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Research Article

Design and Application of a Credit Bank Based on Blockchain Technology

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Abstract

Credit banks are an important way to build a lifelong learning system and a learning society. At present, various types of credit banks in China generally have limitations such as low efficiency in learning achievement certification and conversion, difficulty in ensuring the quality of learning achievement certification, and vague identification of credit banks. Blockchain technology has the characteristics of openness, consensus, transparent transactions, anonymity, tamper resistance, and traceability, which can effectively solve the centralized governance problems faced by the current construction of credit banks. This article elaborates on the current development status and characteristics of credit banks at home and abroad, analyzes the feasibility of combining credit banks with blockchain, and designs a blockchain based credit bank system architecture and processing flow to address the challenges of inconsistent credit conversion standards, low conversion efficiency, and data security risks in traditional credit banks. It proposes using block structure design to achieve secure and tamper proof credit data, proposes a smart contract based credit recognition and conversion method to achieve decentralized governance of credit banks, and establishes a blockchain based credit bank certification, conversion, and other application design models, which can provide technical support for the large-scale application of credit banks in the future.

Keywords

Blockchain, Credit Bank, Design, Application

1. Introduction

The main development goals of the document "China's Education Modernization 2035" are these goals that build a modern education system serving lifelong learning and form a new pattern of education governance with the participation of the whole society. In promoting the modernization of education ten key task clearly pointed out: speed up the construction of lifelong learning system, strengthening the construction of lifelong learning laws and regulations, build communication at all levels of education, connecting various learning outcomes of lifelong learning overpass, speed up the development of community education, elderly education, further promote the construction of learning organization and learning city construction [1]. The Outline of the National Medium-and Long-term Education Reform and Development Plan (2010-2020) clearly points out that "a system of credit accumulation and con-

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version for continuing education should be established to realize the mutual recognition and convergence of different types of learning results" [2]. Credit banks can build educational big data of lifelong learning for learners in various professional fields around the world, provide the possibility for the identification, accumulation and transformation of their learning results in different time periods, and effectively promote the practice and development of lifelong learning. The 20th report of the Communist Party of China proposed that "education, science and technology and talents are the basic and strategic support for building a modern socialist country in an all-round way", and clearly requires "promoting the digitalization of education and building a learning society and a learning country". The "Credit bank" originated in the United States, developed in Europe, and matured in South Korea. The US "Credit Link and Transfer System" has achieved a credit link from community colleges to more advanced four-year universities. The European Credit Conversion and Cumulative System (ECTS) is the most successful cross-national credit conversion system, realizing the mutual recognition of higher education credits among EU countries [3]. The Korean credit banking system is the closest system to the ideal "credit bank" to promote the lifelong learning model. It can not only verify learners 'learning within the formal higher education system, but also verify learners' learning activities in informal and informal learning places [4]. Due to the late start of the construction of "credit bank" in China, only a few provinces and cities participate in the construction. In 2022, "the establishment of a National Credit Bank for Vocational Education" was written into the newly revised Vocational Education Law for the first time. Up to now, China Vocational Education Credit Bank has released 839 learning achievement lists, established 22 million accounts for students, stored 1.8 million certificate results, and achieved credit conversion of more than 9,000 courses [5].

The development of national policy and the development of science and technology promote the vigorous development of credit banks, but the centralized governance problems such as illegal tampering of credit bank records in middle schools, and inconsistent identification and conversion of credit standards have become the bottleneck restricting the construction and large-scale application of credit banks [6]. Blockchain is one of the most revolutionary emerging technologies in recent years, with the characteristics of decentralized, distributed storage, transparent transaction, tamper-proof, and traceability [7], It has natural integration with credit bank, which can effectively solve the centralized governance problems faced by the construction of credit bank [8]. Based on this, this paper studies the use of blockchain technology to solve the problems of data security of credit banks and the inconsistency of credit certification and conversion standards, so as to realize the efficient and reliable application of mutual recognition of credits and the credit banking system.

