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Research Article

Construction of Educational Resource Metadata Management Platform Based on Service-Oriented Architecture

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The existing cloud sharing system of educational resources is in the form of centralized management, which has the problems of small number of concurrent users and low score of resource retrieval results and cannot meet the current needs of implicit educational resource sharing. Therefore, a cloud sharing system of college implicit educational resources based on service architecture is proposed. At present, the sharing of educational resources mainly includes network teaching, distance education, and other methods. These schemes alleviate the sharing problem of educational data resources to a certain extent. However, the sharing and rational integrated utilization of educational application software are still under exploration, and there is no mature solution at present. At present, there is a lack of unified planning for the construction of the educational resource database of the management cadre college, and there are problems such as repeated construction, complex quantity, and nonstandard form, which directly leads to the failure of effective dissemination of resource information in the network distance education system, which is an urgent problem to be solved in the distance education system of the management cadre college. This paper first understands some domestic and foreign standardization and development of educational resources. Then, it introduces the ontology theory and the basic theory of metadata. At present, the construction of educational resource database in colleges and universities in China lacks unified planning, and there are problems such as repeated construction, complex quantity, and nonstandard form, which makes the resource information in the network distance education system unable to be shared and disseminated effectively. In order to improve the utilization of online educational resources and share the data of resource databases with different structures, a metadata management platform model of educational resources is designed. As a new architecture idea, service-oriented architecture can package existing assets and reuse existing assets. It can also minimize the impact of demand changes. This paper puts forward the process of metadata management under the service architecture and independently develops a metadata management platform suitable for the development and use of service mode. It is combined with automatic testing and continuous integration to effectively improve the data quality and development efficiency of service development.

1. Introduction

Nowadays, the hidden resources of colleges and universities are relatively independent, forming isolated islands of information, which cannot be shared among different colleges and universities, resulting in the waste of hidden educational resources. Each university has established a database of educational resources suitable for the use of teachers and students in the school so that teachers and students in the school can easily query and use the information [1]. Although online learning and distance education generated under the traditional education informatization model have improved the sharing and utilization of educational resources, in terms of content, educational resource service providers still provide a fixed amount of resources to learners, lacking dynamicity. Distance education realizes cross-regional and cross-school resource sharing through the network, but the services it provides are too single, ignoring the educational service resources that other educational service providers can provide [2]. For developers of resource

libraries, due to the rapid spread of educational informatization, the demand for resource sharing and resource information exchange has also increased sharply, and to achieve resource sharing and information exchange between different educational resource libraries requires a complete set of sharing and exchange specifications. Education resource libraries are complex in type and in various forms and are relatively inconsistent in data specifications. On the one hand, it is easy to cause wasted investment and repeated construction. On the other hand, each resource library is scattered and isolated, and most of them lack a description of themselves. Education when retrieving materials, workers have to find many resource libraries, which consumes a lot of time and energy [3]. One of the key factors to solve the above problems is to realize the standardization of metadata, because the metadata standard is the most important part of the current network development and the utilization of information resources. With the unlimited growth of resources, the effective management of network information will increasingly depend on the management of metadata [4].

Cloud computing is getting familiar with people gradually, which marks the emergence of a new service model and concept and also has a great impact on the field of university education, thus resulting in the university recessive education resource cloud sharing system. At present, in the process of educational informatization, we should strengthen the top-level design and give full play to the advantages of application services [5]. Based on the advantages of cloud computing in resource integration, building an educational cloud platform and improving the utilization rate of educational application services are a way to solve the above problems. Connecting the database through the network will greatly promote the exchange of educational resources among colleges and universities and also play an extremely important role in the development of modern education and new technology [6]. At present, the number of educational resource pools and the resources of each resource pool are still increasing, and with the development of network technology, the resources of educational resource pools are becoming more and more scattered, and the retrieval burden that users have to bear to obtain information is increasing day by day, making it even more difficult for users to obtain comprehensive and accurate resource information [7]. Many colleges and universities will use substandard document formats for the storage of educational resource information in the database at will because they do not understand the standards, which will bring great difficulties to retrieval, and even if they are connected to the network, it is difficult to share them. Service architecture is essentially a method of constructing distributed application systems, which provides business application functions in the form of services, so as to better assemble and reuse multiple subsystems and jointly build a resource cloud sharing system with loose coupling and high sharing [8]. How to give a standard resource description to the educational resource database, intelligently and seamlessly aggregate it, and help educators find the required resources quickly and accurately is the focus of this paper.

