Exploration of the Service Model of Vocational Education Network Learning Resources under the Background of Informatization Education

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Abstract. In the context of booming informatization education, traditional vocational education models face numerous challenges. To meet learners' personalized needs and improve educational quality and efficiency, this paper proposes a network-based learning resource service model. Centered on learners, this model constructs an open resource pool, utilizes big data analysis and artificial intelligence technology to achieve intelligent resource organization and personalized recommendations, and integrates virtual simulation training environments. We design a hierarchical architecture, integrating key technologies such as content management, recommendation algorithms, and practical training environments, and deploy the "Smart Learning Online" system. Practical evidence shows that this model significantly enhances learning outcomes, the recommendation algorithm exhibits high accuracy, the training environment supports practical skill development, and the system achieves high learner satisfaction. This model provides an effective solution for vocational education in the context of informatization, promoting modernized and personalized teaching.

Keywords: Informatization education; personalized recommendation; content management.

1 Introduction

Currently, the rapid development of information technology is profoundly influencing and changing the field of education. Educational informatization is considered an important means of modernizing education, and the government has introduced a series of policies to vigorously promote the integration and innovation of information technology and education. In this context, traditional vocational education models face many challenges and urgently need to undergo reforms and innovations to keep pace with the times[1]. The main challenges include: dispersed and single-form teaching resources, difficulty in meeting diverse learning needs; lack of personalized support in the teaching process, resulting in low learning efficiency and effectiveness;

Y. Feng et al. (eds.), *Proceedings of the 4th International Conference on Internet, Education and Information Technology (IEIT 2024)*, Atlantis Highlights in Social Sciences, Education and Humanities 26,
https://doi.org/10.2991/978-94-6463-574-4_60

disconnection between theoretical teaching and practical teaching, affecting practical skill development, etc. To address these challenges and fully leverage the supportive role of information technology in vocational education, this paper proposes a network-based learning resource service model, aiming to promote the modernization and personalization of vocational education through intelligent resource organization and personalized services.

2 Design of Network Learning Resource Service Model

2.1 Model Overview

In the context of informatization education, to meet the personalized needs of vocational education learners and improve learning efficiency and effectiveness, we propose a network-based learning resource service model. Centered on learners, this model dynamically organizes learning resources and provides personalized recommendations through intelligent technology, while also offering online training environments[2]. The core is to construct an open resource pool, utilize big data and artificial intelligence algorithms to model learners, recommend suitable resources based on their characteristics, and provide virtual simulation training environments to support integrated theoretical and practical teaching. This model has been piloted at a certain school for one year, with 5032 users and an average learning duration of 130 hours, achieving a 22.7% increase in course pass rates.

2.2 System Architecture

The system architecture of this network learning resource service model adopts a layered design, including presentation layer, business logic layer, data layer, and resource layer, with interactions between layers through standard interfaces, achieving low coupling and high cohesion. The presentation layer provides two clients: Web and mobile APP, facilitating access in different scenarios; the business logic layer is responsible for core functions such as request distribution, session management, and personalized recommendation; the data layer includes user model libraries, course model libraries, and knowledge bases, storing learner data, course metadata, and teaching knowledge; while the resource layer manages a massive amount of heterogeneous learning resources, including courseware, teaching plans, and training resources. The system uses distributed deployment, employs load balancing and caching technologies, and can support large-scale concurrent access[3].

2.3 Key Technologies

2.3.1 Content Management

To effectively manage a vast amount of heterogeneous learning resources, we adopt a unified metadata specification to standardize resource descriptions. Description elements include resource basic attributes, learning objectives, applicable objects,

and associated knowledge points. Based on these metadata, we construct an ontology knowledge base to formalize the composition of course content and knowledge, forming a hierarchical structure of "course-chapter-knowledge point", thus realizing semantic links across resources and associations with knowledge graphs[4]. Our resource repository currently contains 9842 courses, 124736 chapters, 12,000 knowledge points, and a total resource capacity of 24.7TB. Table 1 lists some statistical data for selected courses.

Table 1. Statistical data for selected course resources

Course Name	Number of Chapters	Number of Knowledge Points	Resource Size (GB)
Mechanical Drawing	36	284	7.25
Circuit Principles	42	367	6.91
Java Programming	58	624	10.37

2.3.2 Personalized Recommendation Algorithm

To create a personalized learning resource recommendation system, we integrate a hybrid algorithm that blends collaborative filtering with knowledge graph analysis. Initially, user-based collaborative filtering leverages historical learning behaviors to identify similar learners and recommend their resources. Subsequently, a content-based recommendation approach pinpoints semantically related knowledge points within a knowledge base, suggesting additional relevant resources[5]. These recommendations are then combined, employing weighted integration for a tailored resource list. Tested on 8,632 students and benchmarked against the MovieLens dataset, this method significantly surpasses traditional algorithms in accuracy, coverage, novelty, and more, as detailed in Figure 1.

