Design of Online Education Resource Sharing Model Based on Blockchain Technology

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Abstract. The traditional online education resource sharing model has the defects of low control load and slow response time. Therefore, this study designs an online education resource sharing model based on blockchain technology. According to the principles of model construction, the framework of online education resource sharing model is built, and on this basis, the standards and granularity of online education resources are set. This paper selects the mode of "centralized management, distributed storage" to manage online education resources, analyzes the structure of blockchain, and realizes the transmission and access of resources based on the blockchain technology - equality network, so as to realize the sharing of online education resources. Take the "Computer Network" course as an example to build an experimental environment, make registered resources, and conduct educational resource sharing experiments. The experimental results show that compared with the traditional model, the proposed model has larger control load and shorter response time, which fully indicates that the proposed model has better resource sharing performance and is suitable for promotion and application.

Keywords: Blockchain technology · Online education resources · Resource sharing · Peer to peer network

1 Introduction

With the development of modern society, people increasingly hope that they can acquire knowledge in multiple fields and multiple disciplines without being restricted by space in their daily lives, which makes distance education emerge as the times require and continue to grow. As an important branch of distance education, online online education has entered thousands of households with the rapid popularization of the Internet. Obtaining knowledge through the Internet has also become one of the important means for countries to improve the education level of the people [1]. Statistics show that as of 2019, a total of 68 ordinary universities and colleges in my country have launched modern online education, opened 299 majors, built more than 20,000 online education resources and a batch of online education teaching and management system platforms, and established 9,000 There are a number of off-campus learning centers and teaching sites, of which a quarter are set up in the western region, extending high-quality education and teaching resources and support services to the western region, rural towns, urban communities,

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various industries, enterprises, and military camps. Online education has promoted the popularization and informatization of higher education, and has become an important form of diversified, lifelong, networked and open continuing education in China [2].

However, while creating great value, online education network also exposes some problems. Although the websites providing online education services have their own high-quality education resources, they are still restricted by the region and service ability. In the whole Internet ocean, they are like isolated islands of information. Although each has its own advantages, they can not communicate with each other and it is difficult to realize the sharing of educational resources. It is an urgent problem for the people to integrate and share these resources [3]. In order to solve the above problems, we can introduce the resource sharing mechanism into the field of online education, manage the self-contained network education resources distributed in various regions, and provide a simple discovery and effective use mechanism to realize the sharing of educational resources.

According to the existing research results, the existing online education resource sharing models, such as the ontology-based distance education resource sharing model and the model, etc., have complex computing processes and are difficult to carry out distributed management of resources, thus having the defects of low control load and slow response time. In order to solve the shortcomings of the above traditional model, this study designed an online education resource sharing model based on blockchain technology. Among them, the blockchain technology is encryption technology, hash algorithm, hash function pointer, digital signature technology, binomial tree structure and P2P network propagation, etc., using a consensus mechanism to achieve decentralized authentication and supervision of business activities and distributed Bookkeeping, to realize the non-repudiation proof of the main behavior and content of business activities, and the use of time stamp technology in the block to ensure the traceability of the block content in time.

2 Design of Online Educational Resource Sharing Model

2.1 Construction of Online Education Resource Sharing Model Framework

Before building an online educational resource sharing model framework, it is first necessary to clarify the design principles of the model, then conduct a specific analysis of the various problems faced by the model, and finally make a reasonable design for each problem.

In order to enable the design model to provide various services stably and reliably, certain constraints are required to balance the creative efforts of application development and the standardization requirements of software design during model design and development. Therefore, the following principles should be followed when designing the model:

Principle 1: follow a unified open technology architecture. Open technical architecture has become the mainstream of information technology development. Facing the continuous expansion of model scale, the difficulty of model development organization is

becoming higher and higher, and the construction and management of super large application model are full of challenges. Therefore, it is necessary to follow the open technical architecture system in model design [4];
Principle 2: maintain a unified common basic resource model. The object managed by the model is the key component of the whole model. With the realization of multi-dimensional management view, the access to all management objects will inevitably be involved. Therefore, in the model design, we should establish a unified object model and dictionary, standardize the management and maintenance of public infrastructure resources, and create conditions for resource sharing.