In the field of education, all kinds of educational websites are in full bloom. Almost every university has invested a lot of human and material resources to build its own educational resource website and try its best to improve the construction of digital campus [9]. At present, the application of educational resource management platform in domestic colleges and universities is in its infancy. Although there are some formed educational resource management platforms in the market to realize the interaction between different educational resources, there are common problems such as tight combination of modules, weak scalability, and platform related [10]. The network-based distance education mode integrates modern information technology and traditional education means, breaks the original space and time constraints, changes the original education mode by means of obtaining and using hundreds of millions of information resources on the Internet, becomes a great beneficiary in today's information age, and has been widely used in all kinds of middle schools and colleges [11]. The problems of low integration, obvious information reuse, and poor interaction of various information systems in colleges and universities are gradually emerging, which greatly affects the informatization process of college education [12]. Colleges and universities do not store educational resource information based on a unified standard, so it is impossible to establish an educational resource database that can be shared and used by all [13]. The emergence of service-oriented architecture provides a new solution for the development and integration of application systems, which can easily solve the difficulties of application system integration and expansion, so as to effectively solve the problems of tight coupling and weak scalability of educational resource management platform [14]. This paper decides to use technology to represent the metadata of educational information resources, discusses some key technologies, establishes the application model of technology-based metadata standardization in the development of educational resource database, and establishes the file-based transformation model in the standardization of educational information resources.

2. Related Work

Reference [15] proposed a plan to build cloud services for universities in order to improve the knowledge of computer science students in highly parallel computing practices to better cope with the emerging trend of large-scale distributed computing. Literature [16] proposed that the current construction of educational resource websites should focus on how to improve the sharing and utilization of existing resources, rather than continue to manufacture existing resources behind closed doors. Literature [17] proposes that information resources are regarded as the third national power on a par with natural resources and energy. The key and core task of national information infrastructure construction is the development and utilization of information resources. For its importance and urgency, it should be mentioned quite high to know. Reference [18] proposes that the education cloud can be regarded as taking cloud computing technology as the infrastructure, deeply merging and

integrating various educational resources and application services, and providing educational resources as services to users in the form of lease or free for users to use, to meet the needs of customers in teaching, scientific research, and daily office management. Reference [19] proposes the current typical network education resource management mode, namely, file catalog management, topic and subject website, resource management database, resource center, and distributed resource library system, and points out their basic characteristics and limitations

Literature [20] holds that all kinds of competent departments responsible for the construction of educational resources should set up resource construction expert groups, keep the original core set on the basis of the standardized norms promulgated by the state, and develop their own extended norm sets according to the scale, scope of application, and local specific conditions of resource library construction. Literature [21] points out that there is no unified standard model for educational cloud application service architecture at present. Facing the rapidly developing cloud application service, it is very necessary to design a comprehensive and effective architecture. Architecture design affects the stability, flexibility, and friendliness of cloud application software, which is of guiding significance for the implementation of educational cloud application service and solving key technical problems in the application process. Literature [22] puts forward the data model. In order to eliminate the behavior of each university building online educational resources alone, after unifying the standards, they can share these educational resources within the network. Its main core content is to formulate the relevant educational resource description standards according to different formats and types of educational resources. Literature [23] holds that as long as the business direction and content of the enterprise remain unchanged, the metadata within the enterprise is stable, and the data model composed of metadata is basically stable, while the processing method of metadata is variable. Therefore, all the output data in the system can be derived from these metadata, so as to meet the different needs of people for information systems and even data warehouses. Supporting variable processing methods with unchangeable data is the basic principle of information system engineering and the guiding ideology of information system construction. Literature [24] points out that the emergence of new technologies will always bring new inspiration and ideas to many applications, which is no exception in modern distance education. The emergence of this technology provides an effective solution for the standardization of online educational resources.

3. Methodology

3.1. Metadata Management Technology. Metadata is generally defined as data describing data. The main function of metadata is to use it as a structured information that can facilitate information retrieval, describe and interpret resources, and manage and operate information sources [25]. Metadata management is the core and basic work in enterprise data governance, and it is also the basis of enterprise data management. However, metadata is difficult to be parsed by computers, and it is impossible to carry out necessary interoperability and exchange through computers. Extensible markup language XML is one of the latest technologies on the Internet. The relationship between metadata and technology is reflected in the following aspects. (1) Metadata can be expressed conveniently. (2) The style language can be used to realize the transformation and display of metadata. (3) Metadata can be queried easily. (4) The industry has extensive support for technology. There are three types of metadata. The first is descriptive metadata, whose main function is to describe and identify information resources. The second is structured metadata, which is a kind of data that can store composite objects uniformly. The last one is management metadata, which is used to provide assistance for the appropriate management of a certain kind of information.

One of the great advantages of XML is that it is self-explanatory, because the structural information of the data set can be understood through the DTD and XML schema of the document. There are two main aspects about the transformation of metadata. On the one hand, metadata is converted to each other to share information, and on the other hand, it is converted to meet the output and display of various formats. The transformation method of the template is shown in Figure 1.

Template-based mapping method between XML documents and data structures in other formats, that is, embedding executable instructions in XML documents, these instructions are recognized and executed by the system during the conversion process, and the execution results are replaced to the positions where the instructions are located, thus generating the target XML documents. XML is a specification of computer-readable documents, which describes the data types and logical structure of documents in detail. One of its important features is that each user is allowed to arbitrarily mark or define labels on resources in his own webpage, and at the same time, users are allowed to nest information elements into any level, so as to ensure the uniqueness and standardization of information in his own webpage. Metadata information consists of two levels: metadata information describing the data itself and metadata information describing the relationship between data. The metadata information about the data itself mainly refers to some information only related to the data itself. If it is necessary to extract the core data elements of an educational resource, these core data elements are defined in the instruction program of the template. When the database system calls its own instruction execution program to execute the template, these data will be extracted and filled into the template. At this time, the template will become the final required corresponding XML document. Metadata is one of the important conditions to make data play a full role. It can be used for the establishment of data documents, data publishing, data browsing, data conversion, etc. It plays an important role in promoting the management, use, and sharing of data. Without metadata, the original data cannot be managed and used effectively.

