through the network transmission layer. Finally, the data result is transmitted to the music signal database in the system. Use the internal music feature analysis module of the system to realize the feature recognition of music signal, and identify the music form and the corresponding music feature content of the music emotion according to the recognition result. However, these system platforms are usually more complicated, the design is not flexible enough, and data acquisition is time-consuming. It usually takes more time for students to find the resources they need. Although the above-mentioned cloud platform design software can meet some music teaching courses, it is not suitable for vocal piano accompaniment courses. For this reason, feature comparison technology is introduced, and a mobile teaching platform design for vocal piano accompaniment courses based on feature comparison is proposed.

## 2 A Mobile Teaching Platform for Vocal Piano Accompaniment Courses Based on Feature Comparison

### 2.1 Designing a Mobile Teaching Platform Architecture for Vocal Piano Accompaniment Courses

The design of a mobile teaching platform for vocal piano accompaniment courses divides the overall framework of the mobile teaching platform into two parts, the client and the server. This research mainly designed two main functions of the web page adaptive matching platform and the video transcoding module on the server side of the mobile teaching platform of the vocal piano accompaniment course. The overall structure is shown in Fig. 1.



**Fig. 1.** The overall architecture of the server-side mobile teaching platform

Computer users and mobile phone users share all the information resources and services in the website database through the mobile teaching platform [6]. The web adaptive matching service platform is a core of the entire mobile teaching platform. The platform can automatically convert the web pages in the school website based on the B/S model into Wap pages. So that mobile phone users can browse the same content as when browsing on a computer anytime and anywhere.

The school's Web site itself can implement functions such as news release, educational administration platform login, learning of teaching resources, email service, and viewing of teaching videos. At present, there is still a gap in the processing capabilities of smartphones for video reception and online viewing compared with computers. In addition, when there are more users accessing video resources, it will bring a certain burden to the original server and database containing data and video [7]. Therefore, the relevant information of the teaching video is separated from the original file database.

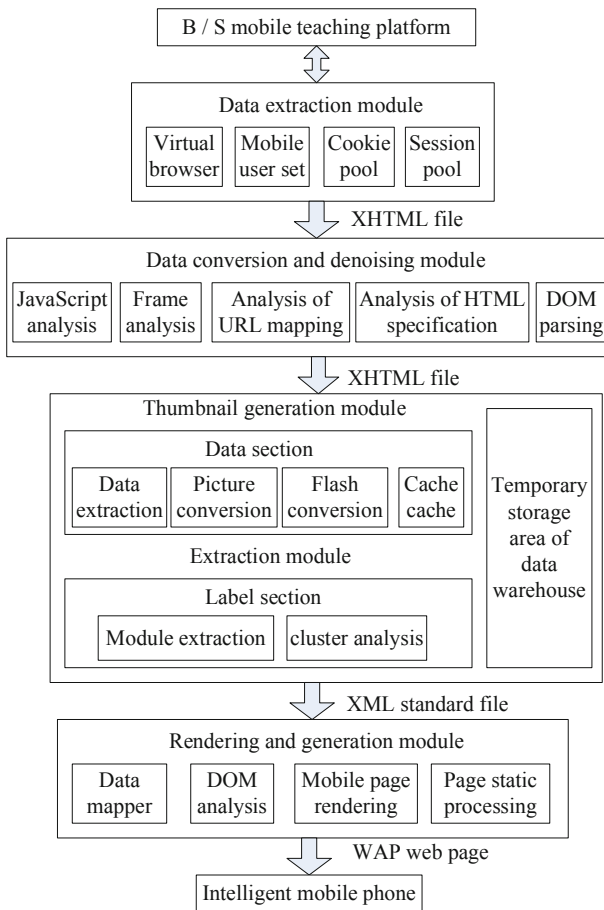
There are certain restrictions on the format, flow and speed when watching videos on mobile phones. Therefore, video transcoding technology has been researched. On the server side of the B/S teaching website, FFmpeg is used to re-encode and compress the videos and package them to adapt to wireless network transmission and mobile phones. The format of the video to watch. Therefore, a video transcoding module is added to the original video module, with the purpose of re-encoding and compressing existing and future videos that need to be added to meet the needs of mobile terminals.

