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Intelligent Education Resource Management System in Cloud Environment

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How to effectively organize and manage education resources is one of the most important and key problem in the area of Education Informationization. As education resources are hybrid in content, multitudinous forms, heterogeneous structure, and dynamic characteristics, building a standardized heterogeneous education resources management system with high sharing degree is a challenging problem and should be solved at first. In this paper, we present a model of intelligent education resources management system in cloud environment. In the proposed model, we firstly describe various kinds of heterogeneous knowledge in a standardized form; then, all knowledge resources are logically stored in the cloud environment. We adopt the B/S mode to design and implement the education resources management system so as to enhance the scalability, reliability and maintainability of the platform. In the proposed system, after authenticated entering, users can browse, search, evaluate, and produce knowledge resources. To further improve the comprehensive performance of the platform, we introduce intelligent knowledge technology to manage and process the education resources. In this way, the education resources are effectively shared for the users of the system.

ISCC 2015
18-19, December, 2015
Guangzhou, China

[1]Speaker
[2]This work has been co-supported by: Natural Science Foundation of China under Grant No. 61472092; Guangdong Provincial Science and Technology Plan Fund with grant No. 2013B010401037; GuangZhou Municipal High School Science Research Fund under grant No. 1201421317; State Scholarship Fund by China Scholarship Council under Grant No. [2013]3018-201308440096; and Yuexiu District Science and Technology Plan Fund of GuangZhou City with grant No. 2013-CY-005.
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PoS(ISCC2015)066

1. Introduction

In recent years, with Internet and multimedia technology developing rapidly, education informatization has attracted more and more attention by both educators and researchers. For there are numerous coursewares, videos, case questions, literatures, online courses and other education resources abounding in various network educating systems, how to construct a rational and efficient education resource management system is an urgent and key problem. At present, the education resources of online learning applications are constructed at a low level state in our country. This can be mainly observed in the following aspects [1]: (1) Production standards of education resources are not unified. (2) Heterogeneous resources can not be visited through cross-platform, which result in low degree of sharing of the education resources. (3) The update rate of resources in many educational websites is slow. (4) For the poor interaction with the users, the feedback is fewer. (5) The resources are low reusability and many are slow to update.

Facing the above poor efficiency and low performance in existing education resource sharing platform, how to obtain large-capacity storage, effective interactive, efficient queries and high intelligence are still a key and important problem on the construction of education resource management system. This paper presents a novel Intelligent Education Resource Management System in Cloud environment (IERMSC). In the platform of IERMSC, the learning resources are organized and stored in a dynamic and adaptive knowledge base. The resources in the system consist of two parts: one is the resources uploaded by registered users and the other is produced by resources managers. On the other hand, users adopt a unified authentication way to log into the system, and then the system will offer guidelines for users to find the related interesting learning resources in the system. In order to locate resources quickly and accurately, the system designs two ways for the users, they are simple retrieval and advanced retrieval. Users can search the resources by the resource name, resource type or keywords. In order to optimize the query speed, we also designed a smart recommendation assistant, which uses intelligent reasoning technology to implement smart information selection and resources recommendation.

2. Related Work

Currently, with both the rapid development of education and the sharply increasing demand for education, how to construct an effective and efficient educational resource management has been intensively studied by researcher in the area. By adopting distribute system architecture and combining hierarchies with peer-to-peer structures, Cheng [2] designed a distributed education resource database, it makes the range of construction of resource database extended, the amount of storage resources increased and the data access rate ensured. With the emergence of grid computing research, paper [3] presented a new trust model to enhance security and extensibility of education resource grid by evaluating resources' trust dynamically. They also studied a hierarchical model based on grid platform that can safely and effectively manage the wide-range education resources. Their model has fine extendibility. The researchers of article [4] starts from the learning object and propose the concept of designing a resource database system based on learning object. It converts the learning object metadata (LOM) into educational resource by technical means, which improves resource utilization and enhances the scalability of the system. In a variety of computer languages, XML language is

based on open standard and has the feature of cross-platform compatibility and so on. So, paper [5] makes use of SQL Server and XML language to develop an education resources system, it has the advantage of optimizing storage and query process. It also can improve the system performance greatly. Paper [6] presents the design and implementation of Japanese language learning online platform, which adopts B/S model. Their system contains Japanese texts, exercises, further reading and many other reference books, and the proposed system works sound On the other hand, by using cookies technology, the system requires students to keep on line for a regulated time so as to prevent the students from cheating the teachers of their learning time of the days. Putting the learning materials as the resource object, MARIA [7] builds a model to manage learning materials, which integrates the material for the distance education in order to provide effective help.