3.2. Design of Educational Resource Management Platform. The application service architecture of education cloud

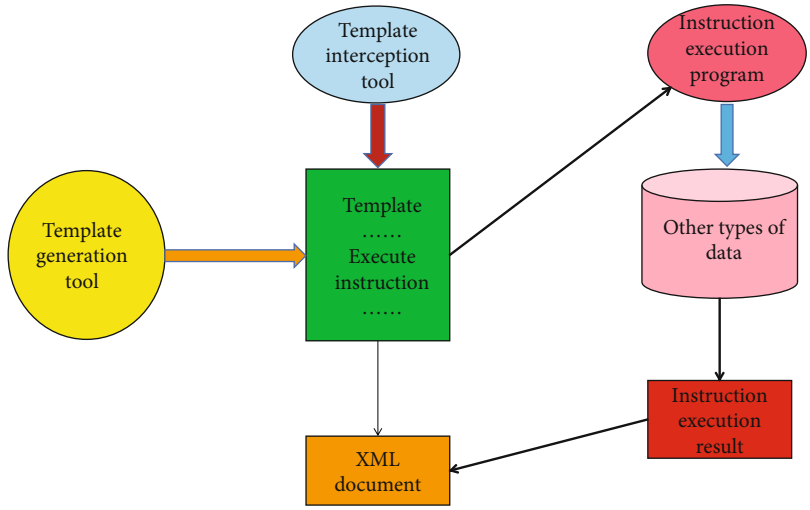

Figure 1: Template-based conversion method.

platform is mainly divided into three functional modules: unified identity authentication, application service management platform, and business process dynamic configuration. The scoring of resource retrieval results is the key to display the performance of the design system, and its calculation formula is

$$\mathrm{idf}(t) = 1 + \lg\left(\frac{\mathrm{numDocs}}{\mathrm{docFrep} + 1}\right). \tag{1}$$

Calculate the similarity of two strings using the Dice coefficient:

$$\mathrm{Dice}(s_1, s_2) = \frac{2 \times \mathrm{comm}(s_1, s_2)}{\mathrm{leng}(s_1) + \mathrm{leng}(s_2)}. \tag{2}$$

Sort all subnets in the hardware resource by their closest distances to subnet b1 from near to far:

$$\sigma_q = \sqrt[2]{\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2}. \tag{3}$$

Calculation formula of metadata storage lifetime:

$$T = \alpha N_s + \beta N_m. \tag{4}$$

The metadata distribution balance is measured by the metadata distribution balance, and its formula is described as

$$F_{\mathrm{DB}} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(\frac{x_i}{S} - 1\right)^2}. \tag{5}$$

The probability N_m that a metadata cache item is accessed by a new user can be calculated as

$$N_m = \frac{\sum_{i=1}^{n} P_i}{t}. \tag{6}$$

The purpose of the unified resource management platform is to realize the sharing of educational resources, completely break the barriers of remote and heterogeneous storage of resources, and avoid information islands. The platform uses the unified resource metadata standard to standardize resources, so as to realize the unified description and management of resource metadata. The unification of metadata provides necessary tools and links for the sharing and integration of distributed and heterogeneous educational resources. The educational resource management platform is shown in Figure 2.

The main function of the metadata editing module in the management platform is to manage the data in the system, which is mainly responsible for inputting, modifying, and deleting the data in the management platform in the form of ontology. Metadata storage module is mainly responsible for ontology-based resource pattern storage; the main function of metadata retrieval module is intelligent retrieval of ontology resources based on semantics. Read-write performance is an important index to measure the real-time efficiency of storage algorithms. It is tested by reading-write rate, as shown in Figure 3.

Enable users to write metadata at the same time. The comparison results of write data rates of this algorithm, hash storage algorithm, and random walk storage algorithm are shown in Figure 4.

At present, the popular Spring Boot architecture is used for background development, and Vue.JS is used for foreground interface development which mainly includes (1) front-end display layer, which uses Vue.JS+ browser to provide user interface; (2) access control layer, responsible for user post management, service monitoring, exception log, login authentication, and other control functions; (3) business logic layer, which provides business functions including public metadata management, database metadata management, and service interface metadata management function modules and is responsible for the input management of metadata in their respective fields; at the same time, this layer provides unified public technical components including code automatic generation, metadata check, impact

