

An Android Learning Platform in Elementary and Secondary Education Based on Micro-Service Architecture

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Abstract: This paper proposes a learning platform based on Android for elementary and secondary students, providing more than 30 function modules concerning study assistance, courses review, and knowledge reinforcement. The platform offers a large number of multimedia files to enhance the experience of learning. Meanwhile, various types of mobile learning games and stories are provided to motivate learning interest and initiative. The system adopts advanced micro service architecture. Different users possess their own interfaces respectively. One of the highlights is the course design hold pace with the synchronous classroom teaching. Through the platform, students can be trained comprehensively in a fragmented time.

1. Introduction

Education is a thought-provoking problem which bothered the parent constantly, especially for the elementary and secondary education. Under the influence of college entrance examination system, students in China cannot be expected to be capable enough to enter the proper school without a good grade. They have to undergo intense training to grasp knowledge. While the problem is that children in elementary and secondary school are very active and out of control. Apparently boring study cannot arouse interest in learning. We try to find an approach to strength and improve the learning process. Meanwhile, reduce the pressure on students.

Many previous research works concerning e-learning in elementary and secondary education have been carried out. Children who make use of technology show better language skills, intelligence, structural knowledge and problem solving skills as compared to children who do not use technology for their learning [1]. Couse and Chen. [2] pointed out the advantages of information technology in the coordinated development of urban and rural schools, Huang and Ji. [3] created a platform and examined the possibility of using a voice and gesture based gamification approach to make educational activities more interesting to the child. P. Kekuluthotuwege and P. Fernando.

Learning Platform based on various kind of technologies play a more and more significant role in the process of elementary and secondary education. In terms of platform performance, the codes of most traditional applications are complexity and enormous, which cause the difficulty of maintaining and high upgrade costs. In addition, there are many problems, such as cyclic dependencies between business modules, unreasonable call, tedious and complicated business process, cause dramatic impact on upgrading new functions. Furthermore, the entire node is not available when there is an unrecoverable failure in system functional component. In terms of scalability, most traditional enterprise applications promote a single deployment that may cause a choke point in the server in multi-user concurrency environment [4]. HuiyiLi.

Micro-services Architecture is adopted to solve the problems in system establishment process. Micro-services originated from the world's best known internet companies, Amzon, Netflix, eBay etc. It is the product of agile development, virtualization, and DevOps. The core concept is breaking up

highly coupled modules into micro-service system that can implement module decoupling. In this way, complex system can be divided into several detailed services. These services are loosely coupled, extended and scalable for mobile application [5]. Lu YuanRong. [6] can improve the time to market capabilities, and promote quick development, deployment, and realization of services. In use of mobile and desktop applications consume them to offer a personalized shopping experience to the passengers. Hari and Viral. [7] proposed the library Micro-services system based on Android ,which can increase the response speed of mobile-library and improve user experiences. Guo et al. [8] implemented a standard development framework to generate micro-services engineering. By employing micro-services building technology and distributed service registry technology, it can help to resolve many problems such as long development cycle, quick respond, etc. [9] presented a flexible Data Acquisition System capable of capturing the human-computer interactions performed by users over mashup (User) Interfaces with the aim of storing them in a relational database. Fernandez-Garcia. [10] used unified Node.js programming model and standardized REST API protocol, and the result has been a low cost, high performance, easy maintenance and security of IOT enterprise application. Haidong Lv.

Taking into account all the present research in this field, there is still a lack of consideration of learning platform. Further research remains to be conducted on the direction of platform content and system architecture. In this paper, the method of learning platform in elementary and secondary education is put forward in detail. The remainder of this paper is organized as follows. Section 2 presents the systems principle about the platform. In section 3, software design and implement is proposed. The technical difficulties discussion is carried out in section 4 to demonstrate the performance. Finally, conclusions are drowned in section 5.

2. Systems principle

This paper proposes a student-oriented platform that combines knowledge from books and cases in life. Take mathematics as an example. We all know 1 and 1 equals 2, so this kind of exercise meant little. While change question status is a good way, such as which number plus 1 equals 2. The status from adds to subtracts makes the computational process not easy. Or another status like which 2 values got a sum equals 2. That is an open ended question with many answers. Essentially, those are the same question with different forms but it is much better to focus on the quality rather than quantity. Other modes are also provided in the platform, such as stage mode, versus mode, and cooperation mode. In these modes time is an important parameter. Student may make a mistake when in a time crunch. The fundamental cause of mistakes is inadequate understanding of knowledge. In this case, a number of practices are necessary.