If the system being built on the platform with no good model, the system will lack of systematic characteristics no matter what kind of object-based resource management mechanism the system are constructed on. By referring to the model-driven MIS (Management Information System) systems research of article [8], I realized that it's very important to firstly design the system model for any management information platforms, including the learning resource management to be presented in our paper. Today, MIS has been widely used in various fields, Tuula [9] mentioned one kind of MIS in the medical management of successful examples, and we can learn from it and apply to the field of teaching resource management.

The above studies designed and developed a series of reasonable standard of system architecture and functional structure by using a variety of technologies and from different perspective, which makes the sharing of education resources improved and network access rate increased. From the current researches, we found that the interaction between education resources management system and the users is poor and feedbacks are not enough. And the construction of existing knowledge base is not very standardized, without a certain self-adaptive and intelligent character.

3. Design of the Proposed Intelligent Education Resource Management System of IERMSC

3.1 Main Idea of the System of IERMSC

In recent years, cloud computing technology has made rapid development and has been widely used in various fields of our society. As a new computing technology, cloud computing environment can integrate a large number of sharing resources and thus provide various scalable capabilities for users to store and process their data. By using the above characteristics of the cloud, we'll find that it is a very important supporting technology for the construction of network education resource platform. At present, there are numerous different kinds of digital education resources deployed in Internet. The digital education resources are not only in structured form, but also in semi-structured or even in unstructured forms. This makes it very difficult to build and deploy high-performance education resource management system by using traditional technology. To solve the above problem, this paper presents a novel smart education resource management model by introducing B/S pattern and reasoning technology with cloud computing technology. In the proposed model, education resources are stored in knowledge database and organized in the form of knowledge tree. The above introduced education knowledge resources management model will simplify the structure of complex education

knowledge resources in uniformed form and thus to facilitate the knowledge's storage. And more, we make use of the object-oriented thought to design the system, so as to improve the adaptive capacity, maintainability and scalability of the system. By taking advantage of the intelligent techniques applied in our model, the designed education resources management platform can understand the users' question and generate the related interpretation and task according to the users' problems. By using cloud computing environment and other related technology, the proposed model of IERMSC can effectively manage various kinds of education resources in unified form.

3.2 System Architecture

The education resource management system of IERMSC is constructed by introducing the hierarchical model. The logical structure of the proposed education resource management system of IERMSC is constituted of four layers: the user access layer, the transaction layer, the data access layer and the physical layer. The architecture of IERMSC is as shown in figure 1.

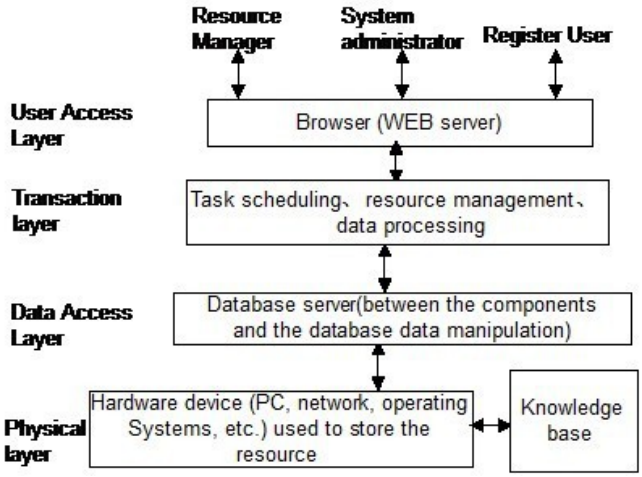

Figure 1: The structure model Chart of IERMSC

Description of the four logical layers is as following:

(1) The user access layer provides an interface for the users to access and use the system. There three kinds of users in the system, and they play different roles: (i) the resource manager is responsible for maintaining various and numerous hybrid heterogeneous digital teaching resources. (ii) the system administrator maintain and supervise the whole system, such as set the basic property of the system, regulate the system's users action, upkeep the learning resources stored in the system, ensure the physical equipments of the system running in normal way, and so on. (iii) the register user utilizes the system to fulfill their learning tasks and to realize their study goals. The user access layer can provide users convenient and quick interaction with the system, and thus largely improve utilization and sharing ratio of the learning resources.