2. Blockchain and Credit Banking

2.1. Blockchain Technology

Blockchain technology refers to the combination of data exchange, processing and storage technologies among multiple participants, based on modern cryptography, distributed consistency protocol, point-to-point network communication technology and smart contract programming language [9]. The blockchain architecture is mainly composed of the network layer, the transaction layer and application layer, as shown in Figure 1. Any Internet users who do not know each other can reach a credit consensus through contracts, peer-to-peer bookkeeping, and digital encryption, without requiring any central trust institutions [10]. The network layer mainly controls the establishment of the blockchain network and the transmission of information between all nodes. Its core content includes two parts, namely, networking mode and data transmission protocol.

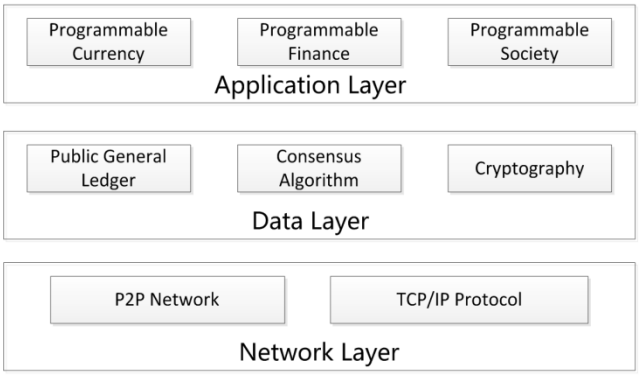

Figure 1. *Blockchain Architecture.*

2.1.1. Network Layer

The network layer mainly controls the establishment of the blockchain network and the transmission of information between all nodes. Its core content includes two parts, namely, networking mode and data transmission protocol. The network layer uses the P2P technology to realize the distributed network mechanism, and the main task is to ensure that the blockchain nodes can be effectively communicated through the P2P network. Through an automatic networking mechanism, nodes maintain communication by maintaining a public blockchain structure. The network layer has encapsulated the networking mode, message transmission protocol and data verification mechanism of the blockchain system. According to the actual application requirements, each node in the blockchain system can participate in the verification and bookkeeping process of block data by designing a specific propagation protocol and data verification mechanism. A

blockchain can only be entered into the blockchain after being verified by most nodes on the entire network.

2.1.2. Transaction Layer

The transaction layer is responsible for the establishment, inspection and preservation of transaction data. The core business of blockchain is implemented in this layer, and the main contents include address format, transaction format, global ledger and consensus mechanism. The core business of blockchain is realized by the transaction layer, that is, reliable and persuasive data transmission between two addresses, and address, transactions, contracts, ledger, consensus mechanisms and incentives are the main contents of its transmission. A series of data interaction processes between users are the "transaction" process in the blockchain, which is recorded and published in the blockchain network. The "address" in the blockchain is a disguise that users use to hide their true identity, Similar to Alipay or bank account, you can use the public key and use the encryption algorithm. In the encryption algorithm, the input address and the output address of the transaction are generated by the public key, and the private key information is saved by the user himself and used to generate the signature to verify the ownership of the required funds.

2.1.3. Application Layer

At present, the programs and interfaces of the application scenario are provided by the application layer, and the various applications installed in the application layer directly interact with users, so users do not have to explore the underlying details of the blockchain. At present, typical blockchain applications include digital currency applications, data storage applications, and energy applications.

2.2. Integration of Blockchain Technology and Credit Banks

2.2.1. Blockchain and Credit Authenticity

Blockchain technology can solve the problem of credit records and authenticity of results; the blockchain encryption technology ensures the reliable source of learning data, the time stamp technology records the time order of learners' credits, ensures the traceable and traceable, the consensus mechanism jointly maintains network data, data transparency, transaction anonymity, and all participants can verify the learning records and achievements of learners anytime and anywhere, effectively avoids false reporting, tampering with credit and even "credit rent-seeking", and improves the data identification [11].

2.2.2. Blockchain and Credit Standards

The blockchain technology can solve the problem of inconsistent conversion and certification standards of credit banks; the blockchain consensus mechanism can realize the certification and storage of learning achievements, and formulate the conversion contract of learners through consensus and smart contract, and realize the independent execution of learning achievement certification, storage and conversion, which can effectively improve the credibility and efficiency of learning achievement certification and conversion.