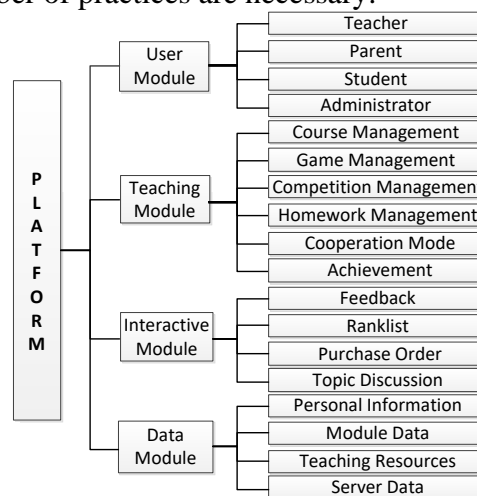


Figure 1. Main function modules in platform

Used in technical analysis, micro-service is a proper architecture in the platform. Firstly, there are multiple independent modules with low correlation respectively. And the services can be deployed

independently. Updating individual module has little effect on the others in the system. In addition, users control only one module when they are using the platform. Communication can be displayed by remote call between services.

As shown in Figure 1, the main functions in the platform can be divided into 4 modules. Each module contains several slave modules, which can be updated and modified quickly when teaching demand changed.

Firstly, users can be divided into the system administrators, parents, students and teachers. Students and parents should register in the application, whereas the teacher members can either register by themselves or created by administrators. User module connects with data module through API. When a user login, he should choose their roles to enter different system interfaces, that can realize distinguishing operation and pages control. Teacher and student users request much data in size such as the section group about course. Most of them are more than 3M which may lead to network delay. For better performance, one of the solutions is local storage and ensures the network request step by step.

Another important micro service is teaching module, which contains 6 sub modules of course management, game management, competition management, homework management, cooperation mode, and achievement. Course management contains international literacy, math, language, geography, history, literature, art, etc. One of the highlights is the course design hold pace with the synchronous classroom teaching. Meanwhile, many mobile learning games are included such as Sudoku, Mathematical Olympiad, and Chinese string up puzzle. These games are especially effective in fostering interest. Teachers set and publish homework according to course design, which helps the students to consolidate the key knowledge points. There are also competition and cooperation management. In these parts, not only contents of the class but also extended resource are provided. Students and their parents can either cooperate to finish a task or compete with others. It is necessary to stop at intervals in the learning process and go back to the difficult points in the lessons. Once the students had done all that, they can find learning progress, progress of homework, and other achievements.

Interactive module is the micro service for students and teachers in which they can discuss, answer questions, and feedback appraisal. Students and teachers can create the topics, while others reply and participate in discussions. They can also ask for advice to their teachers by send voice mail, pictures or text message. Parents can check the studying process and feedback, and also suggest improvements to the teachers or system administrators.

In data module, administrators and teachers manage the data from users, courses and modules. These data connected with each other by data classification and combination. In the platform, each micro service manages its own data which is stored in redis and postgres. Users can browse, search, edit, delete, or create new resource in the application. Most of these data are stored in elastic compute service (ECS), the other storage resources are on user device based on SQLite.

3. Software Implementation

The system functions can be refactored to implement module decoupling. Each module has its own function which communicates with lightweight communication mechanisms. The platform can be used in Android, which can provide users with quick and convenient access to information. It takes users as the center and focuses on result practical application, and has the characteristic of mobile learning and autonomous learning. The learning platform architecture based on micro service is shown in Figure 2.

There are four layers in the platform architecture. In user layer, different permissions are provided for various users. An authentication error will occur if the user trying to connect is not same as the user whose information is in the database. Users can browse, search, and feedback in presentation layer. Administrators and teachers manage some management functions such as data access, teaching information. For the young students, non-educational games are harmful. In this layer parents can monitor the real time that application open and close. In access layer, service discovery is provided

in the platform. High concurrency request is received and various request processes are handled to fulfill load balance. In this layer, module security is important such as decompile and data transmission to establish reliable platform. In micro services layer, each individual module is designed, there are more than 30 independent modules are provided such as strokes, Sudoku, mathematical Olympiad, and idiomwinat solitaire. In the process of development each module are ranked by the importance of function. To fulfill iterative development, important function should be designed and developed in the early stages.