Through the above description, the online education resource sharing model framework is built, as shown in Fig. 1.

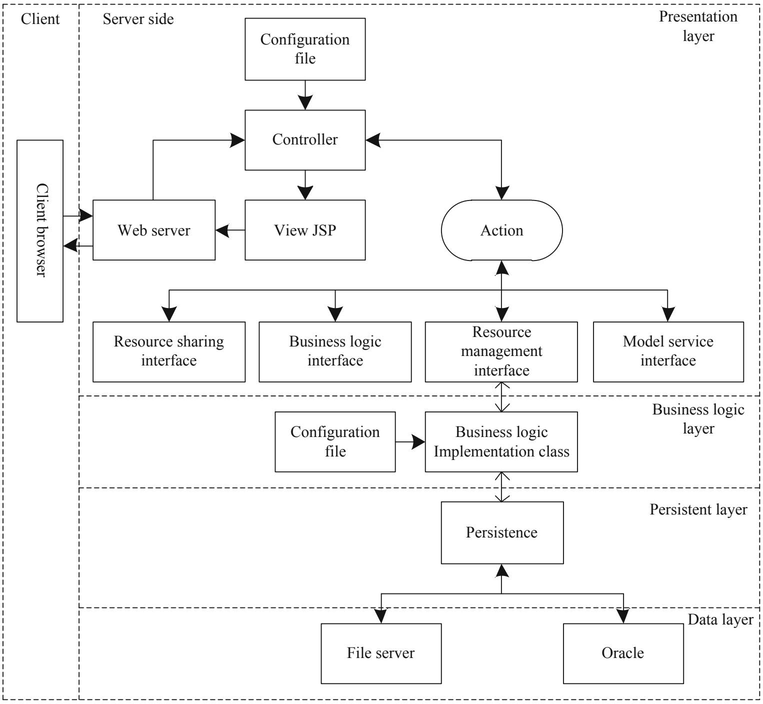

Fig. 1. Framework of online education resource sharing model

2.2 Resource Standard and Resource Granularity Setting

Based on the online education resource sharing model framework built above, set resource standards and resource granularity to prepare for the realization of subsequent resource management and sharing.

The development of online educational resources with reference to relevant standards is a way to solve the problem of co-construction and sharing of online educational resources [5, 6]. At the meeting to promote the implementation of educational technology standards, when analyzing the difference between the SCORM standard and the CELTS standard, Professor Zhu Zhiting pointed out that "the two are actually compatible. If the SCORM standard is truly complied with, the CELTS standard is actually complied with. Zheng Li from the Computer and Information Management Center of Tsinghua University said: "The product will be compatible with many popular international standards, and the fundamental point is to follow the basic national standards." Therefore, domestic products should first consider following our national standards. Therefore, the research adopts the national standard CELTS standard system for standardization. The standardized processing flow of educational resources includes steps such as description, organization, and packaging.

CELTS Learning Object Metadata Specification (LOM) is used to describe online education resources. The data elements of the learning object are organized in a tree structure, which is divided into three parts: "root node", "middle node" and "leaf node". Of these, only the "leaf node" has a specific value.

Learning objects can be described according to the learning object metadata provided by the LOM specification, but the specification does not specify how the metadata can be represented in a way that is computer readable. XML documents are easy to be transmitted and exchanged on the Internet. Therefore, CELTS, the XML Binding Specification for Learning Object Metadata, was selected as the standard for describing the basic information of learning objects that can be transmitted on the Internet.

For the content packaging of online educational resources, the CELTS content packaging specification is adopted. The content packaging information specification regulates the naming of the content manifest file: the learning content published in accordance with the content packaging information specification standard must include a content manifest file, and this file is named celtsmanifest.*, if there is no such file, the resource package will not be deal with. The content manifest file and its supporting files should be placed in the root directory of the package exchange file or package image. The content packaging information specification also specifies the elements of the content list in detail, such as name, corresponding English name, description, binding, multiplicity, type and remarks [7].