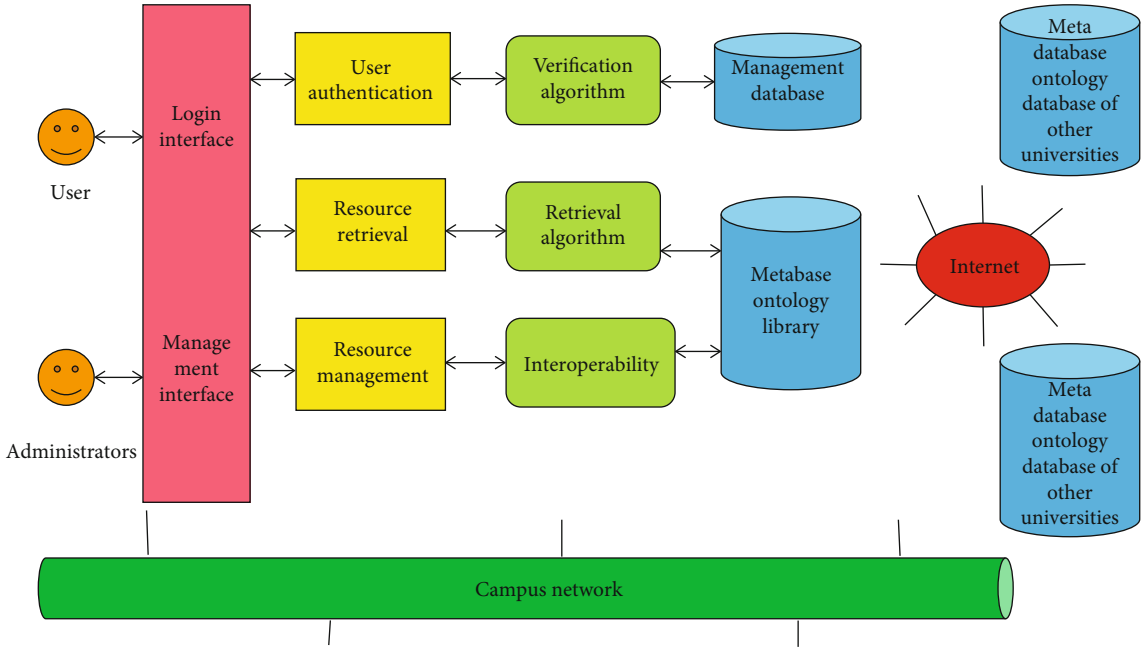

Figure 2: Framework of educational resource management platform.

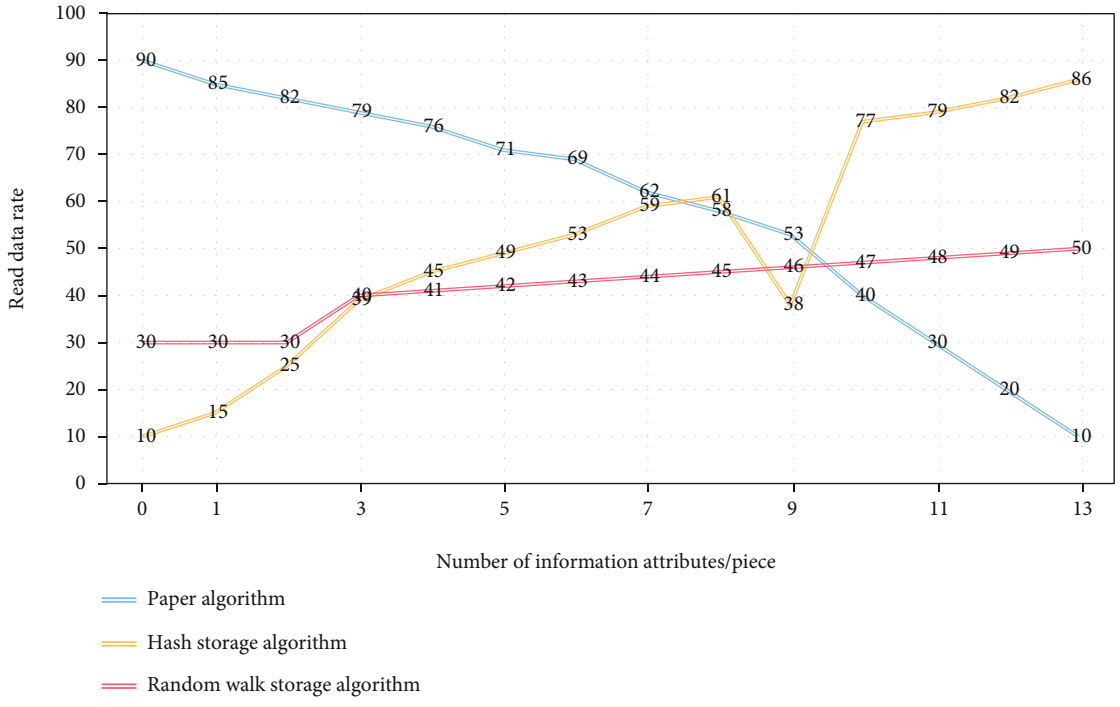

Figure 3: Comparison results of read rates of three algorithms.

analysis, and consanguinity analysis for unified use of upper functional modules; (4) data storage layer, which is the My SQL data and Redis cache. The performance of directory operation and file operation of our system and Gluster system based on ADSP algorithm is shown in Figure 5.

The file operation performance is shown in Figure 6.

The catalog metadata read performance is shown in Figure 7.