Based on the overall structure of the server-side mobile teaching module designed above, it is also necessary to design a web page adaptive matching module to realize web page crawling and perform complex page format analysis. Then use the data extraction component to convert it into a standard XML data stream format. By analyzing the screen resolution of the mobile phone terminal, the browser version and other information, the corresponding template information in the data conversion module in the extraction module is determined, and the corresponding data is loaded. Then display the web page information on the mobile terminal to realize the conversion from the web page to the Wap page [8].

The web pages in the school web site are dynamic web pages. You can build a DOM tree by extracting tags from the web pages, remove tags that are not easily recognized by mobile terminals, extract web tags and attributes that are applicable to smart phone browsers, and generate Wap templates. And write the ID number of the generated template and save it in the web page adaptive matching module. When the user visits a certain ID web page, the Wap template can be called, and at the same time, the relevant data in the database can be called and displayed on the smart phone terminal [9]. Therefore, the web page adaptive matching module needs to construct five sub-modules: data extraction sub-module, data conversion denoising sub-module, thumbnail generation sub-module, template extraction sub-module, and rendering and generation sub-module. The function of this module is mainly to extract data from existing HTML documents in the original Web site through web page denoising technology (JTidy) and XSLT technology, and to normalize the extracted data into XML documents. Then through the XSLT technology, the content of the XML document is reorganized into a Wap document, so as to realize the purpose of logging onto the teaching website anytime and anywhere with the smart phone terminal. The establishment of the web page adaptive matching module is based on the existing web site, maintaining the relevant structure and related data of the original site, and improving work efficiency while meeting the accuracy of information. And targeted removal of some information that wasted traffic due to loading in the original Web site, thus reducing the waste of traffic in wireless network transmission. The specific web page adaptive matching platform module is shown in Fig. 2.

## **2.2 Establish a Mobile Teaching Platform Resource Library for Vocal Piano Accompaniment Courses**

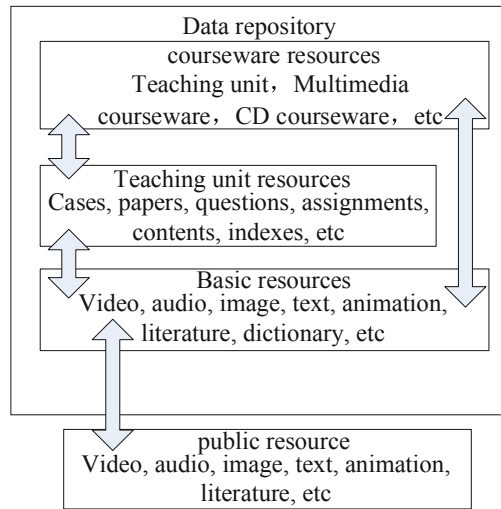
The mobile teaching platform database for vocal piano accompaniment courses is designed this time. The mobile teaching platform database is divided into three levels: basic resources, teaching unit resources and courseware resources, as shown in Fig. 3.



**Fig. 2.** Web page adaptive matching platform module

It can be seen from Fig. 3 that the bottom layer is the basic resources, including text, graphics and images, animation, audio, video, literature, teaching materials, words, vocabulary, grammar, accompaniment, example sentences, application tools, etc. Used in multimedia course teaching. According to the definition of multimedia materials, media materials are divided into five categories: text, graphic images, animation, audio, and video. These materials are the most basic elements of the course. These materials need to be classified, indexed and stored in accordance with the standards of each sub-library. These basic materials can be used by teachers to construct individualized teaching integration units and different forms of courseware. The basic materials have the widest shareability and are most suitable for mass production in a pipeline. The acquisition of basic resources can also be obtained from public resources, such as Internet resources.

