Construction of Web-Based Online Auxiliary Teaching System for Material Physics and Chemistry

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Abstract. With the rapid rise of "Internet + Education", online assisted teaching has become an important force in the construction of high-quality education in colleges and universities. In this regard, this paper takes material physics and chemistry as the research object, and puts forward a set of construction scheme of online auxiliary teaching system to create a new educational ecology in line with the characteristics of material physics and chemistry. The system belongs to B/S architecture, the front-end interactive interface is designed and developed with JSP technology as the core, and the back-end Web Server is built by SpringMVC framework. The function setting of the system will comprehensively cover the teaching needs of materials physics and chemistry, and focus on the network and digital transformation of teaching process from the aspects of teaching content, teaching methods and evaluation system. Through the comparative test, the system not only effectively improves the learning efficiency of student users, but also cultivates the ability of learning analysis and problem solving, which has certain promotion significance.

Keywords: Web · Material Physics and Chemistry · Online assisted teaching · Java · Computer software applications

1 Introduction

Under the background of the new round of scientific and technological revolution and industrial transformation, the material industry, as the material foundation of national economic construction, social progress and national defense security, is rapidly entering a new stage of high-quality development [1]. As a knowledge-intensive industry, materials industry needs a large number of reserve talents to support both technological innovation breakthrough and the overall development of the industry. However, the current training objectives of materials professionals in colleges and universities are not consistent with the social demand structure, and there is a certain degree of disconnection. Taking the course of Material Physics and Chemistry as an example, as an important theoretical basis in the material discipline system, in the actual teaching practice, the traditional classroom teaching mode is still adopted, and problems such as lack of teaching innovation, outdated content, fixed form and one-sided evaluation limit the improvement of teaching effect

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and quality [2]. In view of this, this paper holds that colleges and universities should actively grasp the talent training concept of materials discipline at this stage, adhere to the innovation drive, and build a Web-based online auxiliary teaching system for materials physics and chemistry with the help of the practical advantages of online auxiliary teaching, and strive to deepen the reform of traditional teaching mode under the environment of "Internet + education", so as to make an attempt for the modernization and intelligent construction of higher education.

2 Development Process

The overall development content of the online assistant teaching system of material physics and chemistry is divided into two parts: front-end and back-end Among them, the front-end development takes JSP technology as the core, and combines HTML code, XML elements and JSP operation instructions to form the front-end interactive interface of the system, aiming at facilitating users to log in and use the system with the browser of any device [4]. The back-end development is mainly aimed at building and deploying the system's Web Server. The operating system is Windows 10.0 x86-64bit, the development language is Java, JDK version 1.8.0_251, the Web server is Apache Tomcat 9.0, the database is Oracle 11g, and the integrated development tool is Eclipse Neon 4.6.2. In the development process, the development of the back-end Web Server needs to be realized with the help of the "request/response" web development framework, and follow the MVC design pattern, and the front-end interactive interface and the back-end server are associated and connected under a specific data interface [5]. Under Eclipse, by building a new Maven Project, the type of Web application is determined, and various Jar packages required by the SpringMVC framework are downloaded and introduced into the Maven project through the code in pom.xml file. Then, the corresponding Java files in MVC mode are created in the project directory, which are Controller layer, Dao layer, Service layer and entity layer respectively, and the corresponding configuration is completed in turn [6]. Through the brief introduction of the above key technical theories, the overall environment of system development, the configuration of related software and tools are determined, and the technical feasibility of the overall project of online auxiliary teaching system for material physics and chemistry in colleges and universities is also clarified.

3 Functional Implementation

3.1 Student Side

a. Online learning.

The system supports student users to directly select the corresponding learning resources in the catalog, or to input keywords in the search box for online retrieval of learning resources. The learning resources in the system include video courses, ppt courseware materials, micro-courses, after-class exercises, simulation tests and other forms, aiming at further refining the teaching content of Material Physics and Chemistry and improving the pertinence of teaching. Rich online resources form a multi-dimensional and three-dimensional course content system, which is conducive to stimulating students' interest in learning and promoting their personalized development [7].

b. Simulation engineering practice.
The system will use the advantages of computer application to fuse a large number of dynamic graphics, video images and Flash animations to build a large number of simulation scenes to help students further deepen their understanding of theoretical knowledge in the process of solving practical engineering cases. Especially in the design and preparation technology of thin film materials, micro-nano materials and various artificial microstructure materials, systematic simulation engineering practice has broken through the limitations of engineering practice in time and space, which not only broadens students' horizons, but also greatly improves students' practical ability and innovation ability [8].