It can be seen from the actual demand for standardization that the demand for standards promotes the development of technical specifications, while realizing the standardization of resource attribute annotation and classification system realizes the sharing of resources, improves the interoperability of system design, and enables the sharing of educational information resources to the greatest extent, so as to ensure the efficient utilization of educational resources.

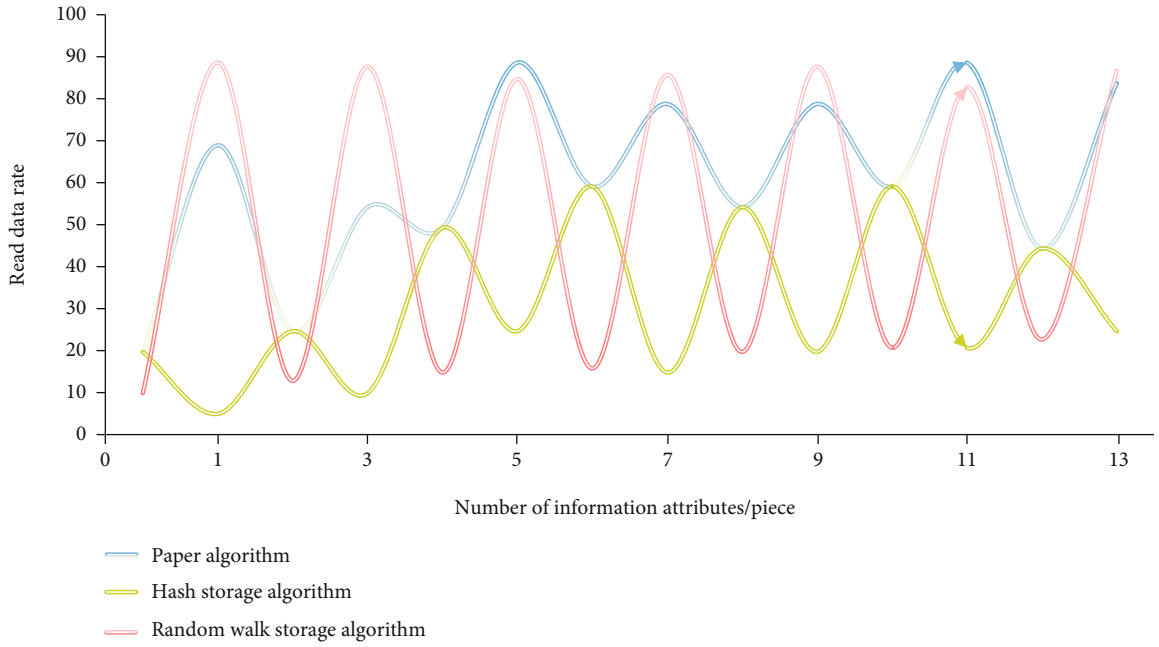

Figure 4: Comparison results of the write rates of the three algorithms.

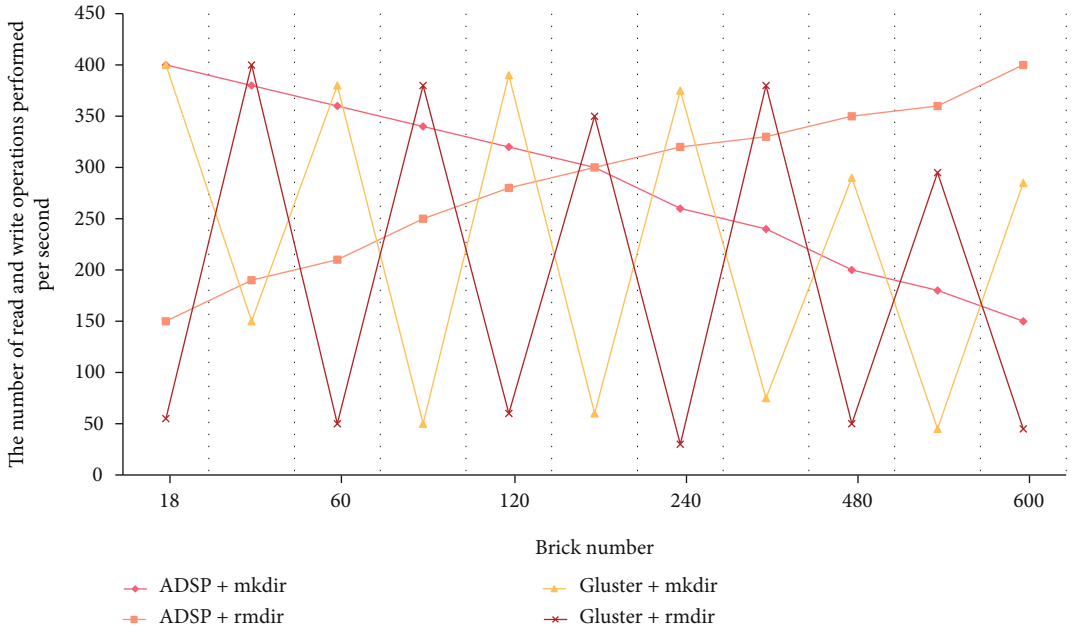

Figure 5: Directory metadata write performance.