The middle layer is the teaching unit resources used in different teaching links for a certain teaching content, including cases, test questions, test papers, homework, common problems, terminology, reference materials, etc. Its content can be a certain knowledge



**Fig. 3.** Database architecture

point, a certain chapter or a certain comprehensive topic, etc., and the teaching function is relatively single. Teaching unit resources can be used directly for teaching, and can also be used to construct complete courseware flexibly and quickly.

The highest level is courseware resources, which use basic resources and teaching unit resources to construct different forms of courseware. Multimedia courseware is to edit and process the video of the teacher's lecture process or the video of some teaching content in the form of video recording, and then put it on the Internet in the form of CD, TV program or digitized for the learner's reference [10]. Its advantage is that the display method is vivid and vivid, especially the lecture process video of excellent teachers has the value of learning, reference and preservation.

Different forms of courseware can be constructed using basic resources or teaching unit resources. Because different teachers face different objects, achieved teaching goals, teaching ideas, teaching design, teaching methods, etc., there are differences. Therefore, integrated teaching resources must have individual characteristics, but a courseware can completely reflect the teaching content and teaching links of course teaching, and is suitable for students to learn independently. The above three levels of resources together constitute the teaching curriculum library.

### 2.3 Design Course Teaching Evaluation Module

#### Extracting Characteristic Parameters of Vocal Piano Accompaniment Based on Feature Comparison

The vocal piano accompaniment signal is a time-varying signal. The short-term stability of the vocal piano accompaniment signal can be used to observe the vocal piano accompaniment signal over a short period of time to track the change of the signal in time [11]. This study uses the fundamental frequency change trajectory and Mel cepstrum

parameters to evaluate the input vocal piano accompaniment. The Mel cepstrum parameter characterizes the content of the sound. The fundamental frequency trace shows the change of sound pitch, reflecting the fluctuation of pitch and the change of rhythm.

- (1) Extraction of fundamental frequency parameters. The pitch period is calculated using AMDF with center clipping. Compared with commonly used pitch estimators based on correlation, homomorphic signal processing, and linear predictive coding, AMDF does not involve multiplication and division, and is more suitable for applications on platforms such as embedded platforms. The valley point at the pitch period point is sharper than the peak point of the short-term autocorrelation function. Therefore, the estimation accuracy is higher and more stable. For the  $n$ -th frame vocal piano accompaniment signal  $S_n$ .

$$AMDF_n(t) = \frac{1}{M} \sum_{M=0}^{M-t-1} |S_n(M) - S_n(M+t)| \quad (1)$$

In formula (1),  $M$  represents the frame length;  $t$  represents the candidate pitch period. When  $S_n(M)$  is periodic and the period is  $T$ , then there is a valley near the  $AMDF_n(t)$  pitch period  $T$  or its integer multiples. Therefore, the first valley point can be selected as the pitch period of the vocal piano accompaniment. The estimated fundamental frequency  $F_0(n)$  is.

$$F_0(n) = \frac{1}{\min_{t>0} \left( \arg \underset{t>0}{localMin}(AMDF_n(t)) \right)} \quad (2)$$

In formula (2), *localMin* represents the function to obtain the local minimum [12]. In actual calculations, the position of the first minimum valley point sometimes does not coincide with the actual pitch period, which is mainly caused by the interference caused by the formant characteristics of the vocal tract. Therefore, before using AMDF to estimate the pitch period, it is necessary to preprocess the vocal piano accompaniment signal to eliminate the influence of formants and improve the estimation effect. The preprocessing method uses the center clipping nonlinear transformation. After the clipped signal passes through AMDF, the trough at the pitch period point becomes more obvious, and the effect of pitch period estimation can be improved to a certain extent. In addition, linear smoothing must be performed on the obtained fundamental frequency curve to eliminate wild points with larger errors.

The acquired fundamental frequency parameter is an important parameter in the score of vocal piano accompaniment, and its level changes reflect the intonation and rhythm characteristics of vocal piano accompaniment. The intonation that imitates the standard pronunciation is a basic requirement in the learning of vocal piano accompaniment. The use of pitch changes for scoring is a feature of the scoring algorithm. It is different from the previous scoring algorithms for vocal piano accompaniment courses based on content accuracy. It evaluates the quality of a vocal piano accompaniment from a higher reading level.