3.2 Teacher Side

The functional authority of teacher users tends to organize and manage teaching practice. The system can combine the traditional summative grade with the data information of students in the system, construct a comprehensive evaluation system of learning effect, and determine the weight of each index with the help of AHP analytic hierarchy process algorithm to complete automatic scoring [9]. Table 1 shows the teaching effect evaluation system.

The platform compares each index value in pairs to determine its importance, and completes the construction of judgment matrix according to the provisions of comparative quantized values, as shown in Formula 1. According to the judgment matrix, the row elements are normalized by columns and then summed, and the row vectors obtained are normalized twice to get the ranking weight vector W, and the corresponding weight λ max is calculated by the sum-product method, as shown in Formula 2. [10] After the weight of each index value is determined, the system automatically calculates the teaching effect score, and the system simulation test results are shown in Table 2. The

Table 1. Teaching effect evaluation system

Main indicators	Secondary indicators
Learning attitude C_1	Login time C_{11}, login frequency C_{12}, cumulative durationC_{13}
Learning process C_2	Course completion degree C_{21}, resource utilization rate C_{22}, study duration C_{23}
Learning ability C_3	Examination performance C_{31}, practice results C_{32}, usual performance C_{33}

Table 2. Teaching effect evaluation results

	Main indicators	Secondary indicators	Weighted value	Item score	Score
Teaching effect score	Learning attitude C1	Login frequency	$C_{11} = 0.057$	85	79.56
		Cumulative time	$C_{12} = 0.105$	90	
	Learning process C2	Course completion degree	$C_{21} = 0.077$	78	
	Learning ability C_3	Examination performance	$C_{31} = 0.167$	71	
		Usual performance	$C_{23} = 0.091$	82	
	…	…	…		

results show that the system can complete the evaluation of teaching effect conveniently and quickly, and correct the one-sidedness of the traditional evaluation method.

$$C = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \tag{1}$$

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} \tag{2}$$

In addition, a comparative reference experiment is set up for the application effectiveness and performance stability of the system. A total of 100 students from the Department of Materials Engineering in the selected campus were divided into two groups: A and B. Group A was the experimental group and Group B was the control group. A students use the online assistant teaching system, while group B still adheres to the traditional teaching mode, after a three-week simulation test. The data is analyzed in three dimensions: comprehensive achievement, innovative practice ability and course satisfaction, and the results are shown in Fig. 1. The comparative experimental data show that the system not only effectively improves the learning efficiency, but also cultivates the ability to analyze and solve problems, which meets the design requirements.

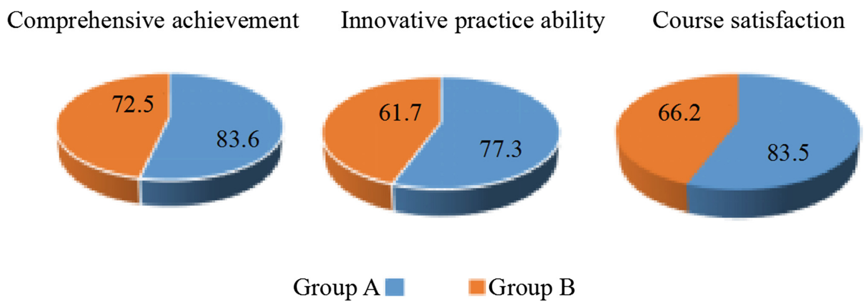

Fig. 1. Data analysis diagram

4 Conclusion

In order to promote the reform of teaching mode of materials physics and chemistry in colleges and universities, this paper puts forward a set of online auxiliary teaching system construction scheme based on Web technology, aiming at many problems faced in the current education and teaching process. The system reshapes the whole process and all aspects of teaching activities, thus promoting the reform of teaching mode, creating a new ecology of material physics and chemistry education in colleges and universities, and making an attempt for the modernization and intelligent construction of higher education. In the follow-up research, the system should further expand the interactive means of the system, and can be combined with virtual reality technology in engineering practice to enhance the realism and immersion of the scene.

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