2.2.3. Blockchain and Credit Bank Decentralization

Blockchain technology can realize the decentralized implementation and application of credit banks; distributed ledger technology can be decentralized; relying on P2P network to establish data sharing between nodes, nodes; coding learning achievement authentication and conversion rules as intelligent contracts with automatic execution, automatic transmission and automatic verification, and the execution of the contract does not depend on trusted third parties or human intervention. The execution results can also be publicly inspected on the blockchain, providing the fairness and transparency of the contract [12].

3. Design of the Credit Banking System Based on the Blockchain

3.1. Architecture Design of the Credit Banking System Based on Blockchain

Core technologies such as distributed ledger, time stamp, consensus mechanism and smart contract in blockchain realize the core functions of credit banks such as recording, certification, accumulation, storage and conversion, and reduce human intervention. Combine blockchain technology and credit bank to build the six-tier architecture as shown in the figure 2 below:

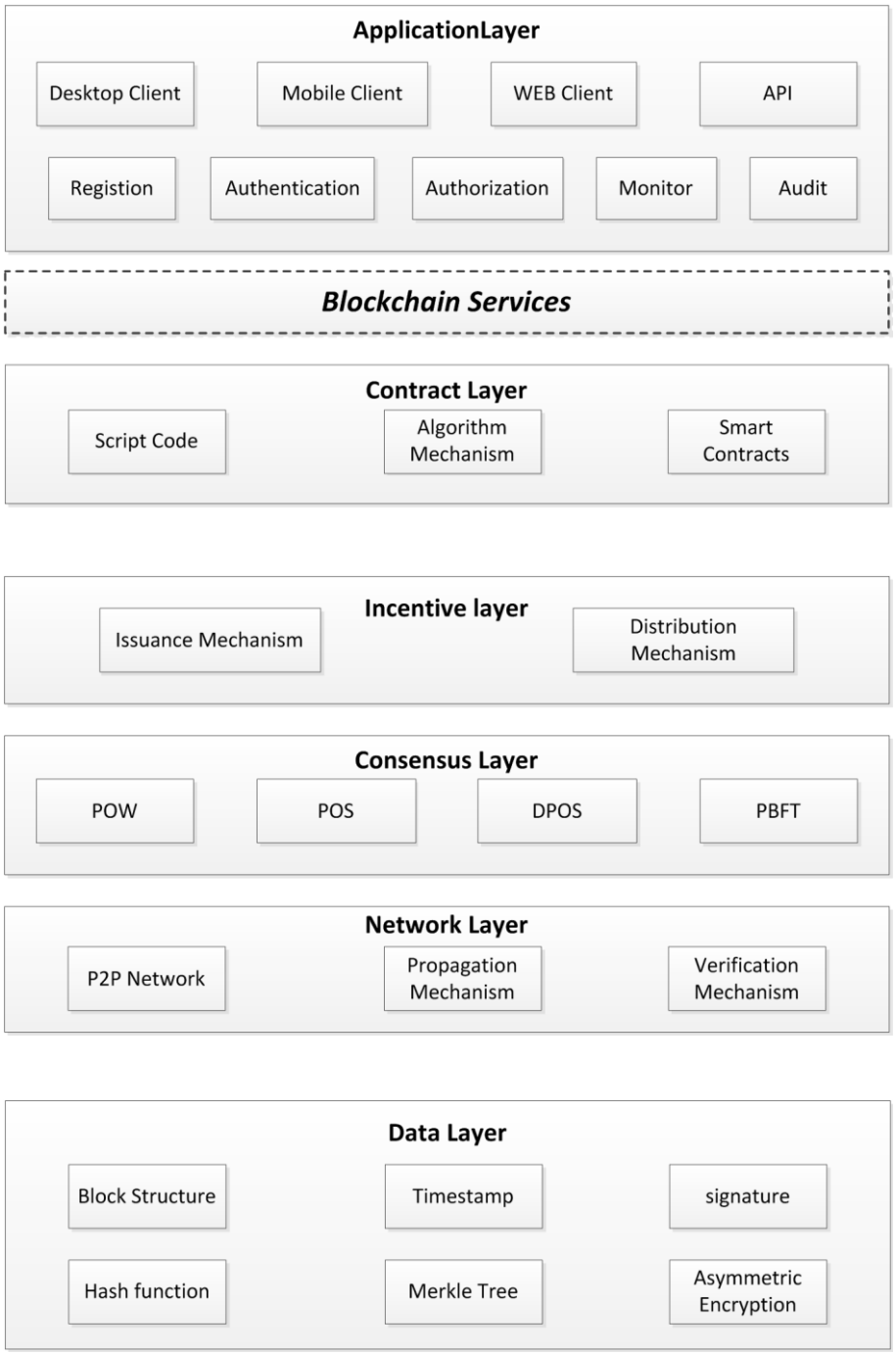

Figure 2. *Map of the credit banking system architecture based on blockchain.*

The system (from bottom to up) is mainly composed of data layer, network layer, consensus layer, incentive layer, contract layer and application layer, among which the blockchain service is the first five layers [13].