- (2) Extraction of Mel cepstrum parameters. After the vocal piano accompaniment signal is pre-emphasized, the suppressed high frequency part of the vocal piano accompaniment signal is compensated [13, 14]. In order to reduce the Gibbs effect, a Hamming window is added to each frame of the vocal piano accompaniment signal. After fast Fourier transform, the frequency spectrum of each frame can be obtained, and the output logarithmic spectrum  $m_j(j = 1, 2, \dots, 20)$  of each frequency band can be obtained through a set of 20 triangular filters. After discrete cosine transform, the 12-dimensional Mel cepstrum parameter  $c_j$  can be obtained.

$$c_j = \sum_{k=1}^p m_j \cos\left(\frac{\pi k}{p}(j - 0.5)\right), k = 1, 2, \dots, 12 \quad (3)$$

In formula (3),  $p = 20$  represents the number of triangular bandpass filters.  $j$  represents the number of logarithmic spectrums.  $k$  represents the number of frequency bands.

Because the pitch frequency of the piano accompaniment signal depicts the vocal characteristics of the speaker, there are some pitch differences in the piano accompaniment music. The score of piano accompaniment in this study focuses on the change of tone and rhythm. In order to better compare different vocal piano accompaniment, we need to regularize the feature parameters, so that the feature parameters with individual differences can be compared under the same benchmark.

### Comparison of Piano Accompaniment in Vocal Music

In order to compare the piano accompaniment of vocal music to be graded with the reference standard piano accompaniment, we can estimate the difference between the two characteristic parameters to reflect the similarity between them. Because they are different in reading speed and pause time, it is impossible to compare them directly. Therefore, the dynamic time warping method is used to find the closest comparison path between the two. In general, DTW correction is applied to each feature parameter, which not only increases the computational complexity of the algorithm, but also cuts off the correlation between feature parameters. Firstly, the WFCC parameter is used to correct the DTW nonlinearity of the two pieces of vocal piano accompaniment, so that the input vocal piano accompaniment and the standard vocal piano accompaniment are corresponding to each other in the similar position. At this time, we can get a path with the least error and the corresponding DTW distance. The distance is the result of the comparison of MFCC characteristics of two pieces of vocal piano accompaniment, which reflects the pronunciation difference in the content of two pieces of vocal piano accompaniment. Based on this correction path, the fundamental frequency change trajectories  $f_1(n)$  and  $f_2(m)$  can be compared at the corresponding positions of similar contents. The object of comparison is the difference between the fundamental frequency point  $|f_1(n) - f_2(m)|$  and its variation  $|\Delta f_1(n) - \Delta f_2(m)|$ . Among them,  $\Delta f_1(n) = |f_1(n) - f_1(n - 1)|$ . The smaller the difference is, the more similar the tone is. It can be seen that only one DTW operation is needed to compare the two feature parameters.

It is assumed that the MFCC eigenvector of reference standard vocal piano accompaniment is  $M_1 = [m_1(1), m_1(2), \dots, m_1(T)]$ . The eigenvector of fundamental frequency is  $P_1 = [p_1(1), p_1(2), \dots, p_1(T)]$ . Where  $T$  is the length of piano accompaniment of reference vocal music. The MFCC feature vector of piano accompaniment to be evaluated is  $M_2 = [m_2(1), m_2(2), \dots, m_2(S)]$ . The fundamental frequency eigenvector is  $P_2 = [p_2(1), p_2(2), \dots, p_2(S)]$  is the length of piano accompaniment to be evaluated, there is the following formula.

$$C = \begin{pmatrix} C_1 \\ C_2 \end{pmatrix} = DTW(M_1, M_2) \quad (4)$$

$$\begin{pmatrix} P \\ M \end{pmatrix} = \begin{pmatrix} P_1 & P_2 \\ M_1 & M_2 \end{pmatrix} \begin{pmatrix} C_1 \\ C_2 \end{pmatrix}$$

In Eq. (4),  $C$  is the feature comparison matrix, which is obtained by DTW using MFCC feature vector of vocal piano accompaniment. Using the feature comparison matrix, the similarity of fundamental frequency change  $P$  and MFCC feature similarity  $M$  can be obtained.