(2) The transaction layer provides related services for the upper layer while encapsulating most of the actual operations. This layer offer following services for the upper layer: task scheduling, resource management and data processing. These functions are carried out by utilizing the operations supported by the lower layer.

(3) The data access layer is the channel of data exchange between the transaction layer system's databases. This layer performs all data manipulation of the system.

(4) The physical layer consists of various hardware equipments, such as PCs, servers, clusters, networks and so on. We use these hybrid machines to establish the cloud environment for the proposed intelligent teaching resource management platform.

3.3 Main Functions of the System of IERMSC

As is discussed above, the presented system of IERMSC is organized as a hierarchical construction. In the hierarchical system, each layer has its own operations and functions. The modules in lower layers provide services for the upper ones, while the components in the upper layers use lower layers' operations to implement its' functions or operations. And more, each layer should do some operation to achieve the functions assigned in their current position. In the system of IERMSC, users can not only browse resources quickly, but also use the resource recommendation assistant to retrieval resources intelligently. In order to guarantee the quality of learning resources stored in the system, they must evaluate resources they consulted. If the score of a learning resource is too low, it will be put on the alert list or even be deleted from the system by resource managers. At the same time, according to the general score of valid resources uploaded, the resource managers will determine to raise or not to raise the level of the user who uploaded it. Generally, resource managers are the scholars and the experts in related field and they are usually the high-level registered users of the system. By using the system, functions and operations that registered users and resources managers can carry out is as following: resources production, resources evaluation, resources audit, resources maintenance, and resources recommendation or other operations. The block diagram of the system's functions is as shown in Figure 2. The main functions of the system are briefly introduced as follows:

1) Browse Resources: As a preeminent education resource system, there is generally a huge amount and a wide variety of learning resources stored in it. How to make it easy and convenient for the system's user to browse and use the stored resources is a much more important problem and needs to be tackled at first. We provide a variety kinds of ways for the users to browse, learn, find or search the learning materials which he or she are interested in. By using classification and paging technology, the learning resources in the system needed by the users will be presented by category and in page, so as to facilitate users to browse and locate resources quickly. By using B/S architecture to construct the resource browse interface, the system's user can use and interact with the system anytime, anywhere. And so, the users are very convenient to feedback their comments of the resources that they are interested in.

2) Upload/Download Resources: This is one of the basic and most momentous functions of the system, and is the base of resource sharing. When the system's users uploading or downloading various kinds of learning resources, the platform will provide different and suitable methods for the users to upload/download their material according to the category of the material. Uploading and downloading resources is not only the channel of interaction between users and the system, but also a way to update the learning resources of the system. This helps the resources in the system being updated rationally and efficiently.

3) Resource Acquisition and Retrieval: In the proposed system of IERMSC, learning resources are mainly derived from two channels: one is from the resource managers who collect teaching resources from individuals or organizations and stores it into the platform; the other one is from the system's general users who upload their learning materials into the system. The presented system conduct two means for the users to retrieve resources, namely, simple retrieval and advanced retrieval. In the simple retrieval method, the users search resources by just

entering the several key words of the resource, while in the advanced retrieval way, the users retrieve resource by the resources' types, keywords, fields or other attributes. By this way, the platform can facilitate the users to view the specific resources of their research field more accurately. The practical and efficient mechanism of resource retrieval in the system raises the degree of the education resources sharing.

4) Resource Evaluation: Resource assessment is not only an important method to judge and guarantee the quality of learning resources but also a pivotal way for users to improve their privilege level. In the system of IERMSC, the evaluation score for resources is given a number between 1 and 5 according to their quality. After having viewed a resource, the user should give the viewed resource a score according to his evaluation of the resource. The higher evaluation score of the resource gained, the more front of the resource will be displayed in. Meanwhile, according to users' evaluation quality on the resources, their priority level in the system will be upgraded or decreased.

5) Resource Audit: Resource audit in the system of IERMSC includes two aspects: (i) The resource manager inspect the uploaded resources and make clear whether they have been existed in system, and then accordingly decide whether these resources are to be accepted or rejected. (ii) To count and synthesize the scores of all learning resources and the privilege level of all the system users. (iii) To record all kinds of activities of the system, this will help system managers to efficiently maintain the system and thus to make the system more robust.