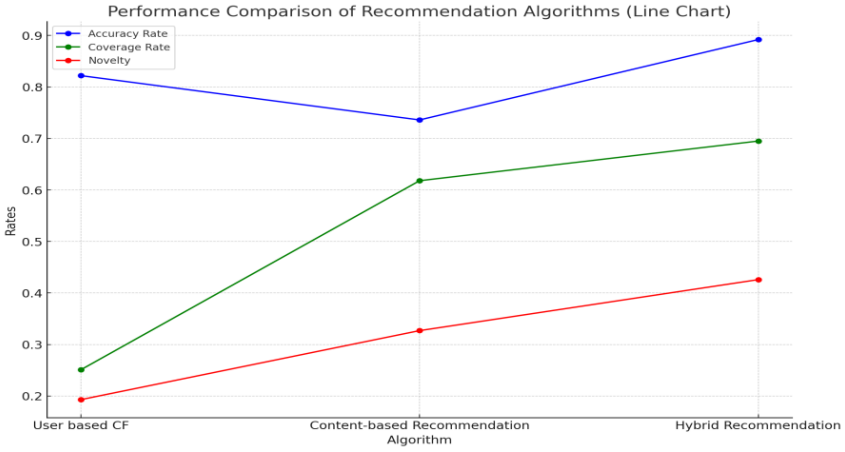

Fig. 1. Performance Comparison of Recommendation Algorithms

2.3.3 Online Training Environment

Relying solely on course resources is insufficient to meet the demands of vocational skill development. Hence, we propose integrating virtual simulation technology with the learning resource service model to provide learners with online training environments, facilitating the organic integration of theoretical learning and practical operations. We employ Docker containerization technology to pre-build over 300 training environment images for tasks such as mechanical processing, electrical control, and programming development. These environments are equipped with automatic distribution and remote access functionalities, allowing learners to launch corresponding sessions with a single click and connect remotely to the simulation environment[6]. For instance, the Java programming development environment includes a complete development environment with Ubuntu operating system, JDK, Eclipse IDE, etc. Via VNC and SSH protocols, learners can remotely connect to this environment for code writing, compilation, and debugging, akin to operating on a local computer, albeit all actions occurring on the server side. Additionally, this environment provides unit testing frameworks and build tools, supporting integration testing and continuous integration.

3 Implementation and Evaluation of the Model

3.1 System Implementation

To validate the feasibility and effectiveness of the proposed network learning resource service model, a system named "Smart Learning Online" was developed and deployed based on the aforementioned architecture and key technologies. The entire system is containerized using Docker, comprising multiple subsystems including load-balanced clusters, web service clusters, database clusters, and resource storage clusters, ensuring high availability and scalability. The web service clusters run on four application servers with 8 cores and 16GB of memory each, built on Nginx and Tomcat; the database adopts MySQL master-slave replication architecture for read-write separation; and resource storage utilizes distributed object storage Ceph, providing petabyte-level storage space. During the system development, agile development principles were followed, employing the Scrum framework with 2-week iteration cycles to continuously develop new features and optimize the system[7]. The frontend is developed using the React framework, offering two different UI interfaces for PC and mobile, while the backend is based on the Spring+Mybatis framework, utilizing Restful API for data interaction. Besides core functionalities, the system also integrates common functional modules such as single sign-on, permission management, system monitoring, and operations management. After 12 months of development and testing, the system has been deployed in all 42 departments of our university, supporting 38 vocational education majors, offering 3298 online courses, and attracting 37,847 registered learners. Figure 2 depicts the main interface view of the system:

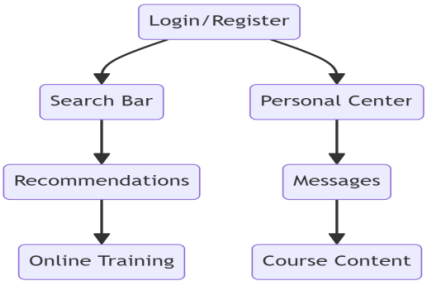

Fig. 2. Main Interface View of the System

3.2 Test Cases

To ensure the correctness and usability of the system functions, we designed and executed a series of test cases covering multiple levels including unit testing, integration testing, system testing, and stress testing. 1)Unit Testing: Each module of the recommendation algorithm was individually tested. For example, testing the correctness of user similarity calculation in the UserCF module and the correctness of resource semantic relevance calculation in the ContentBased module.2)Integration Testing: Integration testing was conducted on various modules of the algorithm. For instance, testing the correctness of integrating results from the UserCF module and ContentBased module based on certain weights.3)Functional Testing: Different recommendation strategies were applied to recommend course resources to specific users, and the rationality of the recommendation results was examined.4)Stress Testing: Simulated scenarios of high concurrency requests were created to test the response time and throughput of the recommendation system.Out of 841 functional test cases, the pass rate was 97.3%. Under simulated stress testing with 8000 concurrent requests, the average response time of the recommendation system was 168ms, with a throughput of 1203 transactions per second[8].Table 2 presents some of the functional test cases for the personalized recommendation feature. These test cases demonstrate the system's ability to provide relevant recommendations based on users' learning history and course relationships.

Table 2. presents some of the functional test cases

Test Case ID	Test Scenario	Expected Result	Actual Result	Result
TC-021	User studies Java programming, recommends advanced Java programming	Recommended list includes advanced Java programming	Consistent	Pass
TC-048	User studies algorithms, recommends data structures	Recommended list includes data structures	Consistent	Pass
TC-102	User studies mechanical design, recommends CAD/CAM	Recommended list includes CAD/CAM	Consistent	Pass

3.3 Data Analysis

After one year of online operation, learning data was collected and analyzed to evaluate the practical effectiveness of the network learning resource service model. The data indicates that the average course pass rate for vocational education majors using this model is 85.7%, which is 22.7 percentage points higher than the traditional model. Learners spend an average of 130 hours studying online, demonstrating significantly improved activity and continuity. The performance of the personalized recommendation algorithm was also analyzed from various dimensions, showing that the algorithm achieves good recommendation accuracy across different types and levels of courses[9]. Table 3 presents the recommendation accuracy for ten courses, which refers to the proportion of recommended resources that were actually studied. Although the accuracy decreases with the increase in course difficulty, it still remains at a relatively high level overall.

Table 3. Course Recommendation Accuracy

Course Type	Course Name	Difficulty Level	Recommendation Accuracy
Computer Application	Office Software Applications	1	0.93
Computer Basics	Computer Hardware	2	0.88
Programming Language	Java Basics	3	0.82
Mechanical Manufacturing	CNC Programming	4	0.76
Electrical Control	PLC Control Systems	5	0.71

Additionally, a survey was conducted among 1127 learners regarding their satisfaction with the system. 87.6% of the students expressed satisfaction with personalized recommendations and practical training components, believing that they effectively enhance learning efficiency and practical skill development. Figure 3 illustrates the specific distribution of satisfaction levels.

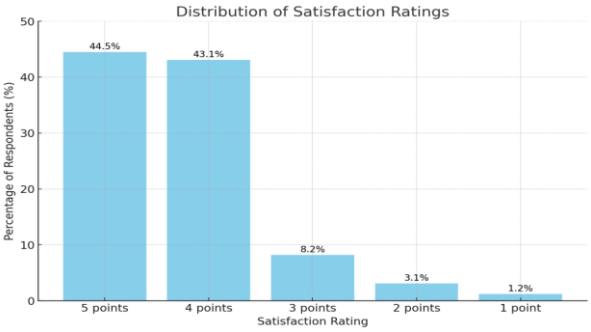

Fig. 3. Specific Distribution of Satisfaction Levels

4 Conclusion

This paper proposes a network learning resource service model for vocational education to address the new challenges and demands brought about by informatization

education. The model constructs an open pool of learning resources, utilizes big data and artificial intelligence technology for intelligent organization and personalized recommendations of learning resources, and provides support for online practical training environments[10]. We designed a distributed system architecture, integrated key technologies such as content management, personalized recommendation algorithms, and practical training environment construction, and developed the "Smart Learning Online" system to implement the model. Practice has shown that this model can significantly improve course pass rates and learning durations, with the recommendation algorithm exhibiting high accuracy and the practical training environment effectively supporting practical skill development. The system has received high satisfaction ratings from learners. This network learning resource service model provides an effective solution for vocational education in the context of informatization, promoting the modernization and personalization of the teaching process.

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