The characteristics of relational database establish a series of regulations, and then use these regulations to store educational resource information knowledge in the form of ontology, and then use the rule association ability in relational database to manage data information through management ontology. In service architecture development test, the main part of automation test is the automation test of service interface, which usually requires testers to manually write cases according to the developer's interface definition. If the interface written by the developer cannot be effectively synchronized with the tester's case, the test is invalid. Realize the data exchange between different resource databases, achieve the sharing of educational resources in a wide range, and ensure the smooth implementation of resource construction and the efficient utilization and sharing of educational resources in a regional range. Now, the development trend of metadata standards is to make their own standards more comprehensive. The educational resource metadata management platform metadata a large number of resource data collected in the field of education and distributed in different schools and creates, classifies, controls, accesses, and maintains them so that they can be stored and managed in a

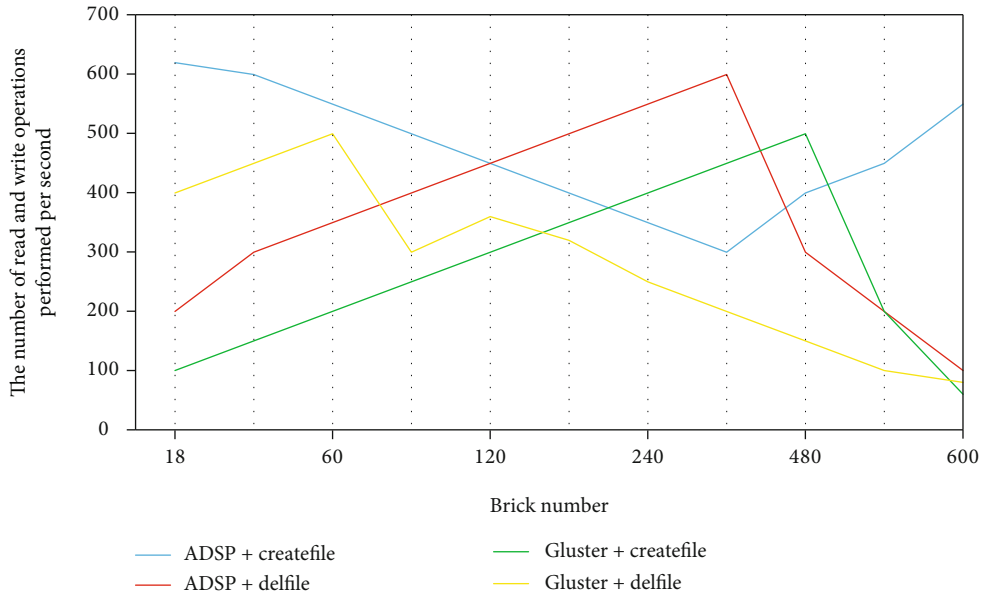

Figure 6: File metadata write performance.

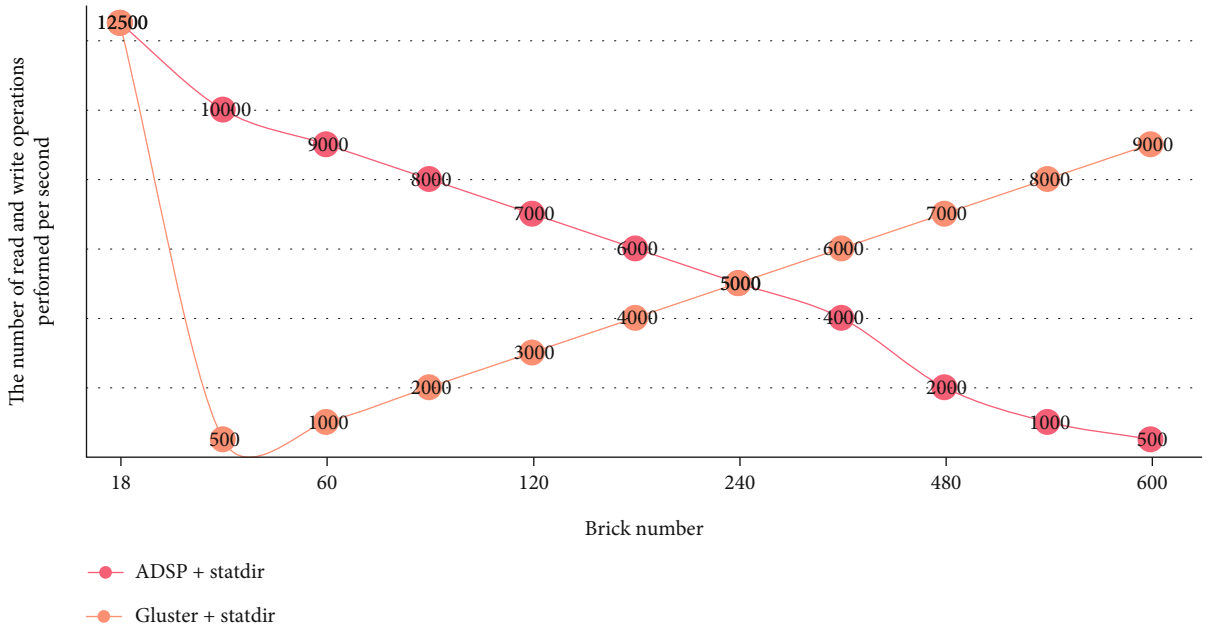

Figure 7: Read performance of catalog metadata.

