Design of a Lightweight Autonomous Learning System for the Course of Software Testing Based on Android

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Abstract. A lightweight autonomous learning system for the course of software testing based on Android is developed according to the local teaching environment, and the system is fully applied on autonomous learning process outside class on campus. The system is designed on the architecture of SSH (Struts-Spring-Hibernate) which is based on J2EE for web server, and the functions of Course Information, Resource Management, Exercise, User Management and Online Discussion can be provided to client users by Android platform. Finally, further work such as how to add the function of online exam for subjective exam items in the system, how to add powerful function of micro video content editing for the management of course resource, and how to integrate this system into the local informational learning platform to complete the blended learning mode on SPOC (Small Private Online Course) are expected in the paper.

1. Introduction
In recent years, software testing is getting more attention from Industry, Education and Academic [1]. Now, the content of software testing has been evolved from a previous chapter in the curriculum of software engineering to an independent course. Software testing is also an important learning course for college students who are about to work for jobs on software testing in IT enterprises. Because of the practicality and comprehensiveness for this course, it is more difficult to learn the relevant theoretical knowledge of software testing only from books. Therefore, an autonomous learning system is to be designed between learners and the course, which allows learners to quickly master the content structure for knowledge of software testing course.

With the continuous development and popularization of the Internet, network teaching and long distance teaching have gradually become the mainstream teaching mode in China, and open network teaching is used to meet the needs of individual development of students. Mass groups show high dependence on mobile terminals such as mobile phones [2]. With the widespread popularity of smart phones and mobile Internet development trend, those which based on status of the smart phone market share in the Android system is much higher than IOS system for smart phones [3]. In practical application, it is necessary to provide a solution which can be quickly designed and implemented with simple structure for the requirement of a small group of users, such as students in one university.

In this paper, a lightweight autonomous learning system for the course of software testing based on Android is designed and applied on autonomous learning process on campus. The system has a beautiful interactive interface, which can accurately present learning resource, learning strategy and method, and ensure the accurate processing of learning data. The structure of the paper is organized as follows: Section 2 presents the concept on relevant technologies of the whole development. Section 3 establishes the architecture and requirement of this lightweight autonomous learning system. Section 4 descripts the design and implementation of a major module of the system. Section 5 descripts the application and puts forward the further work. Finally, Section 6 concludes the paper.
2. Relevant Concepts and Technologies

2.1. SPOC and Autonomous Learning
As a supplement to MOOC (Massive Open Online Course), SPOC (Small Private Online Course) deeply combined a large amount of learning resources with traditional classroom teaching in campus, which is not only the reform and innovation of the MOOC, but also reflects the development of traditional teaching in post-MOOC period [4].

In blended learning mode on SPOC, teachers carefully design and edit micro-videos for online teaching according to teaching targets and teaching content, students are required to complete the watching on micro-videos outside the classroom by way of extracurricular task. Learning activities such as discussion on learning topics, answering questions, evaluating the learning effects on students are used to implement in classroom on campus. In online learning session, some universities use the existed MOOC platforms in domestic or abroad available and some universities develop autonomous learning systems independently which are suitable for localization teaching environment to guide students for online learning. Autonomous learning requires learners to have the ability and willingness to study independently. They use mobile terminals such as smart phones or PADs to complete learning tasks according to learners’ own needs and combined with their own level of knowledge ability. In autonomous learning system, students are allowed to choose learning strategies and learning methods freely according to their own characteristics and complete the learning process. In the learning process, you can interact with other learners and even teachers online at any time [5]. The autonomous learning system needs to provide an online testing function. In the course of autonomous learning, learners should be reflected by their own learning behaviour and learning process, and provide reference for better learning in the future.

2.2. Android Platform
Android is developed by Google, based on the Linux kernel and designed primarily for touchscreen mobile devices such as smart phones and PADs [6]. Android platform adopts the software architecture for four-layers. The bottom layer is the Linux core layer which includes operating system and driver programs, the middle layer includes various functional libraries and Java local operating environment, the frame layer provides software applications and framework design in Java language, and the application layer which includes some functions for user's actual access on Internet, using of telephone, text messaging, and so on [7]. Android platform is a platform which is very suitable for providing campus digital and information application services and the main advantage is that Android platform is completely opened to the third-party software and the service is free.

2.3. SSH
SHH (Struts-Spring-Hibernate), as the three layers on architecture based on J2EE for web server. Spring is a lightweight framework for open source, that the core is control reversal and orientation, which is easier for programing and code management [8]. Struts is based on MVC (a design mode on Model View Controller), improving development efficiency and facilitating later maintenance. Hibernate is a mapping framework for object relationships that performs data persistence. Load balancing technology is used in SSH to ensure that data access delay or response time slows down for the system are not happened when there are many PC clients who visit the server whatever on campus or off campus.

2.4. Paging Display for Data Sheet
We use the technology of GirdView to complete the function of paging display of a large amount of data automatically. The item on SQL-data source can be configured on “enable cache” to achieve cached data pages for displaying to improve the scalability of web applications and the efficiency of the program's operation.
3. System Architecture Design and Requirement Analysis

3.1. Introduction on System Architecture Design
The client of the learning system is developed by using the Android platform to complete data interaction with the server and its own network for communication services, database management, and so on. On the server side, the framework of SSH (Struts-Spring-Hibernate) is used to manage various course learning data. It's important to note that the objects of TCP-client are initialled by the server-side to create the data stream of Socket. The client site also establishes the Socket objects, and their IP address and port numbers are obtained from the configuration file [9]. According to Socket, the objects for OutPutStream are created, the interface on Date Output Stream is established too, and the data is written out through the interface to complete the information interaction between the server and the client[7][9].