Based on the description of metadata information, the content packaging information specification defines a reasonable and effective way to organize and package learning content, which is easier to effectively manage, share, exchange and retrieve resources. Therefore, this study takes it as the final standardization specification of resources. The XML description standard corresponding to content packaging information specification is CELTS, which is the XML binding specification of content packaging [8, 9]. This study will be designed in strict accordance with this specification in the process of resource production and resource standardization verification.

Learning objects refer to various entities for learning. A course, a picture, a set of question banks, a video, etc. can all be considered as learning objects. Learning objects can be divided according to the size of the granularity. Low-granularity resources refer to individual entities. Such entities have no internal organizational structure, such as text, pictures, and videos. High-granularity resources are composed of low-granularity resources with internal Learning objects with complex organizational structures, such as courses or question banks; medium-grained resources are somewhere in between, and have internal organizational structures, but they tend to be relatively simple.

The definition of resource granularity is shown in Fig. 2.

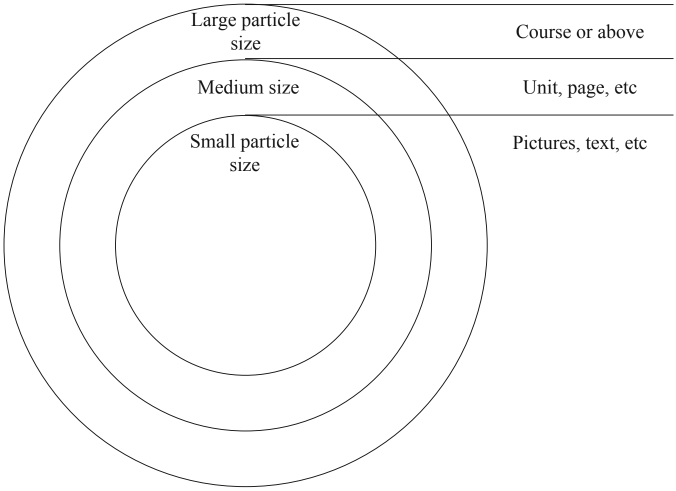

Fig. 2. Definition of resource granularity

The LOM specification and content packaging specification do not care about the issue of resource granularity. The LOM specification and CP specification can be used to describe and package any granular resources. However, for standardized resource sharing, only packaged resources can be published and used on the model. The model designed in this research supports resources of various granularities, such as: videos, courseware, texts, online courses, etc. At the same time, considering the issue of mutual recognition of credits, only resources with a granularity above the curriculum can achieve the goal of mutual recognition of credits. Therefore, this study stipulates that if the resource type uploaded and registered is "online course" or above, in the metadata information of the course element, the cost value of the sub-element of the rights element is set to "course specific credits", and this value for other low-granularity resources Set to "resource value points or other virtual currency number", the use of virtual currency means no actual charge, which shows the principle of resource openness.

2.3 Online Education Resource Management

Centralized and distributed storage, as two storage methods often used in resource storage, have their own advantages and disadvantages. This study combines centralized and distributed storage to form a "centralized management, distributed storage" storage mode, so as to improve the efficiency of resource retrieval and management under the premise of decentralized resource center access pressure [10]. Specifically speaking, this storage method is to store the low granularity physical file resources in the user upload package transmission files in various management models, and for non-standard resources, each resource file is directly stored in each existing learning model, and the resource description information and resource package related information are stored in a centralized way. The unified management mode is shown in Fig. 3.