The data layer includes learning outcomes, learning track records and other data. Data structure using the traditional block chain chain structure, the learners in each stage learning results, learning trajectory structured data take structure chain storage, through hash algorithm and asymmetric encryption technology for learners learning data encryption, using the time stamp links blocks to form credit sequence block structure, ensure the credit data traceability.

The network layer includes distributed networking mechanism, data transmission mechanism and data verification mechanism, etc. Due to the complete P2P networking technology.

The consensus layer mainly includes various consensus mechanism algorithms that encapsulate the network nodes. The consensus mechanism determines who accounts and is crucial to the security and reliability of the whole system. The commonly used consensus algorithms mainly include proof of work mechanism (PoW), proof of equity mechanism (PoS),

certificate of commission equity mechanism (DPoS), and practical Byzantine fault tolerance (PBFT).

The incentive layer integrates economic factors into the blockchain technology system, mainly including the issuance mechanism and distribution mechanism of economic incentives. This layer mainly appears in the public chain and private chain. The incentive mechanism is also often like a game mechanism, so that more nodes are willing to follow the rules.

The contract layer mainly packages all kinds of scripts, algorithms and smart contracts. Smart contracts are responsible for the registration and issuance of contracts and the triggering and execution of contracts. The logic of the contract template or programming language defines the contract release to the blockchain. According to the logic of the contract terms, the execution is triggered by the user's signature or other time of the contract terms. The certification and conversion rules of learning results are coded as smart contracts to realize the automatic audit of learners' credit banking business, including the registration, identification and conversion process of learning results, so as to ensure the transparency and fairness of the certification and conversion of learning results.

As a part of directly interacting with users, the application layer encapsulates various application scenarios and cases of blockchain, realizing the main businesses including account opening, achievement input, achievement identification, achievement accumulation, achievement conversion and achievement query.

The operation process of the blockchain-based credit banking system is shown in the figure 3 below:

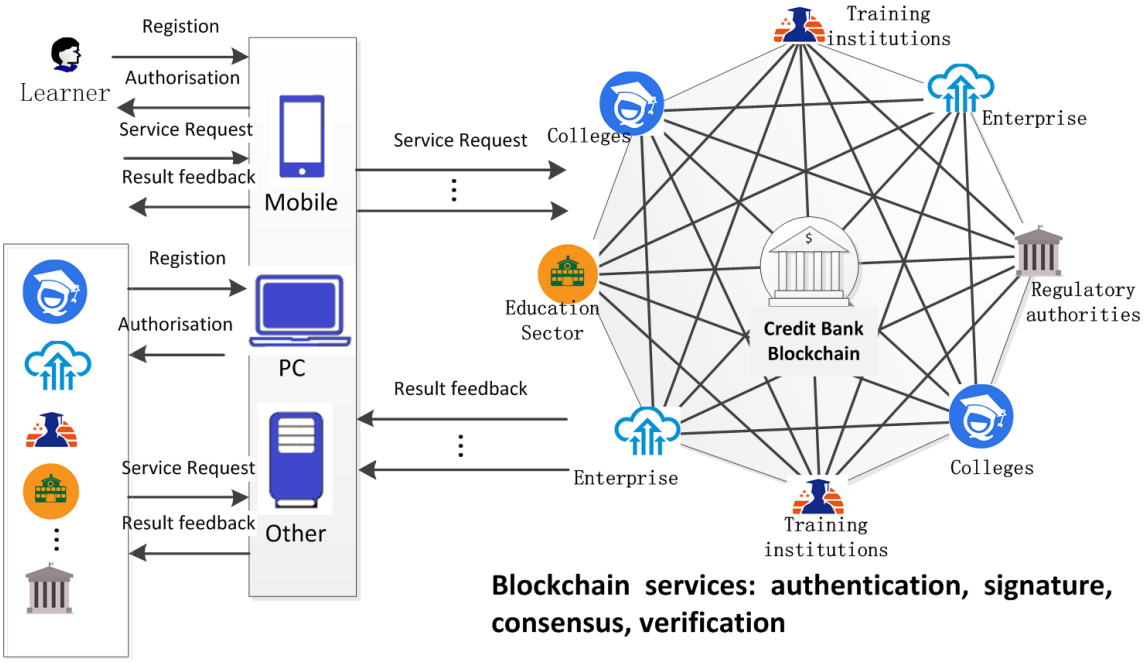

Figure 3. *Operation process of the credit banking system based on blockchain.*

The credit bank blockchain composed of relevant universities, training institutions, enterprises, regulatory departments and education departments is responsible for the application for entry, authorization, exit mechanism and verification of universities, training institutions, certification institutions and other node units. Learners apply for registration with the blockchain through the client. After obtaining authorization, they will participate in the course learning track and learning results in different institutions and publish them on the blockchain, and send requests for achievement authentication, accumulation and conversion. Each node on the blockchain verifies the authenticity of the learner's learning track and learning results, and queries, verifies, stores and approves in accordance with the mutually agreed results authentication contract and conversion rules, Finally, the results will be fed back to the learners to realize the implementation of the service application for learning achievement recognition, recording, conversion, storage and so on.

3.2. Key Technologies

3.2.1. Credit Bank Block

The block structure of the credit bank is shown in Figure 4. The block header packages the current version number, the previous block address, time stamp, random number, the target hash value of the current block, the root value of the Merkle tree and other information. The block mainly includes the transaction counts and transaction details. Transaction details are a ledger book, where each transaction is permanently recorded in a data block and can be checked by anyone. The Merkle tree in the block will digitally sign each transaction, ensuring that each

credit record and certification cannot be tampered with and repeated. All transactions will produce a unique Merkle root value through the Hash process of the Merkle tree.

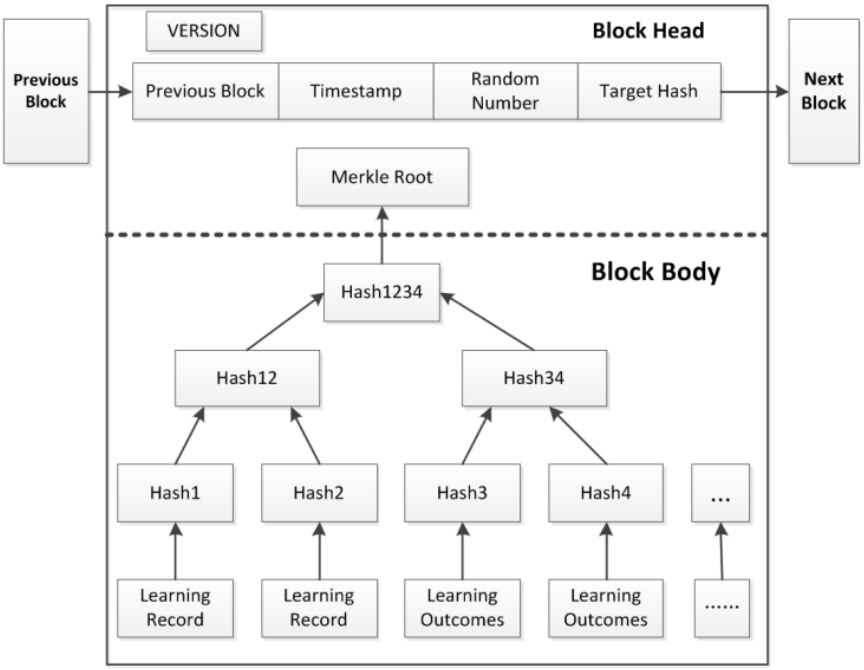

Figure 4. *Data Block structure of the credit bank.*

Merkle Root records the status of the current database. Leaf nodes show the hash values of each learning records and learning results in the database. All the information in the block header is hashed as parameters to verify the consistency of the ledger. Once the leaf node data changes, the Merkle root will also change, thus causing the block hash to change. Therefore, the consistency of the accounting ledger is guaranteed by maintaining the consistency of the Merkle roots.