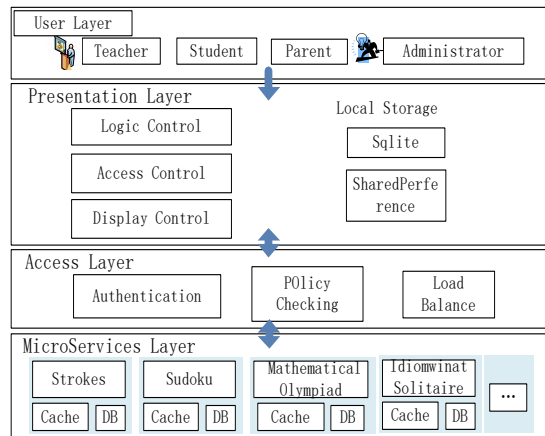


Figure 2. Platform architecture

4. The technical difficulties discussion

4.1 Stroke Order

Mandarin language is one of the international languages widely spoken nowadays which is not easy for the elementary and secondary students [11-12]. In the platform, there is a function to demonstrate how to write the correct characters. That function train the ability to remember the rules of the strokes. The principle is encoding Chinese character into JSON format and parsing it by the program code. Canvas is adopted in development which can be divided into normal and writing statuses. The key codes are as follows:

```
protected void onDraw(Canvas canvas) {
case STATE_NORMAL: { // display outline only
    if(null != mOutline.bitmap && !mOutline.bitmap.isRecycled()){
        canvas.drawBitmap(mOutlineDrawInfo.bitmap, 0, 0, null);}
    }
case STATE_WRITING: { // display outline and text direction
    if(null != mOutline.bitmap && !mOutline.bitmap.isRecycled()){
        canvas.drawBitmap(mOutlineDrawInfo.bitmap, 0, 0, null);
        }
    }
    .....
}
```

In this part, it takes large amount of computation to parse JSON file. After a lot of computing, the order of strokes will be displayed on the screen coordinate. Finally the characters are showed in the form of animation, which require the application runs in a high performance environment with little delay or stuck. To resolve this problem, multi-threading technology is adopted to read JSON data. Calculate the sequence JSON file in several tasks simultaneously, which can promote reading speed. As shown in Figure 3, hollowed part is the character outline whereas solid part is order animation of strokes.



Figure 3. Stroke order animation

4.2 Content Presentation

There are some contents and constructions of modules need to be adjusted frequently in the platform. For these parts HTML5 is used in the application. But for the mathematical problem analysis module, HTML5 is not proper because of the complicated work when mathematical formulas and geometric figures are displayed.



Figure 4. PDF file display

PDF file presentation is adopted, of which the advantage is the format not easy to change. The content in the bottom half of Figure 4 is PDF file, users can zoom in or out this view through gestures. Specifically, due to the limitation of mobile device, horizontal screen display is adopted to display more information. In addition, PDF files will be deleted automatically when the users quit the platform considering security and privacy. The key codes are as follow:

```

if (dir.isDirectory()) {
    String[] children = dir.list();
    for (int i=0; i<children.length; i++) {
boolean success = FTPdeleteDir(new File(dir, children[i]));
        if (!success) {
            return false;
        }
    }
}
return dir.delete();// the directory is empty and remove it

```

4.3 Audio and Video

As a means of testing, dictation can reflect students' ability of using language completely. In the platform, the words of Chinese and English dictation are provided. Sometimes pronunciation test is

also needed for the students. This part API from iflytek is adopted [13], which can translate pronunciation into text to check pronunciation accuracy rating. As shown in Figure 5, audio player is designed which contains starts, stop, replay and pause function.



Figure 5. Chinese dictation

For performance reasons, multi-threading technology is adopted ether. The codes about audio play are as follows:

```

mMediaPlayer = new MediaPlayer();
new Thread(new Runnable() {
    @Override
    public void run() {
        try {
            .....
            mMediaPlayer.reset(); //reset MediaPlayer
            mMediaPlayer.setDataSource(url); // set audio file path
            mMediaPlayer.prepareAsync(); //prepare audio
            mMediaPlayer.start(); //start audio
            mMediaPlayer.setOnCompletionListener(
            ..... //release and start new audio);
        }
    }
}

```

4.4 Words Formatting Problem

China is a country of many dialects, and pinyin helps the realizing of a common language for the entire nation. Pinyin is of great importance which is much more like phonetic symbol in English. Each word has its own pinyin, whereas the length of pinyin is different. How to justify a word and its pinyin is a key problem to solve. In the platform, GridView layout is chosen for words formatting. Take word and its pinyin as a whole item to justify content. Other situation such as punctuate or subtitle should be taken into consideration. As shown in Figure 6, the position of poem is the proper display mode.



Figure 6. Words formatting

4.5 Mobile learning games and stories

In the platform, there are several learning games and stories for students to provoke interest such as Sudoku, Mathematical Olympiad, and Chinese string up puzzle. These contents are not only the knowledge from books but also extracurricular knowledge, which is the accumulation of geography,

history, literature, and art. As shown in Figure 6, Sudoku and Chinese string up puzzle are implemented in this part.



Figure 7. Mobile learning games & stories

5. Conclusion

This paper focus on the problem of the elementary and secondary education, presents an application based on micro service to control students teaching and testing management, puts emphasis on the implement of software programming. From the platform, students can be trained comprehensively in a fragmented time. A survey was made to the parents in the platform, from this most parents think the platform is helpful. Mobile learning games and stories can gradually motivate students' learning interest and initiative and improve their learning effect. We will do the deeper research on performance enhancements in the next step such as multi-thread problems when audio and Chinese character animation is played.

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