6) System management: Operations of system management are listed as followings: (i) to record and analyze all kinds of activities of the system, this will help system managers to efficiently maintain the system and thus to make the system more robust. (ii) The system administrators of IERMSC should manage and statistic the information of various kinds of users of the system.

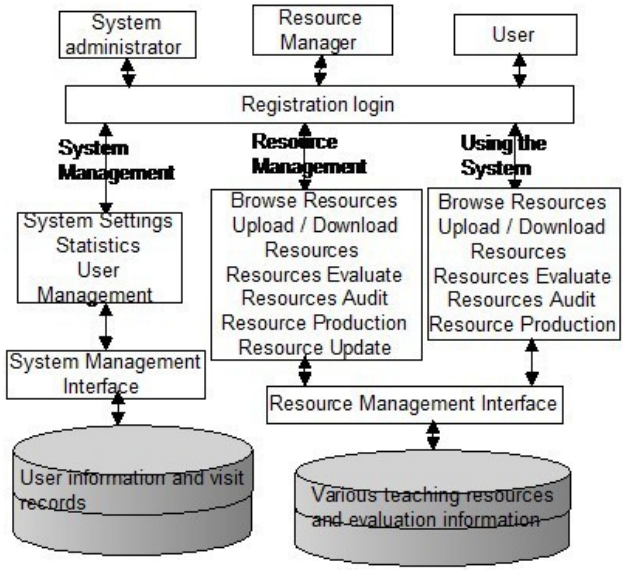

Figure 2: Main Function Chart of IERMSC

4. Implementation of the System of IERMSC

For the contents of education resources are rich and the styles and forms of it are diversified, how to build an effective and high-performance resource storage base is the most important and crucial problem and should be solved at first. Moreover, in order to achieve better

effective interaction with the users, the system adopts friendly operation to assist the user to find resources easily in the system.

4.1 Implementation of Education Resource Storage

According to the classification of "Technical Specification for Educational Resource Construction" formulated and promulgated by the Ministry of Education of China, we group the various kinds of educational knowledge resources into nine categories: educational media material, examination item database, test papers, network courseware, teaching and learning cases, literature documentation, online network curriculum, frequently asked questions, resource directory & index. In order to excellently and a high efficiently stockpile the vast amount of different types of learning materials, the system of IERMSC uses distinct symbolic codes to represent each type of the teaching resources. The specific codes for different types of resources are as listed in Table 2.

type	***media material***	***item database***	***test papers***	***courseware***	***cases***
code	01	02	03	04	05
type	***documentation***	***online curriculum***	***FAQs***	***Directory & index***	
code	06	07	08	09	

Table 1: Code Table of Different Types of Resources

Because of the characteristics of complex structure of the resources, the logical structure of the educational knowledge resources described in a unified form, and each resource attribute is regarded as a unit of the structure. Thus, in the system of IERMSC, the fields of the education knowledge materials comprise of fixed attribute and expanded attributes. The expanded attributes are as follows: index number, node information, priority, and so on. Learning knowledge materials are stored in the database of the system in the form of table. The specific structure of the table is shown in Table 2.

index (id)	***resource name***	***fixed properties***	***type***	***node information***	***priority (1-5)***	***content***

Table 2: Attribute Fields of Education Knowledge Resource

In order to further improve the performance and efficiency of the system, we establish a node information table for the storage of education materials, which effectively improve the retrieval speed and optimize queries in the system. The detail constitution of the node information table is as shown in Table 3.

No	***node name***	***parent node***	***child node***	***type***

Table 3: Node Information Table

4.2 User Role and Information in the Syetem

Before users logging into the system, they should register an account and provide some basic information so as to complete the registration process. According to the system's functions we designed, the registered users are divided into three kinds, and their roles are as followings: the registered user, the resources manager and the system administrator. Different kinds of users

have different requires and are granted different permissions of operations in the platform. And each kind of the users has its own attributes and corresponding authorized operation privileges.

In the system of IERMSC, object-oriented technology is introduced to organize the above three kinds of users. By this way, all users' information and relevant operation in the platform are rationally managed and authorized. The class of user (cUser) is set as the parent class, and the three child classes are as follow: the class of registered user (cRegisteredUser), the class of resource manager (cResourceManager) and system administrator class (cSystemManager). The parent class owns the common attributes and abstract methods, while the sub-classes have their own attributes and functions and are required to implement the abstract methods of the parent class according to their respective operation permissions.

