Design and Application of Hybrid Teaching Mode of Pharmaceutical Analysis Experiment Based on SPOC and CBL

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Abstract. At present, more and more colleges and universities are beginning to use the innovative form of "Internet+Education" to realize the reform of teaching ideas and teaching modes, so as to further improve the teaching effect. Under this background, this paper focuses on the construction of online teaching system of pharmaceutical analysis experiment course based on SSM framework in Java language development environment. On this premise, it will promote the formation and application of the hybrid teaching mode combining online teaching with offline classroom teaching. The online teaching system of pharmaceutical analysis experiment course organically combines SPOC course with CBL teaching method. Aiming at many shortcomings existing in the current actual teaching process, it comprehensively reforms and practices the pharmaceutical analysis experiment course by means of online teaching resources construction, updating of teaching methods, and improvement of assessment and evaluation system, which is conducive to students' personalized learning and all-round development. It improves the teaching quality of pharmaceutical analysis experiment course and further promotes the process of information reform of college education and teaching.

Keywords: Java · SSM framework · SPOC · CBL · Pharmaceutical analysis experiment · Hybrid Teaching

1 Introduction

At the present stage, China's higher education reform is in the deepening stage, and the construction of "four new" is progressing steadily. As one of the "four new", the new medical construction will also realize the linkage development of higher education and scientific and technological innovation, integrate new technologies and new models into the talent training program, and carry out all-round reform from the talent training paradigm such as educational thought, development concept, quality standards, technical methods and quality evaluation [10]. The new medical construction covers clinical medicine, nursing, preventive medicine, pharmacy, rehabilitation medicine and other specialties. Among them, pharmacy specialty has gained more attention due to the global epidemic and the tilt of national policies. As one of the core courses of pharmacy specialty, pharmaceutical analysis gives full play to its professional advantages

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in epidemic prevention and control, and has made outstanding contributions in many aspects such as drug research, production, storage and use. Since then, pharmaceutical analysis specialty will usher in comprehensive innovation and reform, which is not only a breakthrough in pharmaceutical treatment practice and pharmaceutical research construction, but also puts forward new requirements for the cultivation of pharmaceutical professionals.

Under the dual background of epidemic situation and new medical construction, the teaching of pharmaceutical analysis major in colleges and universities should adhere to the goal of cultivating high-quality compound talents with solid foundation, broad caliber and close to the demand pattern of the industry, adhere to the training method of integrating theory with practice, and complete the implementation of daily education and teaching planning. However, in the actual teaching process, it is not difficult to find that the current teaching of pharmaceutical analysis major in colleges and universities has the problem of emphasizing theory over practice, emphasizing only the systematicness and discipline of knowledge, and paying attention to the teaching of book knowledge. There is a lack of a better way to implement the practical experimental course teaching. One of the reasons is that experimental equipment and supplies cost a lot, which increases the burden of schools. Secondly, experimental teaching resources are insufficient, and it is difficult to achieve ideal teaching results only by relying on fixed teaching materials and teachers' explanations. Third, the lack of comprehensive assessment system leads to the low degree of teachers' involvement and students' participation, and insufficient attention is paid to the experimental teaching of pharmaceutical analysis. The course of pharmaceutical analysis has strong practicality and application, and the level and effect of experimental teaching are closely related to students' professional quality [7]. In view of this, this paper holds that, with the prevalence of "Internet+education" today, based on Java language development environment, SSM framework is adopted to complete the construction of online teaching system of pharmaceutical analysis experimental course. With the help of the application advantages of network information technology, the system will complete the optimization and reform of the experimental teaching path of pharmaceutical analysis in the form of online teaching. Compared with single classroom teaching, the system can introduce SPOC teaching course and CBL teaching method into daily teaching practice, and through online teaching, expanding materials, exercises, homework assessment, interactive communication and other functional modules, it can assist teachers to complete experimental teaching tasks, strengthen assessment and evaluation. And at the same time, enhance students' sense of participation in a more flexible and convenient way, and stimulate students' interest in learning. In addition, the virtuality, richness and free nature of network resources have also overcome the problem of cost, realized the reform from traditional teaching mode to hybrid teaching mode, and promoted the deep integration of modern educational technology and classroom teaching.