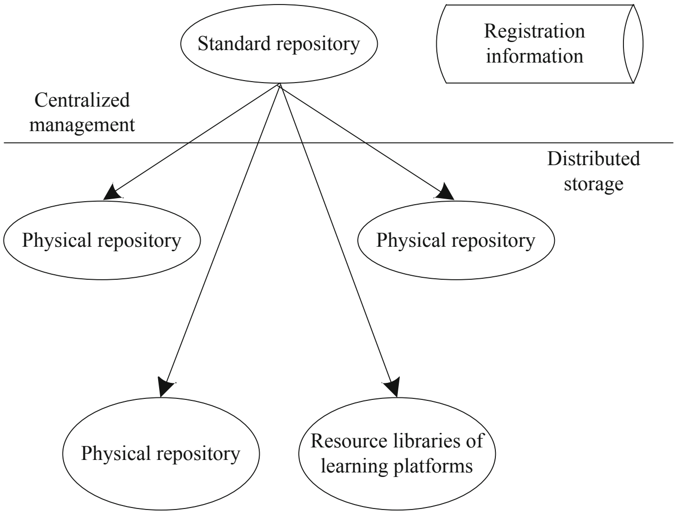

Fig. 3. "Centralized management, distributed storage" mode

The "standard resource package" is stored in the standard resource library. The standard resource package depends on the "physical resources" in the physical resource library, that is, low-granularity resources, and the "registration information" comes from the description information in the "standard resource package" [11].

The management model of learning resources is divided into three levels:

Level 1, the resource production layer. Users conduct standardized resource development according to standardized specifications or resource production software, complete resource production, and register through the resource registration interface;
Level 2, the resource storage layer. Provide resource registration interface, conduct content standardization and legitimacy audit on uploaded resources, store resources and store resource metadata information after passing the audit;
Level 3 is the resource publishing layer. The registered resources can be published on the Web platform for users to search and access.

Combined with the "centralized management, distributed storage" mode and the hierarchical management model of learning resources, the model resource management process, that is, the resource flow process, is obtained. The resource management process is divided into the following six steps:

Step 1: the resource producer packages the physical resources distributed in different places according to the standard specifications, forms the resource bundle, and collects the access address of each low-granularity resource in its own learning model;

Step 2: the resource package is uploaded to the model through the registration interface provided by the resource sharing model. According to the interface provided by the model, non-standard resources form resource description files and register resources in the model;
Step 3: the resource sharing model carries out standardized detection of resources. Through the detection, metadata information is extracted, and the metadata information is stored in the registration information database. At the same time, the low granularity resources are stored in the distributed physical resource repository;
Step 4: the resource sharing model stores the resource package into the standard resource package library;
Step 5: if the resource passes the approval of the resource sharing model, the model obtains the resource metadata information from the registration information base and publishes it to the model for users to use;
Step 6: the resource details obtained by the user are obtained from the resource package by the model.

2.4 Online Education Resource Sharing Based on Blockchain Technology

Based on the resource standards, resource granularity and management mode set above, blockchain technology is introduced to realize the sharing of online education resources. The specific implementation process is as follows:

The structure of the blockchain is divided into a block header and a block body. The data in the block is the transaction record stored in the merkle tree. The construction of a Merkle tree is a process of calling recursively to calculate the hash value. The calculation rule is usually SHA256 or MD5. Due to the binary tree characteristics of the merkle tree, the merkle tree has good scalability and can record a large amount of information in several layers.

The block header includes the root value of the merkle tree, the hash value of the previous block, timestamp, random number, and version number.

Hash value is a very important attribute in the block header. The hash value of the previous block obtained by hash calculation ensures that the block is stored in chain. At the same time, this value also ensures that the block information can not be tampered with. Because the calculation process needs to combine the characteristics of the current block, if you want to modify the information in a block, you need to modify the information of all blocks after the block, and this needs to cost a lot. Therefore, the hash algorithm ensures the security of the model.

Timestamp is another important component of the block structure. Since there is no central server in the network, there may be a delay in the time between each node. In order to avoid the occurrence of information asymmetry, it is necessary to detect the nodes in the model. The time includes long and transaction storage. The entire node block is designated as the priority block, and other nodes discard their own blocks and use the priority block instead. The timestamp stores the blockchain in time sequence to facilitate block sorting and block query. Combined with the hash value, the separation of the generation block order and the model time can be realized, and the purpose of distributed storage can be achieved.