4.3 Implementation of Resource Recommendation Assistant

In the proposed education resource management platform of IERMSC, to enhance the users' experience of using the system and to help the users accurately obtain the right resources they really needed, an intelligent resources recommendation assistant has been deployed in the system. The assistant uses machine learning method to reason and recommend resources to the users. As is discussed above, all the resources are ranked by their scores, thus the intelligent resources recommendation assistant will preferentially provide the resources with high rank. We also adopt intelligent inference rules for the recommendation assistant to carry out its' recommendation task by integrating various factors, such as user's academic background, work organization, research field, industry category, preferences on certain kinds of resources and so on. By this way, when the users try to retrieve or search the learning materials they want, our platform will intelligently recommend appropriate resources to them which largely meets their needs. In this way, the presented system optimizes the user's query speed and simplifies the query process with enjoyable using experience.

To realize the intelligence characteristic of resources recommendation assistant, we designed several tables to store the recommendation knowledge so as to carry out intelligent recommendation. Table IV is designed to store the usage condition of related learning resources that users accessed. Fields of Table IV includes: id of the resource, id of the user, frequency of the user access the resource, evaluation score of the related resource given by the user, recommendation intention rate that the user will recommend the resource to others. The detail construction of the table of user's usage condition of resources is shown in Table 4.

re-source id	*user id*	*fre-quenc y*	*evalua-tion score*	*recommenda-tion intention*

Table 4: Table of User's Usage Condition of Resources

Table 5 is the table of the average evaluation score of related resources. In the system of IERMSC, we calculate the resource's average evaluation score from effective evaluations of the user's while excluding invalid evaluations. The table of resource's average evaluation score is as shown in Table 5, and it consists of two fields: resource id and average evaluation score.

resource id	*average score*

Table 5 : Table of Average Score of Resources

Table 6 is designed to store some information of the users on their work and learning condition, which will help us to analyze their learning habits and to find their learning interests.

By doing so, we can recommend learning resources to specific user more accurately and efficiently. The table of users' information for smart resource recommendation is shown in Table 6.

user id	*current work field*	*major*	*latest accessed resource id*	*most accessed resource field*

Table 6: Table of Users' Information for Resource Recommendation

Besides related tables for intelligent resource recommendation, we also conduct some rules for it. In the prototype system of IERMSC, the smart resource recommendation rule is as following: when a user requests or searches for learning resources, we firstly search resources from the whole system by the key words or other demands submitted by the user just now, then we use information of Table 4, 5 and 6 in turn to accurately recommend the most appropriate learning resources to the user. By this way, the proposed system of IERMSC can play a more intelligent assistant for the users of the system.

4.4 Composition of the Prototype System of IERMSC

By taking the advantages of the open source platform, we construct the Prototype System of IERMSC by using Unbuntu Linux System (version 14.04). To simplify the construction of the prototype system, we use four Unbuntu Linux Servers to build a tiny cluster, one of which acts as the control nodes and the other three as work nodes. The cloud computing environment is constructed by installing and configuring high-throughput Apache Hadoop software framework and with two related components: ZooKeeper and HBase on the main node and work nodes. To make sure the environment being constructed successfully, SSH (abbreviation for Secure Shell) protocol should be installed and activated in Linux platform for Hadoop uses SSH protocol to communicate between its' nodes. After systems and modules having been installed and configured successfully, the Hadoop based cloud environment can be started, the process of the state diagram of hadoop cluster as is shown in Figure 3.

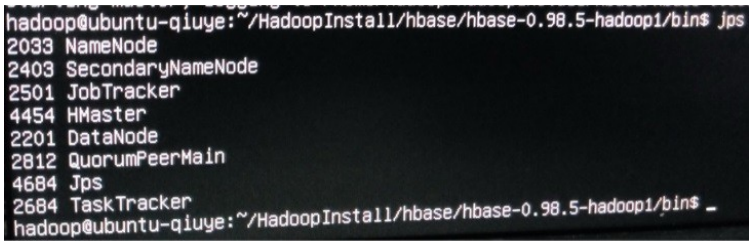

Figure 3: The Process of the State Diagram of Hadoop Cluster

4.5 Realization of Key Components ot the Prototype System and Related Technologies

1) Data Storage Modules: There two types of data storage in the prototype system of IERMSC: Hadoop HDFS and MySQL server based data storage.