### Scoring Mechanism

The purpose of piano accompaniment score is to show whether the tone of the accompaniment is correct and standard, and whether it meets the requirements. The higher the score is, the higher the satisfaction of the accompaniment is. On the contrary, the lower the score is, the less accurate the tone of the accompaniment is. Therefore, the evaluation score can be defined as.

$$(P, M) = k_1P + k_2M + k_3PM \quad (5)$$

In formula (5),  $k_1$ ,  $k_2$  and  $k_3$  represent the weight of each scoring parameter in the scoring,  $P$  for the similarity of fundamental frequency change, and  $M$  for MFCC feature similarity. The selection of weight can be different according to different requirements or the focus of scoring. In order to make the computer better simulate the score of accompaniment experts, we can train the weights and find out the best mapping relationship between computer score and manual score.

## 3 Experiment

In order to verify the design of the mobile teaching platform for vocal piano accompaniment course, two groups of commonly used mobile teaching platforms are selected for comparative experiment. Choose the vocal music piano accompaniment course as the comparative experimental object of this design, verify the design of vocal music piano accompaniment course mobile teaching platform. From two aspects of platform response delay and memory occupancy, the running stability of three groups of mobile teaching platform for vocal piano accompaniment course was compared.

### 3.1 Experimental Preparation

This test vocal piano accompaniment course mobile teaching platform, will choose PHP server and Android client-based related equipment as the platform test necessary tools. Based on the actual situation, the platform will be specially configured with relevant staff for unified testing and installation of the system, and there are strict requirements for basic configuration of mobile phones, mainly reflected in Android 2.2, which is the minimum configuration. The server side shall carry out relevant tests with the help of the server of business application. In the actual test process, the server shall be replaced by the same PC if necessary. The specific configuration is shown in Table 1.

**Table 1.** Server hardware and software configuration

	Name	Specifications
Software	Compiling software	Eclipse + ADT
	Operating system	Windows 7 + Windows Server 2003
	Database	MySQL 5.6
Hardware	Graphics memory	1 GB
	Hard disk capacity	500 GB
	Memory capacity	2 GB
	CPU brand	Intel E5.2620
	Inspiron model	620S-356
	Product name	Dell 620S-356

Choose the Monkey platform testing tool to test the response delay and memory occupancy of the mobile teaching platform, and let three groups of mobile teaching platforms. Run on the server hardware and software configuration shown in Table 1, compare the response delay and memory occupation rate of the three groups of mobile teaching platforms, and verify the stability of the three groups of mobile teaching platforms.

### 3.2 Experimental Result

#### The First Group of Experimental Results

Based on the experimental parameters set in this experiment, the monkey platform test tool is selected, and a total of 300 people are selected to test the platform concurrency. Set the initial concurrency of the three groups of mobile teaching platforms to 50 people, and increase the concurrency of 50 people every 5 min until the total concurrency of the platform reaches 300 people. Verify the response delay time of three groups of platforms facing different concurrency, and the experimental results are shown in Fig. 4.