2 Introduction of Related Technologies

2.1 Web Technology

Web is an application architecture based on the Internet, which provides users with multimedia message service with hypertext, hypermedia and hypertext transfer protocol as the main technical means. Web technology is the general name of all technologies that support the operation of Web application services under the Internet environment. Web technologies are divided into two categories according to their functional attributes, namely, client-side technologies and server-side technologies.

Common client technologies include: HTML, JavaScript, CSS, etc. Among them, HTML is the basic language used to form the client display interface, which can complete the basic structure of the whole page for deployment and definition. CSS can define the decorative effect of each part of the structure, including font, color, position and so on. As a scripting language, JavaScript can add dynamic effects to the basic structure of the page, such as Flash animation player, video player and so on, so as to increase the display effect of the page and improve the interaction efficiency of users [8]. The change of server-side technology determines the development and application of the whole Web technology, and it is also intuitively reflected in the transition of server-side functions. From simply responding to the HTTP request sent by the client, to executing external programs, which can generate dynamic content according to the content of the Web request, to a large number of object-oriented languages and framework applications to strengthen the interaction between users and systems to enhance the user's experience of using the Internet. More and more high-tech applications promote the development of Web technology, which brings convenience to our applications and brings new value to the whole Internet.

2.2 MVC

MVC is the abbreviation of Model View Controller, which stands for model, view and controller respectively. The combination of the three forms a software development framework model, which can realize the dynamic design of programs on the Web, simplify the subsequent modification and expansion of programs, and increase the reusability of some programs [5].

In the actual development process of Web application, the core application of MVC pattern lies in the hierarchical design idea of the system. Under the unified standardized specification, all levels will be divided according to their functions, and only rely on the unified data interface to complete the correlation and call, which can effectively reduce the dependency among levels and ensure the overall scalability of the system. Compared with the traditional software development mode, MVC mode has obvious advantages such as low coupling degree, high reusability and fast development speed [9]. In different language development environments, there are many types of MVC frameworks, such as Spring MVC and ASP.NET MVC. Different MVC frameworks have different development efficiency, running performance and application scope, which increase flexibility and adaptability for the design and development of Web applications (Fig. 1).

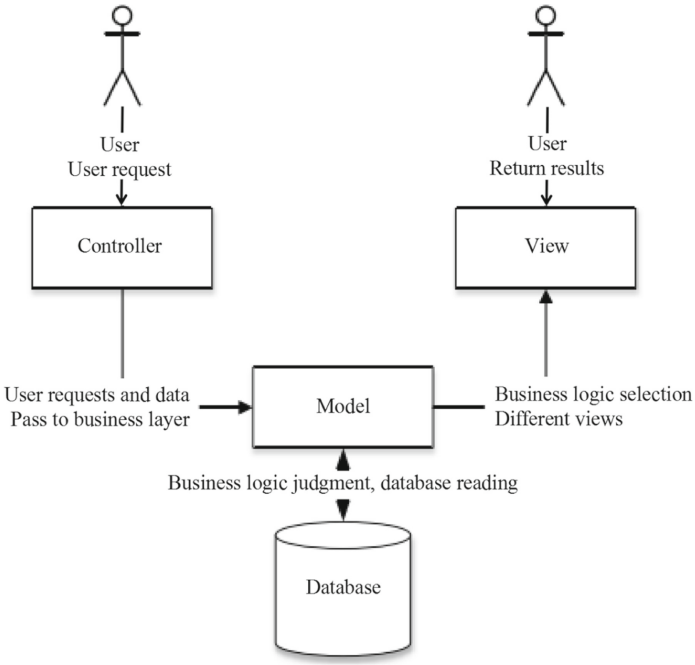

Fig. 1. The working principle of MVC pattern

2.3 SSM Architecture

SSM (Spring+SpringMVC+MyBatis) framework set is the integration of Spring and MyBatis. SSM framework is subordinate to the standard MVC development framework model, and it is a Web application development framework with simple data sources under the Java language development environment [3]. SSM architecture complies with J2EE development specification, as shown in Fig. 2, which is a schematic diagram of SSM architecture's working principle.