Hadoop HDFS storage schema owns many effective mechanics which are very ideally apt for information storage for the system of IERMSC. In the prototype system of IERMSC, we conduct Java API package provided by HDFS to realize the related operations learning resources especially in the form of large files.

In order to obtain the best comprehensive performance and meet the needs, both of structured and non-structured data access is supported in the prototype system of IERMSC. To interact with structured database system of MySQL server, the Java API package included in

Hadoop software provides two classes to fulfill this task: DBIutputFormat and DBOnputFormat. The Hadoop software also provides method to communicate with non-structured database system of HBase by calling HBase Shell or related Java API. In the prototype system of IERMSC, we use Java API package attached with HBase software to access the learning resource data stored in HBase. By calling the functions of class HBaseConfiguration included in HBase Java API, the experimental prototype system can operate teaching resources stored in HBase server. The running instance of the HBaseTable is as shown in figure 4.

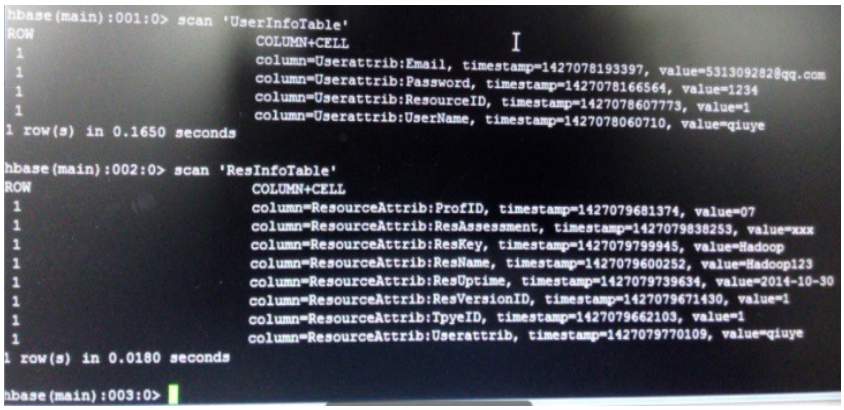

Figure 4: The Running Example of The HBaseTable

2) Other Function Modules: The system function modules are classified into two parts: the front-end function modules and the backward management modules. The front-end function modules of the proposed system consist of several sub-modules. In the prototype system of IERMSC, some of the sub-modules we have implemented are as followings: module of user register & login, resource browse module, module of resource upload & download, resource evaluation module, resource recommendation component, and so on. For example, we show several function modules of IERMSC in Figure 5-7. Figure 5 shows the interface for the users to register and login to the system. Figure 6 is the main entrance and home page of IERMSC. The module of resource upload and evaluation are shown in Figure 7.