Here, browser mode is used for completing the collection with the Android client and server for data exchange by invoking Webkit core. The advantage of this mode is that a system has achieved perfect functions on its web side. Developers only need to write simple programs and invoke them to achieve the similar functions on mobile terminals for users, which greatly reduce the difficulty of programs and shorten the development time [10].

3.2. Requirement Analysis on Functionality
The development of lightweight autonomous learning systems is different from the traditional learning systems. The former is no longer focused on comprehensive system functions but provides appropriate services according to different user groups. In general, developers cut some non-core functions on the basis of existing learning systems, or optimize some functions to form a lightweight system.

In general, most autonomous learning systems include two major modules: core functions (Course Information/Resource Management/Exercise/User Management) and auxiliary functions (Learning Progress Monitoring/Video Edit/Online Exam/Evaluate/Online Discussion/etc.). The main purpose of the core functions is to achieve better teaching results, and the auxiliary functions provide the necessary convenience for users to participate in the course [11].

The development of the lightweight autonomous learning system in this paper is used for senior students in computer and software engineering specialities on campus, who learn the course of software testing as an elective course outside the class. Because the user group is small scale, so the function of the system is relatively simple. The functions of the system are divided into four modules, and the description of function of each module is shown as Table 1.

| Function          | Description                                      |
|-------------------|--------------------------------------------------|
| Course Information| Release and manage the course information.       |
| Resource Management| Manage the relevant operations on resource of the course. |
| User Management   | Manage the authorization for users.              |
| Exercise          | Student users complete the exercises after each chapter. |
| Online Discussion | Teachers and students complete communication and discussion from online forum. |

Authorization for users are divided into three categories, they are administrators, teachers, and students. Student user with the real name registration and logins the system, he or she can browse the course resource online, downloads the corresponding resource attachments. Student user can attend a learning topic discussion through the forum and receive the teacher's response. When the teacher user logins the system, he or she can release and manage all sorts of learning resources such as syllabus, electronic courseware, application cases, exercises, and so on. Teachers can also answer students ‘questions through forum messages. Administrators can edit and modify the information of teachers and students and provide teachers with relevant learning data for student. The Use Case Diagram of the overall function of the system is shown as Figure 1.
Figure 1. Use case diagram of the overall function

Figure 2. Main interface of the system

3.3. Analysis on the Database
According to the characteristics on this lightweight autonomous learning system, some data tables and their E-R relationships are analysed and designed, such as course forum, discussion topic, post bar, learning resource, and so on. They are not listed here due to limited space.

4. Design and Implementation
The main interface of the system is shown as Figure 2. In this chapter, the design and implementation of module of Resource Management is described only due to limited space.

We design the class diagram of this module by using mode of policy-based. Three classes of Doc Add, Doc Del and Doc Mana are designed to complete the functions of delete resource, add resource and edit resource, using the common interface of HibernateDaoSupport to implement these operations.

The class diagram of this module is shown as Figure 3.

Figure 3. Class diagram of the module of Resource Management

During the process of autonomous learning, student users could download the course resource by this module. Here, we use the design method to complete the function which is from reference [11].
After the user selects the button of download, the current page will be jumped to the UpDown page automatically, and the method of down() is used to obtain the file path, the method of out Body() is called to complete the operation of download[11]. The sequence diagram of the function of download the resource is shown as Figure 4.

![Sequence diagram of the function of download the resource](image)

**Figure 4.** Sequence diagram of the function of download the resource

5. **Application and Further Work**

The first version of this lightweight autonomous learning system was released three months later and applied on autonomous learning process for students in their spare time on campus. After the teacher released the related resource of the software testing course, such as syllabus, electronic courseware, application cases, exercises, and so on, more than three hundred students logged in the system and finished studying the course through the Android mobile phone. Now, more and more students on campus are interested in participating in the discussion of the learning topic actively, a total of more than a thousand messages are sent out by learners and they are all replied in time by teachers or students. Better effect on learning feedback is gotten by students.

But, further work will be researched in the future. Firstly, a relative perfect sub-system for function of online exam will be integrated in this lightweight autonomous learning system. In addition to have the function of testing for objective exam items, some exam items such as subjective questions which have no standard answers should be added in the sub-system. Secondly, watching learning videos is also an important part of autonomous learning. Powerful course content editing functions that the course resource can be added, such as course micro video and so on [12]. Thirdly, on the background of big data, how to integrate this system into the local informational learning platform to complete the blended learning on SPOC, and it is also the further work in the future.

6. **Conclusions**

A lightweight autonomous learning system for the course of software testing based on Android platform is designed by cutting the functions of the traditional learning system and fully applied on campus. The stability and reliability of the system are good. Experimental result shows that the application of the lightweight autonomous learning system is of great significance in improving the teaching effect of teachers, stimulating students’ interest and initiative in learning process, and improving the construction level of SPOC on local campus.

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