2.3.1 Spring

The core application of Spring Framework is a container framework, which can accept multiple functional modules and functional levels in the system, and through the control inversion (IOC) feature, centrally manage and control the dependencies among various modules or levels, and change the process of system development from the aspects of simplicity, usability and loose coupling.

2.3.2 Spring MVC

Spring MVC framework, as a part of Spring framework, is a lightweight Web development framework using MVC design idea. In the actual application process, Spring MVC mainly uses the central controller DispatcherServlet to complete the requests sent by the client. After receiving the request, query one or more HandlerMapping to match

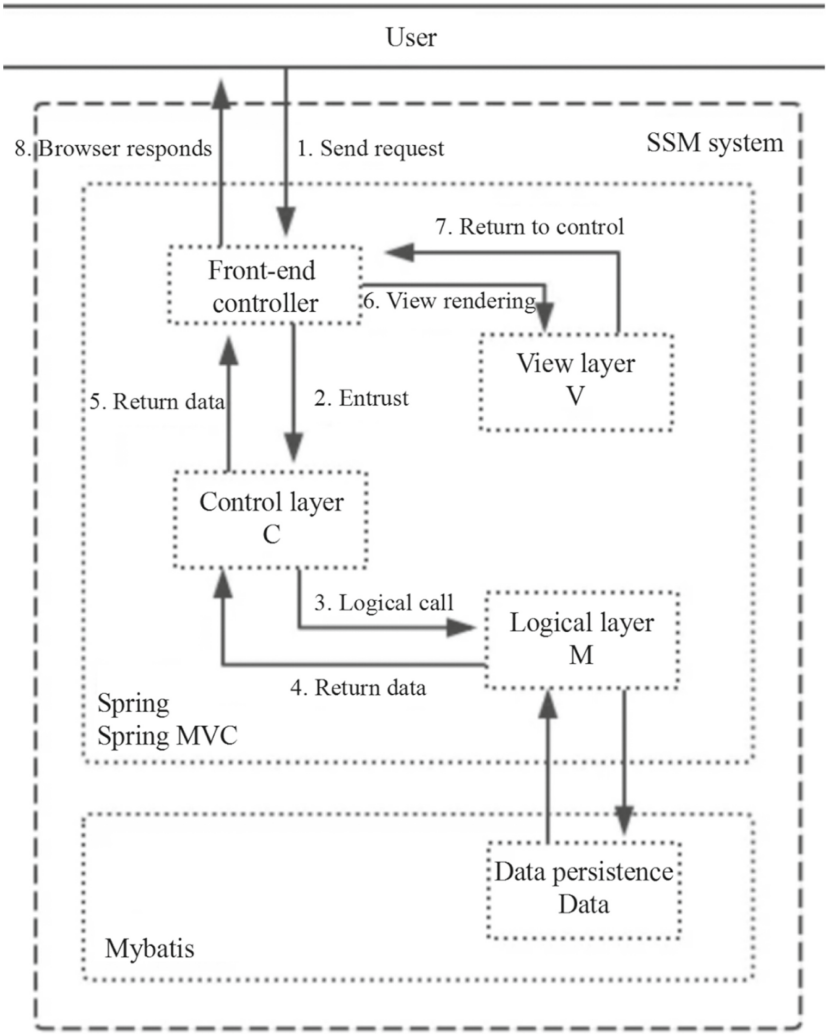

Fig. 2. Schematic diagram of SSM architecture working principle

the Controller. After the operation is processed, the ModelAndView is returned to the DispatcherServlet, and then rendered to complete the response to the user request [4].