Blockchain has the following characteristics:

Characteristic 1: Security. The distributed storage of blockchain ensures the decentralization of data interaction and avoids human intervention. If you want to tamper with the data in the blockchain, you need to control 51% of the nodes in the whole network. On the data transmission level, if the attacker outside the node wants to hijack the data through P2P network to tamper and then send, it is very difficult to crack the private key in encrypted transmission. At the information integrity level, if you want to modify the information of a node, you need to modify all the information in the remaining chain. These are obtained by strict encryption according to the hash algorithm, and the security is guaranteed because the hash algorithm is irreversible.
Characteristic 2: Transparency. Blockchain has the characteristics of searchability, traceability, and block chain timing. The completed behavior information is fully recorded and can be checked. Any node can query any block information in the blockchain, which greatly improves the transparency of interaction [12].
Characteristic 3: Participation. The generation and storage of blockchain depend on user nodes. If the nodes are insufficient or the participation is not high, the integrity of the blockchain cannot be guaranteed: when querying or calling the blockchain, if the amount of data stored by the selected node fails to meet the expectation, there will be missing blocks in the collected whole chain. In addition, in the process of blockchain storage, new blocks are constantly generated, and new data need to be stored constantly, which will have a certain pressure for each node participating in the behavior. Although the participation ensures the independence in the interactive communication, it also brings potential overhead and security risks to the model itself.

Blockchain technology mainly includes peer-to-peer networks, encryption algorithms, and hash algorithms. Based on online education resource sharing needs, peer-to-peer network blockchain technology is selected as the supporting technology for this research.

The role of P2P network in blockchain is to connect all nodes, so as to ensure that any two nodes can establish interconnection communication without relying on a third party, and transmit data information in the form of broadcast, so that the model can run normally. There are two key concepts in P2P networks:

One is broadcasting mechanism. In P2P network, there is no centralized special node and hierarchical structure in theory. Each node will undertake the work of network routing, verifying information, disseminating information, discovering new nodes and so on. The way of blockchain publishing information is broadcast, and the information generated in the network will be broadcast to all nodes. In the process of broadcasting, the node will verify whether the message is legal, and then judge whether to broadcast to the adjacent nodes. As long as the information is received by more than 51% of the nodes, the information is considered to be passed and can be recorded in the new block. If the node judges that the information is wrong, it discards the information and terminates the broadcast operation. In addition to the verification of transaction information, P2P broadcast mechanism is also used to confirm the permissions of nodes. By calculating the dynamic random number and having the most complete record, the nodes broadcast the new block data to the whole network. Other nodes discard their own blocks, receive the block data obtained through broadcasting, and store the new block into the blockchain after verifying the authority. The broadcast mechanism implemented in this research will be realized through the network process broadcast mechanism, that is, using socket management framework, the block information and legal education resource information will be transmitted to the nodes except themselves.

Second, the consensus mechanism. There is no centralized centralized management model in the blockchain network. It is all the participating nodes that play a key role. The problem to be solved by blockchain technology is to let the nodes interact to form a storage system that is simple, easy to use, low cost and can be grouped and managed.

Whether the two points of data consistency and data availability can be guaranteed in the resource sharing network model are two factors to be selected in the model design. In online education resource sharing, the POW consensus mechanism is used to ensure the consistency of the data, that is, the method of "mining" calculation is adopted: the nodes participating in the calculation use the traversal calculation method to withdraw a random number according to a certain hash rule. It is satisfied that the hash calculation result of the current block header is less than a certain number. The node that obtains the random number obtains the authority, and the calculation process ensures the security of the consensus and the consistency of the data. The blockchain technology of this research will adopt a more reasonable Pos mechanism, that is, the integrity of the block information recorded by the node will determine the degree of difficulty in the consensus process. As long as the node has relatively complete blockchain data, the consensus process will be calculated. The power consumption will be greatly reduced, so as to prevent the learner from interfering with the calculation of the learning part when using it.

Through the above blockchain technology, the application of equation network, the sharing of online education resources is realized, which provides a reliable support for the development of China's education field.