unified and standard format. When formulating updated standards, they should not only keep up with the development of the times but also refer to each other. As a result, although it is impossible for everyone to unify their standards, they can certainly be consistent to a great extent in some specific industries so that everyone's metadata records can be easily converted to each other. When combined with automated testing tools, the platform provides the query function of microservice interface definition. The automated testing tools automatically read the interface defined by the metadata management platform and automatically generate interface cases, which improves the efficiency of interface case writing.

4. Result Analysis and Discussion

4.1. Problems with Educational Resource Banks. (1) There is too much information in resources. Originally, it is the advantage of modern distance education. For users, the greater the amount of information means more choices. (2) However, when the amount of information exceeds a certain limit, this advantage becomes a disadvantage, and users are easy to get lost in the face of the huge amount of information they retrieve. Because users use multiple systems, it is possible that users in these systems use the same password. Once the password of one system is leaked, it is

likely that other systems will also be attacked by security. (3) All user passwords are stored in the authentication system. If the authentication system is attacked and the password file is stolen by the attacker, all user information and system security will be seriously threatened. With the increase of educational resources, the heterogeneity of educational resource management platforms, and the distributed storage of educational resources in colleges and universities, the sharing of resources is a key issue for the large-scale construction and operation of educational resources. For user management, it is role-based management. Each user has a certain role, and different roles have different permissions, so different operations are carried out. Because this platform is specific to educational resources, it has its particularity, that is, the information of institutions of resources. Different users of the same role may belong to different institutions, so the available resources may be different. The research in the field of metadata description and ontology has achieved mature theories and certain achievements, but there is still a long way to go to fully realize all functions. A large amount of information redundancy has a great influence on maintaining the consistency of information. At present, a complete and easy-to-understand tool and example has not been developed. Because the network is too large, the feedback cycle of the effectiveness of development results will be longer for developers, which is not conducive to the analysis of research results

If metadata cannot be managed uniformly and a unified metamodel cannot be formed, a unified "language" cannot be formed between micro services, and data communication and interaction cannot be completed. Because of various factors such as resource form and style, each site implementing distance education repeats the resources that have been built by many other sites to a certain extent. Only the effective management of educational resources can ensure the service quality of educational resources. However, the inherent characteristics of educational resources, such as complex content, diverse forms, and wide distribution, make the management of educational resources a thorny problem. Therefore, we must define a reasonable management model in order to realize the effective management of educational resources. The information resources in the network are stored in a decentralized way, resulting in too many file formats; users are not familiar with the file format, so it is too inconvenient to call or even read out. There are also reasons for the privacy of the file. In order to ensure the security or interests of the information, the information content is encrypted or restricted, which hinders the user's retrieval of the information. Of course, the most important point is that there are a lot of irrelevant information in the network, resulting in too long retrieval time and so on. Educational resources are a project that needs to invest a lot of human and material resources for a long time and need continuous maintenance after completion. In addition, due to the different knowledge between disciplines, nouns and terms cause heterogeneous attributes, which causes great inconvenience to the later maintenance work. Due to the characteristics of the technology itself, through the binding of the attributes of educational resources, the content-based directional retrieval of resources can be realized, so as to improve the search efficiency on the Internet, provide a standard file exchange format, provide a standard interface for the exchange of data between different systems, and so on.

4.2. Application and Significance of Metadata Management Platform. The educational resources mentioned in this paper mainly refer to the data information in the network. Its main work content is to obtain the information in the network, obtain the results after logical reasoning, and provide the results to users after user retrieval. Compared with the existing system, the design system has more concurrent users and higher scores of resource retrieval results, which fully shows that the design system runs better. The overall implementation of the application service architecture of the education cloud platform first introduces the functional structure of the whole architecture, then introduces the implementation of cloud service management and application service creation in the application service architecture, and finally verifies the functions in the architecture through an implementation example. The description information of educational resources can be managed centrally. By standardizing the description information of educational resources to form a unified metadata information structure and registering the nondata information in a few resource publishing management centers, the unified management of educational resource metadata can be realized. The advantage of this is that it not only solves the phenomenon of "information island" but also does not damage the interests of resource providers. Through the centralized management of resource metadata, it solves the contradiction between centralization and decentralization, realizes the "distributed storage and centralized management" of educational resources, and achieves the effect of "one registration and sharing everywhere." Predict the results, analyze the problems that may be encountered in the construction of each model, and find the inevitable relationship between ontology and educational resources. Finally, after clarifying the complete functions of each model, they are combined and tested to ensure the normal operation of the management platform. The application of metadata system in educational resources is shown in Figure 8.