2.3.3 MyBatis

MyBatis can encapsulate JDBC and complete various database operations through various APIs. The framework preset a number of MappedStatement objects, and each MappedStatement object contains parameter mapping configuration, SQL statement execution, result mapping configuration and so on. When the API interface receives the

call information, MyBatis will automatically enable the corresponding MappedStatement object to complete the parsing and operate the SQL statement to complete the execution, which greatly improves the operation convenience of the data persistence layer [2].

2.4 Development Environment

According to the system development requirements and the use requirements of the above key technologies, complete the configuration and deployment of the development

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/maven-v4_0_0.xsd">
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      <groupId>com.chillax</groupId>
      <artifactId>Maven_Project</artifactId>
      <packaging>war</packaging>
      <version>0.0.1-SNAPSHOT</version>
      <name>Maven_Project Maven Webapp</name>
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      <properties>
           <srping.version>4.0.2.RELEASE</srping.version>
           <mybatis.version>3.2.8</mybatis.version>
           <slf4j.version>1.7.12</slf4j.version>
           <log4j.version>1.2.17</log4j.version>
      </properties>
           <!-- java ee package -->
           <dependency>
                <groupId>javax</groupId>
                <artifactId>javaee-api</artifactId>
                <version>7.0</version>
           </dependency>
      <!-- mybatis Frame package start -->
           <dependency>
                <groupId>org.mybatis</groupId>
                <artifactId>mybatis</artifactId>
                <version>${mybatis.version}</version>
           </dependency>
           <dependency>
                <groupId>org.mybatis</groupId>
                <artifactId>mybatis-spring</artifactId>
                <version>1.2.2</version>
           </dependency>
           <!-- mybatis Frame package end -->
```

Fig. 3. The key codes of Java EE package and Mybatis package are introduced under pom.xml

environment. The overall development of the system is based on Windows10.0 operating system, with Java as the basic development environment, JDK version 1.8 and above, MyEclipse 2018 as the Java development environment, Tomcat 8.0 as the Web server and MySQL 5.8 as the database server. And the project object model (Maven) is used to manage the project structure. Maven chooses Apache-Maven-3.2.1 version.

After the above software is installed and set up, the basic framework of the project is built through Maven Project function under MyEclipse 2018. Pay attention to the selection and matching of Maven and Java jdk versions during the operation. After that, under the generated pom.xml file, various Jar packages required by SSM framework are introduced through code editing, such as Java EE package, Spring framework package, Mybatis package, JDBC package, etc. Some key codes are shown in Fig. 3. After the introduction, the controller package, entity object package, mapper package and service package are newly created in src/main/java directory to further improve the operation control and management of SSM framework. After adjustment and testing, it is proved that the overall development environment is built. Through the introduction of the above key technical theories, we have determined the overall environment of the system development, the configuration of related software and tools, and the technical feasibility of the overall project of the online teaching system for the experimental course of pharmaceutical analysis.

3 Requirement Analysis

3.1 Functional Requirements Analysis

The online teaching system of pharmaceutical analysis experiment course can aim at various shortcomings existing in current pharmaceutical analysis experiment course teaching, combine SPOC course teaching with CBL teaching method with the advantage of network information technology, and provide a comprehensive solution for the construction and implementation of hybrid teaching mode with online teaching as the medium.