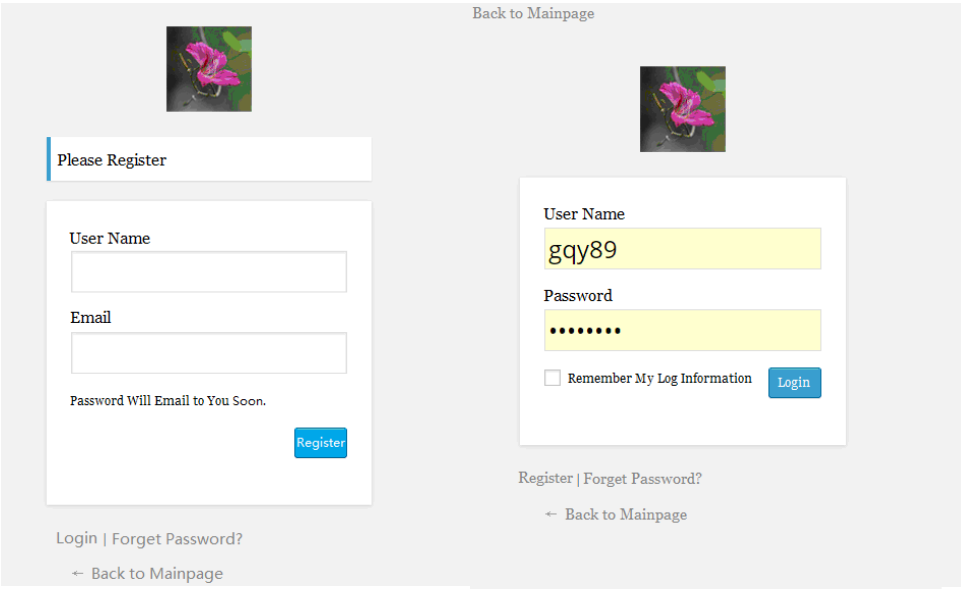

Figure 5: The Interface for User Registration and Login

Figure 6: Homepage of the System of IERMSC

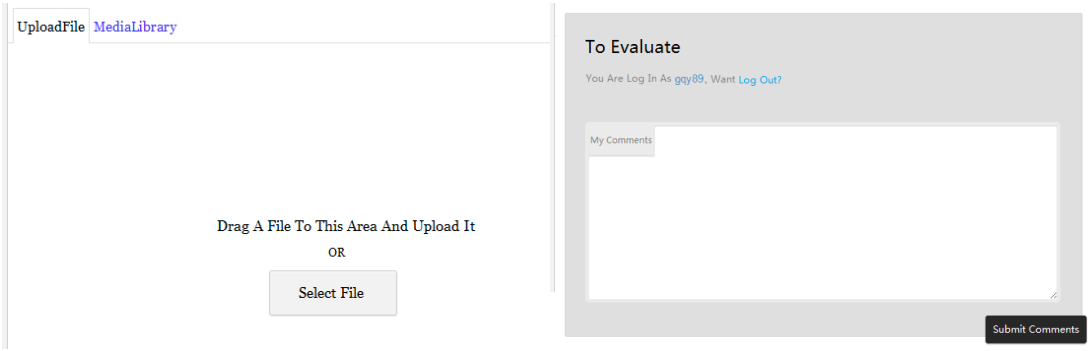

Figure 7: Resource Upload and Evaluation

The backward management modules of the Prototype System includes: user information maintenance and management module, learning resource processing and management module, and system monitoring and management module. This module will carry out the actual operating and processing actions according to the needs of the system users or be called by the upper level modules to fulfill complex functions. As for example of the system management, we present the user information maintenance and management module in Figure 8.

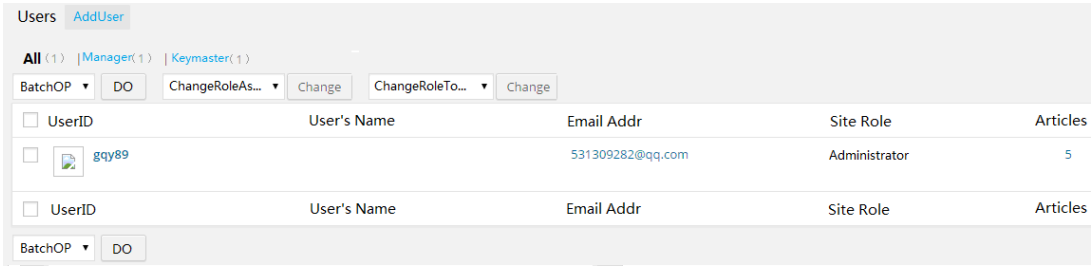

Figure 8: A Module of the System Management

5 Summaries and Future Work

The Intelligent Education Resources Management System in Cloud environment (IERMSC) proposed in this paper can provide effective learning resource management service

for the users with sound performance. By introducing cloud computing environment and other related technology to construct the prototype system, we have tried to overcome some bottleneck problems in some extent in the area. In our system, we use a unified form to describe the complex heterogeneous resources so as to convert the complicated resources into simple structure ones. The prototype system uses paging mechanism to present resources by resources categories which facilitate the user's learning experience on the platform. To elevate the convenience and efficiency of resource searching, the system provides two kinds of searching: the simple retrieval and the advanced retrieval. Moreover, by applying intelligent technology and related mechanics, the system provides an intelligent resource recommendation assistant to smartly select appropriate learning resources to be present to the users. The implemented prototype system of IERMSC can carry out the preplanned functions, and had been experimentally running for a period time. Experiments show that the design and implementation are reasonable and feasible.

In the future, we'll do more work on improving the performance and intelligence of the system. For example, we may introduce machine learning and reasoning technology to achieve the above goal.

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