The metadata management platform provides external metadata query functions, including service interface query, standard field query, and database script query. Therefore, metadata management can be incorporated into software development processes such as automated testing or continuous integration and called and then integrated into unified development process management. The system has the characteristics of low cost, easy realization, reliable data transmission, and low power consumption, which greatly reduces the difficulty of realizing remote monitoring, and is very convenient to install, maintain, and manage, avoiding many disadvantages of traditional remote systems in the past and representing the development trend of the system towards wireless networking. When publishing resource information, that educational resource server can generate document containing resource information according to the standard, and any authorized client can compile his own application to obtain the information. In this way, the

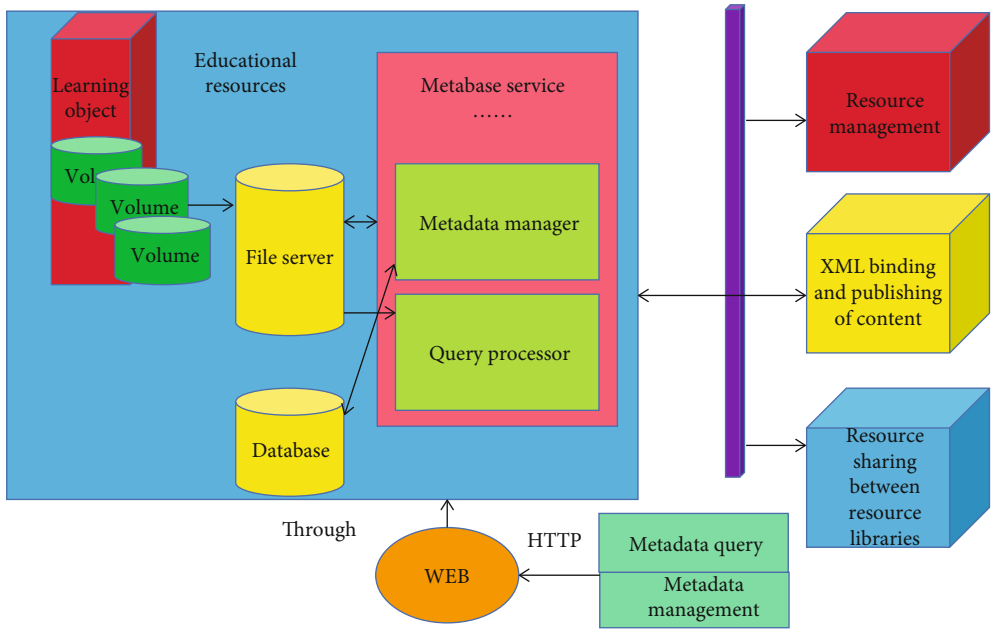

Figure 8: Application of metadata system in educational resource library.

established standards can be easily applied to the extraction, publication, and query of resource information. Realize the exchange of data between different resource banks, achieve the sharing of educational resources in a wide range, ensure the smooth implementation of resource construction, and make efficient use and sharing of educational resources in the region. The main advantages of building a good educational resource database are as follows: it can screen the school's teaching resources, filter out the information that is not conducive to learning in the network, and ensure the security of school educational resources. It can realize the sharing of educational resources among schools, avoid the phenomenon of repeated development, and ensure the multidirectional development of academic research by saving human and material resources. It can provide great help for students' learning so that students can obtain knowledge without the restrictions of regions, schools, and grades, ensuring the development of education in a more balanced direction and cultivating more excellent students.

5. Conclusion

The design direction of ontology-based educational resource metadata is to realize network sharing and integrate the resources of various colleges and universities. However, because the current implementation conditions are not mature, especially the communication conditions of various colleges and universities which are insufficient, the operation of the test system can only be carried out in a LAN, and the sharing of network knowledge cannot be realized. This paper establishes the application system of metadata system based on XML in the standardization of educational resource database. The functions are as follows: (1) effectively help demanders describe, retrieve, and process information resources; (2) provide extended applications; and (3) realize efficient search on. This paper analyzes the problems faced in the process of educational informatization, such as uneven distribution of educational application service resources, low utilization rate of resources, and repeated development of service tools, and expounds the important role of building a reasonable application service architecture to realize scientific and reasonable educational informatization. By analyzing the current situation of the existing educational resource management platforms in colleges and universities, this paper puts forward the way of metadata sharing, standardizes the metadata of educational resources to make it meet the standards, and then uniformly registers and manages the metadata. All users' operations on resources are based on metadata, which solves the problems of distributed storage and heterogeneity of educational resources. This paper studies the management of metadata under service and develops a metadata management platform suitable for service development mode. It improves the metadata management level under the service and the design and development efficiency of the application system, improves the phenomenon of nonstandard service design, and promotes the data governance of the education platform to move forward to "consistency, standardization, openness, and sharing." It greatly improves the number of concurrent users and the score of resource retrieval results, provides a more convenient resource query channel for users and colleges, and also provides a more effective means for the development of college education.

Data Availability

The labeled dataset used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no competing interests.

Authors' Contributions

Jingbin Zhang designed this study. Jingbin Zhang and Tianxiang Qi performed the experimental work and wrote the manuscript. Tianxiang Qi provided the majority of statistical analysis as well as provided the figures and tables for the manuscript. All authors read and approved the final manuscript.

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