According to the actual application needs of teachers and students, the system will conduct a comprehensive virtual daily education and teaching process, design a number of functions and links, pay attention to the correlation and interaction between online teaching and offline teaching, realize the perfect fit between them, and create a feasible teaching path. SPOC course combined with CBL method effectively solves the problems of single teaching resources, outdated teaching forms and lack of experimental equipment. The system will complete the experimental teaching of pharmaceutical analysis from a new perspective to stimulate students' interest in learning and improve the learning effect. In addition, SPOC courses have strong restrictions on access, resource use and course withdrawal, and student users need to be audited by teachers when registering. The functional design of the system is also more detailed and comprehensive to strengthen the control and supervision of students' learning process. The standard of restricted withdrawal comes from the final evaluation result of the combination of the procedural evaluation function and the conventional summative evaluation under the system. Compared with the traditional evaluation method, it is more scientific and reasonable, and the whole process is more information-based and systematic. The construction of the system

can not only solve the difficulties in the teaching of pharmaceutical analysis experiment course, but also help teachers to play an auxiliary role in teaching management, reduce the workload of teachers and improve work efficiency.

3.2 Global Design

In view of the functional requirements of the online teaching system of pharmaceutical analysis experimental course, combined with the application and configuration of the above-mentioned related technologies, the overall design of the system is completed. The whole system design takes JavaWeb technology as the core, and adopts B/S architecture

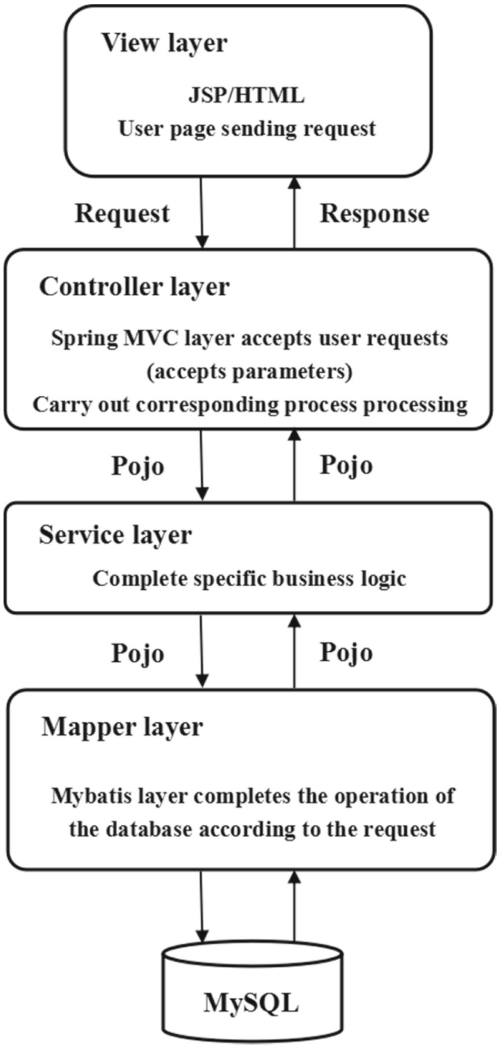

Fig. 4. System overall operation flow architecture diagram

to divide the whole system into three parts: application layer, business control layer and data service layer. Figure 4 shows the overall architecture of the system, in which SSM framework further subdivides the business control layer to strengthen the functions of the Web server. Among them, Spring MVC corresponds to the Controller layer in MVC mode, which is responsible for the control of business module process. Mybatis corresponds to Mapper layer in MVC mode, and is responsible for interactive design with database, which is used to handle data persistence. Spring layer is the Service layer, which is responsible for the logical application design of business modules [1]. In the end, the system relies on MySQL to provide the storage space of data information for the whole system, so as to support the smooth operation of the overall function of the system.

4 Function Implementation

4.1 Student Side

The online teaching system of pharmaceutical analysis experiment course is open to students in the form of Web application, and students can log in and use the system through various terminal devices connected to the Internet. When logging in for the first time, after students submit their registration materials, they will be audited by the course teachers. After the audit is passed, they can obtain the access rights of the system, so as to realize the access restriction function of SPOC courses.

4.1.1 Preview Before Class

The functional design of the system not only covers the whole process of pharmaceutical analysis experiment teaching, but also further improves the design and optimization of the course system. Under the hybrid teaching mode, the system adds the preview function before class. Under this function, students can know the learning task of this course in advance through the course learning task list issued by the teacher before the formal class, and guide themselves to complete the self-study of the course content, aiming at cultivating students' autonomous learning and experimental preparation and design ability. Learn SPOC course resources with experimental teaching contents of pharmaceutical analysis, mainly in the form of video lessons, as well as various learning materials and micro-lessons made and uploaded by teachers themselves. For example, impurity inspection of drugs, identification and microcrystalline reaction of barbiturates, and analysis of glucose injection. In addition, it also includes CBL-style real experimental cases, such as reading and thinking of sample materials for drug quality evaluation and control under the quality standard of Chinese Pharmacopoeia [6]. Because of the particularity of the experimental course of pharmaceutical analysis, a good preview before the experimental course is a necessary prerequisite for deepening the study and an important guarantee for the experimental operation. Therefore, after completing the preview before class, the system will promote students to complete the preparation report as required.

4.1.2 Self-test Exercises

Under this function, the system supports two self-test forms. First, after the preview before class, complete the self-test according to the preview content before class. Second, after completing offline classroom teaching, return to online to complete targeted consolidation exercises. The system presupposes the system library, and also supports the random selection of test questions. On the one hand, it can help students to self-check their learning effects, and on the other hand, it can provide the necessary digital basis for online process assessment.