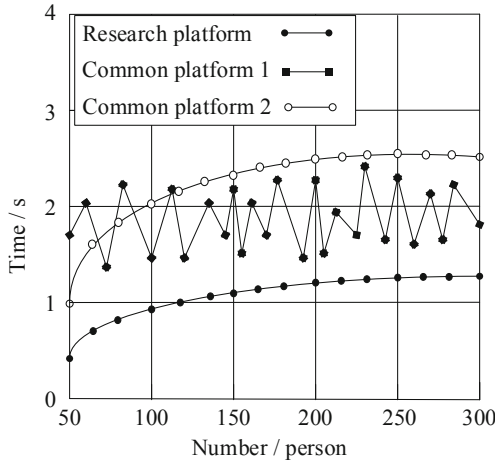


Fig. 4. Comparison of platform response delay test

As can be seen from Fig. 4, with the increase in the number of visitors, the response delay time of the three groups of mobile teaching platforms increases, which is affected by the running cycle to a certain extent. Among them, the common platform 1 faces the concurrency of 300 people. The delay time is basically maintained at 1.9 s, without large delay, which can ensure that 300 people visit the mobile teaching platform at the same time. However, its balance is poor. Whenever the concurrency of the platform changes, the delay time of the mobile teaching platform will change, which can only meet the basic needs of the platform. Common platform 2 faces the concurrency of 300 people, and the delay time increases with the increase of concurrency. However, when the number of people who log on to the mobile teaching platform at the same time reaches 250, the platform delay time shows a downward trend, which is not different from the actual cognition. It shows that the common platform 2 crashes, only 250 people can access the mobile teaching platform at the same time, but it has a good balance. The research platform faces the concurrency of 300 people, and the delay time increases with the increase of concurrency. However, when the number of people who log in to the mobile teaching platform at the same time reaches 250, the delay time of the platform is basically unchanged, and it is difficult to ensure the normal operation of the platform. It shows that the research platform can only guarantee 250 people to visit the mobile teaching platform at the same time, and the curve is smooth, and it also has a good balance. However, compared with common platform 2, with the increase of concurrency, the latency of the research platform is significantly less than that of common platform 2, which shows that the research platform has short response latency and fast response speed.

### The Second Group of Experimental Results

On the basis of the first group of experiments, the second group of experiments was carried out. Using the monkey platform test tool, test three groups of mobile teaching

platform memory occupancy. In this group of experiments, 150 users are selected to test the memory occupancy rate, and the test results are shown in Fig. 5.

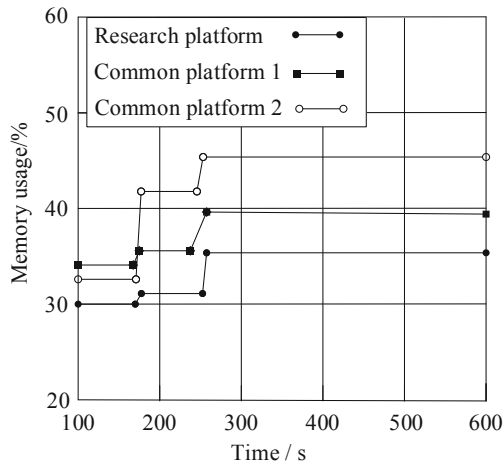


Fig. 5. Memory usage

As can be seen from Fig. 5, under the same amount of concurrency, the change of test time will also change the actual utilization of existing resources to a certain extent. Among them, the memory occupancy rate of the platform is faster than that of the two groups of platforms, and the memory occupancy rate is only 35%.

## 4 Conclusion

The design of a mobile teaching platform can play a guiding role in the planning of vocal piano accompaniment courses. This article builds a mobile teaching platform architecture, designs a mobile teaching platform database, uses feature comparison technology to extract vocal piano accompaniment parameters, and according to the actual parameter results obtained, The teaching effect of the vocal piano accompaniment course is optimized and upgraded, and the course teaching evaluation model is improved. The design of the mobile teaching platform for vocal piano accompaniment courses based on the comparison of features in this study is beneficial to optimize the update and upgrade of the mobile teaching platform, effectively improve the response speed of the system, reduce the system memory usage, increase the system load capacity, and expand the vocal piano accompaniment content The search range improves the overall teaching effect of the vocal piano accompaniment course system. In the actual application process of this article, the mobile teaching platform has always improved the teaching efficiency of vocal piano accompaniment and ensured the quality of teaching. At the same time, it has also improved the classroom teaching efficiency of teachers, and provided more reliable teaching methods for the learning of vocal piano accompaniment courses. The design of multimedia teaching system adds theoretical support.

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