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Design and Development of School Credit Bank System Based on Blockchain Technology

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Abstract: *The school credit bank system refers to a system that collects, stores and manages students' academic performance and credits. It allows students to transfer credits between different educational institutions and training institutions, providing convenience for lifelong learning and career development. In China, the concept of school credit banks is also gradually being promoted and practiced, especially in the fields of higher education and vocational education. Various regions and educational institutions at all levels are exploring credit bank models suitable for their regions and institutions. However, the traditional school credit bank system has problems with data security, reliability, and authenticity. Blockchain technology has the characteristics of high reliability, traceability, non-tampering, and decentralization. Therefore, we propose to build a school credit bank system based on blockchain technology. Experiments and facts prove that our blockchain-based credit banking system is more transparent, efficient and secure.*

Keywords: *Blockchain, School credit bank system, High reliability, Traceability, Non-tampering, Decentralization*

1. Introduction

The school credit bank system refers to a system that collects, stores and manages students' academic performance and credits. It allows students to transfer credits between different educational institutions and training institutions, providing convenience for lifelong learning and career development. In China, the concept of credit banks is also gradually being promoted and practiced, especially in the fields of higher education and vocational education.

The school credit bank system first has the function of credit accumulation and transfer, allowing students to study at different times, different locations, and different education or training institutions, and accumulate the credits earned. At the same time, students can transfer earned credits from one institution to another. The school credit bank system provides students with a more flexible learning path. Students can choose different courses and training projects according to their interests and career plans. The credit bank system supports the concept of lifelong learning. No matter what stage students are at, they can continue studying and save the credits they earn in the credit bank. The credit bank system supports a variety of different learning models, including traditional face-to-face classroom learning, online learning, hybrid learning, etc. To ensure the quality of credits, credit bank systems usually have a complete set of quality assurance and certification mechanisms. This includes audits of education and training providers participating in the credit banking system, as well as quality control of courses.

China's school credit bank system is still in the development stage, and various regions and educational institutions at all levels are exploring credit bank models suitable for their regions and institutions. With the development of new technologies, we introduce blockchain technology to make the credit banking system more transparent, efficient and secure.

2. Literature Review

Over the past few years, the potential application of blockchain technology in education has become the focus of many researchers.

In terms of school credit and certificate certification, many researchers have explored how to

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leverage the immutability of blockchain to create a safe and reliable authentication system. For example, Prinz and Koch Grech [1] proposed a blockchain-based open certificate system that can provide transparent, verifiable and durable academic records. In order to solve the transfer and mutual recognition of credits, Sharples and Domingue [2] discussed how to use blockchain technology to simplify this process and provide a decentralized and automated solution. In order to solve the problems of traditional closed credit management system and limited data access, Chen et al. [3] studied how to use the transparency characteristics of blockchain to improve the accessibility of data while protecting students' privacy, and better Addresses issues of data transparency and accessibility. Turkanović et al. [4] explored a blockchain-based learning archive management system that can provide students with a lifelong, comprehensive learning record. Azaria et al. [5] proposed a solution to the problem of preventing forged certificates and credits through a blockchain-based certificate verification system. Schmidt et al. [6] explored how to reduce the high cost of traditional credit management and certification methods by automating the credit transfer and certification process. In order to achieve mutual recognition and transfer of credits, Condie and Hillaire[7] analyzed the current credit management standards and proposed a standardized framework based on blockchain.

As a revolutionary technology, blockchain has attracted the attention of a large number of scholars and engineers since the birth of Bitcoin in 2008. Narayanan et al. [8] discussed in detail the important role of cryptographic hash functions in ensuring blockchain data integrity and tamper resistance. Cachin and Vukolić [9] conducted an in-depth analysis of several main consensus mechanisms in blockchain, such as Proof of Work (PoW) and Proof of Stake (PoS), and implemented distributed protocols and guarantee systems in blockchain networks. Key technologies for consistency. Christidis and Devetsikiotis [10] explore the design principles and application of smart contracts in implementing automated business logic, allowing automated, trustless transactions and operations to be performed on the blockchain. Zyskind et al. [11] proposed several data privacy protection schemes based on blockchain, which to a certain extent solved the challenges that the openness and transparency of blockchain bring to data privacy and security. Swan [12] analyzed the basic principles and potential applications of distributed ledger technology from a macro level and solved the problems of distributed ledger technology, which provides a decentralized data storage and management framework. Miller et al. [13] discussed the technical challenges and solutions for on-chain and off-chain interactions, and the key technologies for realizing the connection and interaction between blockchain and the real world.

As can be seen from the above literature review, the application of blockchain in the field of education is still in the exploratory stage, but it has shown great potential. How to comprehensively integrate the advantages of high reliability, traceability, non-tampering and decentralization in the development of specific information systems is still a challenge. Only by solving the above problems can an efficient credit bank system based on blockchain technology be developed.

3. System Design

The blockchain-based credit banking system aims to provide a safe, transparent and credible credit management and certification platform for the education field. The design of the system needs to consider various technical and business requirements. We conducted a comprehensive design from system architecture, data storage, transaction packaging, blockchain updates, user interface and data model.