3 Experiment and Result Analysis

In order to verify the performance difference between the online education resource sharing model based on blockchain technology and the traditional model, the MATLAB software platform is used to design the experiment. The specific experiment process is as follows.

3.1 Construction of Experimental Environment

The experimental environment is shown in Fig. 4. Using a PC as the web server, using a PC as the database server, using PC as the physical resource storage server, and using PC as the client.

In the experimental part, Tomcat is selected as the Web container and Oracle 10g is selected as the database server. At the same time, the project was built according to the model architecture, and MyEclipse was selected as the auxiliary tool for project development in this study.

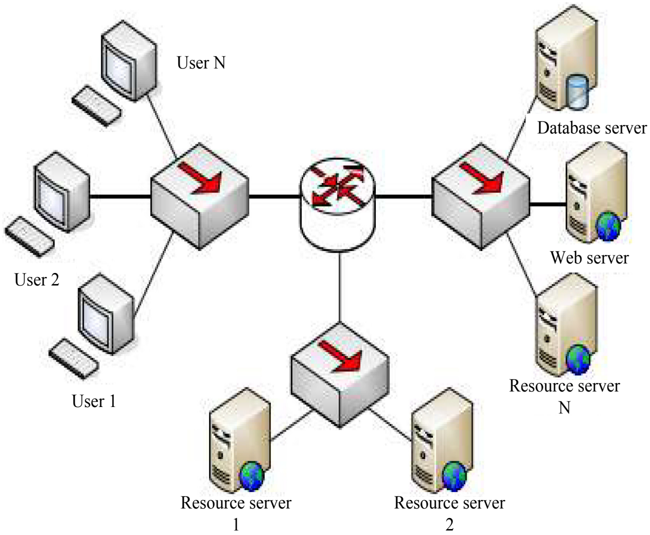

Fig. 4. Experimental environment

3.2 Resource Production Registration

The experiment took the “computer network” course as an example, and made the “computer network” course according to the steps of standardized resource production.

First, analyze the structure of the “computer network” course, which is mainly divided into two units, each unit is divided into four modules, and each module contains varying amounts of content, as shown in Fig. 5.

After analyzing the structure, prepare the low granularity resources. After the preparation of resources, we describe the resources. We use the standardized resource description tools provided by the model, which can greatly reduce the cost of learning XML. In addition, “animation demonstration”, “video lecture” and “learning test” are remote resources stored on Web server, while “knowledge map” and “electronic courseware” belong to physical resources and need to be packaged and uploaded. When the resources are packaged, the correctness of their respective positions should be ensured.

For resource packs that do not conform to the specification, the model will prompt accordingly, such as lack of celtsmanifest.xml file, or celtsmanifest.xml file syntax error. Using the model’s resource standardization tool to automatically generate celtsmanifest.xml can reduce the possibility of grammatical errors, but the relative scalability is not strong. Manually writing xml by yourself has strong scalability, which also increases the probability of corresponding errors. If there is no error in the resource detection, the model will prompt that the resource upload is successful.