4.1.3 Interactive Exchange

In order to facilitate the communication between teachers and students and students, the system adds the function of chat room. Under this function module, all users can communicate in the open chat room, and users can join or quit at any time. The content of communication is open to all users. At the same time, the system also supports small chat rooms in groups, which is more convenient and direct to improve communication efficiency. Through interactive communication, it can not only promote the sharing of learning experience among students and form a strong learning atmosphere, but also pull the distance between teachers and students to make up for the lack of interaction in classroom teaching mode. In addition, in the process of communication, teachers can not only give students targeted questions and guidance, but also can timely obtain students' inner real thoughts and understand the real needs of students.

4.1.4 Learning Materials

Under this function, the system supports the centralized storage of preview content before class, including SPOC video lesson, CBL case database and courseware and materials involved in classroom teaching, which is convenient for students and users to consolidate their learning anytime, anywhere and repeatedly. In addition, the system also integrates a large number of extra-curricular development materials. For example, the electronic version of "Compendium of Materia Medica", "Treatise on Febrile Diseases and Miscellaneous Diseases" and other traditional pharmaceutical works, as well as modern works such as "New Drug Synthesis in the 21st Century" and "Innovative Pharmaceutical Chemistry". It also contains excellent documentaries at home and abroad such as "Materia Medica China" and "Pill Poppers". These materials not only enrich students' knowledge and broaden their horizons, but also help students to improve their thinking and establish higher aspirations.

4.1.5 Experimental Report

Under this function module, the system supports students to upload and submit the completed experimental report. After the teacher finishes checking and marking, the students can check and get the corresponding scores.

Table 1. Framework of evaluation system for pharmaceutical analysis experiment

	Assessment content	Proportion
Process assessment (70%)	Completion of pre-class study	15%
	Preview report	15%
	Completion of self-test exercises	10%
	Communication and interaction	10%
	Experimental report	20%
Final assessment (30%)	Experimental operation	20%
	Final evaluation results	10%

4.2 Teacher Side

Compared with the online learning function of student side, teacher side pay more attention to the overall management and process supervision of pharmaceutical analysis experiment teaching.

Teachers have the right to edit, make and upload the preview content and task list before class. Teachers can gradually complete the upload in the form of unit and modular form according to the teaching plan and teaching objectives, so as to improve the control of the course learning progress and learning effect. Teachers will also be responsible for updating and maintaining the contents of the exercise bank and learning materials. In addition, the core function of teachers lies in the process assessment of students' online learning. The assessment contents and corresponding proportions are shown in Table 1.

By combining the process assessment results under the online learning system with the traditional final results, a comprehensive assessment system is formed, which not only meets the restrictive requirements of SPOC course withdrawal, but also effectively improves students' learning effect.

5 Conclusions

The online teaching system of pharmaceutical analysis experiment course based on Web technology can effectively improve various difficulties in current teaching practice. With the help of the application advantages of network information technology, SPOC course and CBL teaching method are organically integrated and introduced into the experimental teaching process of pharmaceutical analysis, and improvements and breakthroughs have been made in teaching contents, teaching resources, teaching forms and evaluation system. It is not only conducive to students' personalized learning and all-round development, but also promotes the reform of experimental teaching mode of pharmaceutical analysis. It has made a new attempt to realize the deep integration of modern educational technology and classroom teaching, and further promote the construction of new medicine.

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