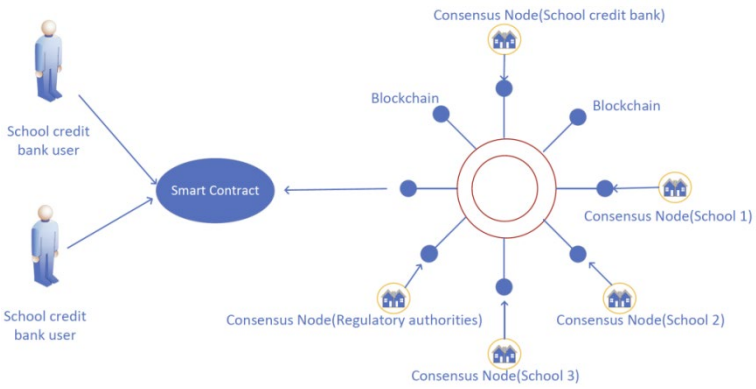

Figure 1: Design of Smart Contract Structure for School Credit Banks

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3.1. System architecture

Our system adopts a layered architecture design, including data layer, logic layer, and application layer. Among them, the data layer is mainly responsible for the storage and management of data, including blockchain data, databases, etc. The logic layer is mainly responsible for processing business logic, including transaction processing, credit certification, etc. Application layer: mainly responsible for providing user interfaces and application services, including web pages, mobile devices, etc.

3.2. Data model

Firstly, we have redesigned and optimized the credit data model to adapt to the data structure and transaction processing mechanism of blockchain.

(1) Understand the business needs, clarify the main business needs and functions of the credit bank system, such as the accumulation, transfer, certification, etc. of credits, and understand the main participants of the credit bank system, such as students, educational institutions, enterprises, etc.

(2) Define the data structure, including the credit data structure and transaction data storage structure. Credit data is the core data of the system, and a suitable data structure needs to be designed to store and manage the credit data. For example, each piece of credit data may contain attributes such as the number of credits, course information, and acquisition time. Transaction data storage structure supports operations such as accumulation and transfer of credits. For example, each piece of transaction data may include attributes such as transaction type, transaction parties, and transaction amount.

(3) Security and privacy protection mechanism design. Ensure system security and privacy protection, such as protecting sensitive data through encryption technology and protecting user privacy through permission control.

Designing and optimizing the data model of a blockchain-based credit banking system is a complex and important task. A suitable data model can effectively support the functional requirements of the system and improve the efficiency and scalability of the system.

3.3. Data storage

It is divided into on-chain storage of important data and relational database storage of basic information. All credit data and transaction records will be stored on the blockchain to ensure the non-tamperability and integrity of the data. Each block contains a set of transaction records, such as credits earned, transferred, etc. All data used to store user information, course information, etc. that do not need to be uploaded to the chain are stored in the relational database.

3.4. Transaction processing

Users submit transactions through the application layer, such as transfer of credits, purchase of credits, etc. The system verifies the validity of the transaction, such as user identity verification, credit balance check, etc.; through the consensus mechanism, the verified transactions are packaged into blocks; finally, the new block is added to the blockchain, the system status is updated, and completion the whole deal.

3.5. Credit certification

It is divided into credit inquiry, credit verification and credit transfer. Users can query their credit records, including the acquisition and use of credits, etc. Schools and businesses can verify the authenticity and integrity of credits. Supports the transfer and sharing of credits, and automatically executes relevant business logic through smart contracts.

3.6. Smart contract

We mainly consider implementing business logic methods to achieve operations such as credit accumulation, transfer, and authentication. The contract includes well-defined interfaces and events to support transaction processing and event notification in the system. Figure 1 shows the structural design of the credit bank smart contract.

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3.7. User interface

We design a web user interface where users can access the system interface through a browser. At the same time, I provide a mobile application that facilitates users to use the system anytime, anywhere. Provide complete API services and support access to third-party systems and services.

3.8. Security design

We ensure the security and privacy protection design of the system through technologies such as data encryption, permission control, identity authentication and authorization, and privacy protection. Through this architecture design, the blockchain based school credit bank system can not only provide a secure and trustworthy credit management and authentication platform, but also have good scalability and compatibility, supporting multiple application scenarios and business requirements.

4. System Implementation

We develop an application system based on blockchain, and the development process includes blockchain platform selection, programming language, data storage, and front-end development framework. The specific implementation is shown in Figure 2.

4.1. Blockchain platform selection

Based on the specific needs and privacy protection requirements of the credit banking system project, we have selected the appropriate alliance chain for the project. The reason for choosing is that it is more suitable for cooperation between educational institutions and enterprises. We choose China's domestic open-source blockchain Blockchain Open Consortium Operating System (FISCO BCOS). FISCO BCOS, as an enterprise-level blockchain platform, is an enterprise-level financial alliance chain underlying platform that is led by domestic companies and is open source, secure and controllable. It takes the actual needs of the alliance chain as the starting point, takes into account performance, security, operability, ease of use, and scalability, supports multiple SDKs, and provides visual middleware tools to significantly shorten chain building, development, and deployment. Application time.