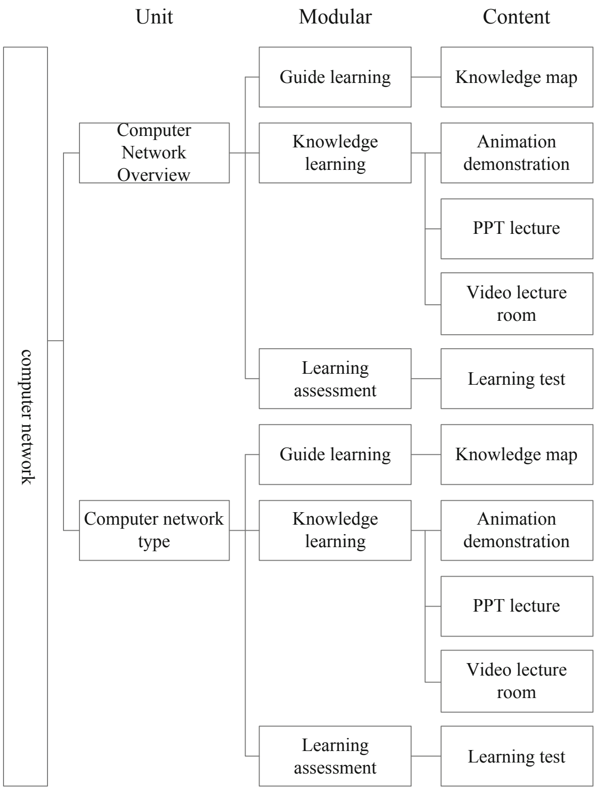

Fig. 5. "Computer network" course structure

3.3 Analysis of Results

According to the experimental environment and registered resources, the experimental data are input into SPSS software for centralized processing. Finally, the model performance evaluation data is obtained, as shown in Table 1.

As shown in Table 1, compared with the traditional model, the control load of this model is larger and the response time is shorter, which fully shows that the resource sharing performance of this model is better.

Table 1. Model performance evaluation data table

(1) Control load data		
Number of experiments/time	Control load (MB)	
	Paper model	Traditional model
1	425.46	301.25
2	462.13	302.54
3	495.58	325.48
4	480.25	315.42
5	501.49	395.48
6	528.45	345.20
7	546.21	385.74
8	498.57	401.20
9	462.01	401.28
10	429.78	400.17
(2) Response time data		
Number of experiments/time	Response time (s)	
	Paper model	Traditional model
1	10.25	15.49
2	10.32	11.25
3	10.00	15.49
4	9.56	16.00
5	9.81	15.40
6	10.25	15.27
7	11.54	15.09
8	11.59	14.53
9	11.90	16.28
10	10.57	16.84

4 Conclusion

Aiming at the problems of low control load and slow response time existing in the traditional online education resource sharing model, a new online education resource sharing model is constructed by applying block chain technology. This model greatly improves the model control load and reduces the model response time, which proves that it has strong load capacity and fast response speed, which can provide users with better online education resource sharing experience, and also lays a foundation for the development of education resource sharing in China.

References

1. Xu, Z., Yang, D., Li, W.: Microgrid group trading model and solving algorithm based on blockchain. Energies **12**(7), 1292 (2019)
2. Zhang, J.: Interaction design research based on large data rule mining and blockchain communication technology. Soft. Comput. **24**(21), 16593–16604 (2020)
3. Alcarria, R., Bordel, B., Robles, T., et al.: A blockchain-based authorization system for trustworthy resource monitoring and trading in smart communities. Sensors **18**(10), 3561–3561 (2018)
4. Bartholomew, S.R., et al.: Factors influencing student success on open-ended design problems. Int. J. Technol. Des. Educ. **28**(3), 753–770 (2018)
5. Jiang, X., Yu, F.R., Song, T., et al.: Blockchain-enabled cross-domain object detection for autonomous driving: a model sharing approach. IEEE Internet Things J. **7**(5), 3681–3692 (2020)
6. Zou, J., Ye, B., Qu, L., et al.: A proof-of-trust consensus protocol for enhancing accountability in crowdsourcing services. IEEE Trans. Serv. Comput. **12**(3), 429–445 (2019)
7. Rawat, D.B.: Fusion of software defined networking, edge computing, and blockchain technology for wireless network virtualization. IEEE Commun. Mag. **57**(10), 50–55 (2019)
8. Liu, S., Glowatz, M., Zappatore, M., et al. (eds.): E-Learning, E-Education, and Online Training, pp. 1–374. Springer International Publishing, Heidelberg (2018)
9. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
10. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
11. Hu, P., Zhao, C.L., Liang, Y.Z., et al.: Research and development of PEI interactive evaluation model for online educational resource. Educ. Res. **24**(2), 113–120 (2018)
12. Fan, Y., Liu, M.: Design and research of online education course resource sharing based on cloud platform. Mod. Electron. Tech. **43**(1), 175–178 (2020)