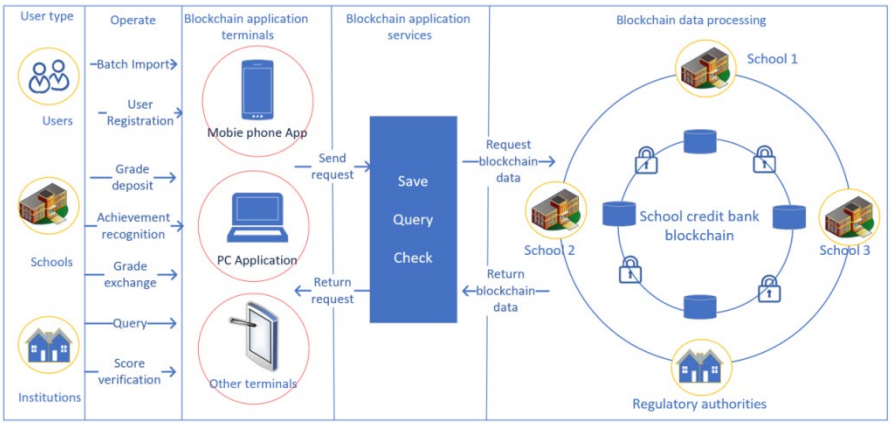

Figure 2: System Details Implementation Diagram

4.2. Smart contract development

Based on the project goals, we chose Solidity, which supports smart contract development, as the programming language, and used standard “Mythril” as the smart contract security check and audit tool to ensure the security of the smart contract code.

4.3. Data storage and management

Except for the data on the chain, we use MYSQL as a distributed database for the remaining data to achieve efficient and reliable storage of credit data. Adopting advanced data encryption and

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desensitization technology to ensure the security and privacy of sensitive data.

4.4. User interface and interaction

To provide a good user experience, we have chosen the mature and stable front-end development framework Vue.js as the user interface. Considering supporting mobile access, we adopt responsive design to develop corresponding mobile applications.

5. System Testing and Evaluation

In order to ensure the system correctness, performance and safety performance, we conducted functional testing and performance testing after the system development was completed.

We design detailed test cases based on system requirements and business processes, and use automated testing tools to execute test cases to verify the correctness of system functionality. We also record and track defects found during testing, as well as conduct repair and regression testing. Through load testing and stress testing to verify the stability and response speed of the system under high load conditions, we tested all functions to achieve the expected goals.

In order to ensure the data security and privacy protection of the system, we conduct security testing, vulnerability scanning, permission testing, and encryption and privacy protection testing. In addition, we also conducted a security audit of smart contracts. The security of smart contracts is critical and requires detailed security audits. The first step is to audit the smart contract code to check for possible logic errors and security risks; then use formal verification tools to check the correctness of the smart contract.

We evaluate the overall performance, availability and security of the system. The evaluation of performance indicators such as transaction speed, system response time, and data consistency are all very good, meeting the expected needs and goals.

Through comprehensive testing and evaluation, it can be ensured that the blockchain-based credit bank system reaches the expected standards before going online, laying a solid foundation for the official launch and promotion of applications.

6. Summary and Outlook

This study conducted in-depth discussion and practice around the design and development of a credit banking system based on blockchain technology. By analyzing the principles and core technologies of blockchain technology, as well as researching the challenges faced by the existing credit banking system, we designed and implemented a blockchain-based credit banking system. This system effectively solves the problems of data inconsistency, lack of trust and inefficiency existing in the traditional credit banking system by leveraging the immutability, transparency and smart contract functions of the blockchain.

Main results and implications:

(1) The system architecture is reasonably designed and has perfect functions. By designing a reasonable system architecture, blockchain technology is effectively applied to the credit bank system, solving core issues such as data storage, transaction processing, and credit authentication.

(2) The data model optimization is obvious. Through the optimization of the data model, the system can better adapt to the data structure and transaction processing mechanism of the blockchain, and improve the operating efficiency of the system.

(3) Good security and privacy protection. By applying encryption technology and permission control mechanisms, system security and privacy protection are achieved, ensuring the security of user data.

(4) The technology is verifiable and robust. Key technologies such as smart contracts and consensus mechanisms in the system were successfully implemented, verifying the feasibility and effectiveness of blockchain technology in the credit banking system.

Future outlook:

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(1) With the further development of blockchain technology, the scale and efficiency of the system can be achieved by introducing more efficient consensus mechanisms and data processing technologies in the future.

(2) By adopting more advanced front-end technology and interaction design, the user experience and interactivity of the system can be further improved.

(3) Good security and privacy protection. By applying encryption technology and permission control mechanisms, we have achieved system security and privacy protection, ensuring the security of user data.

(4) Using big data and machine learning technology on the blockchain, more intelligent data analysis and credit recommendation functions can be implemented in the credit bank system in the future.

In summary, the blockchain-based credit banking system has broad application prospects and unique advantages. Through further research and development, we are confident that we can promote the practical application of blockchain technology in the field of credit management and certification, and contribute to the innovation and development of the modern education system.

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