3.2.2. Credit Bank Recognition

Learners can automatically match the learning results stored in the blockchain through the institutional learning results database of the achievement certification contract, complete the identification of credits according to the consensus mechanism, grant the learning results credits, and deposit the credits into the individual credit accumulation module of the individual learning account, so as to realize the transparent production, transmission and inspection of individual credits. The specific implementation process is shown in the following figure 5:

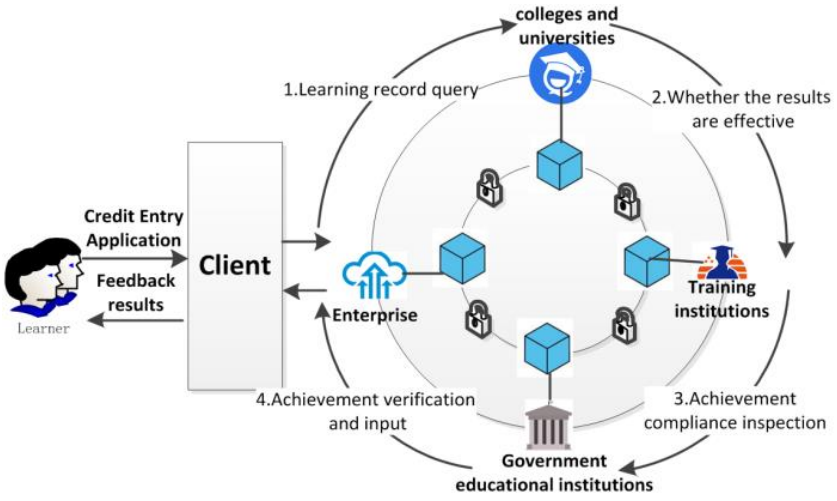

Figure 5. *Credit recognition and entry of learners.*

3.2.3. Achievement Transformation

Block chain on the agency node such as government education institutions, can release conversion rules coding, into the chain on other node consensus agree set conversion rules, learners accumulated learning results according to the results conversion consensus mechanism, through the results conversion rules coding intelligent contract, automatically implement the original results into other institutions learning results, and convert the learning results as the new generated object record in the block chain books, block chain on the complete keep each learning results conversion application times, conversion status, conversion success, conversion failure data records, to ensure the data transparent and fair.

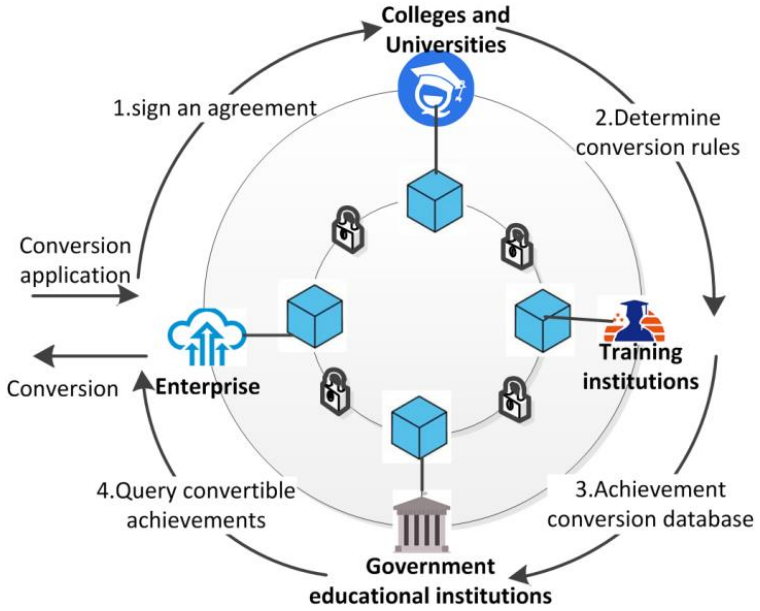

Figure 6. Mutual Recognition and conversion of credits in educational institutions.

Learners learning records and results in credit bank block chain books, according to the learning institutions, results type classification, storage, display, each block record learner account, name, results that time, service information, login block chain agency node can real-time query institutions results statistics, the results of the institutions and the institution of individual learners results storage details, etc.

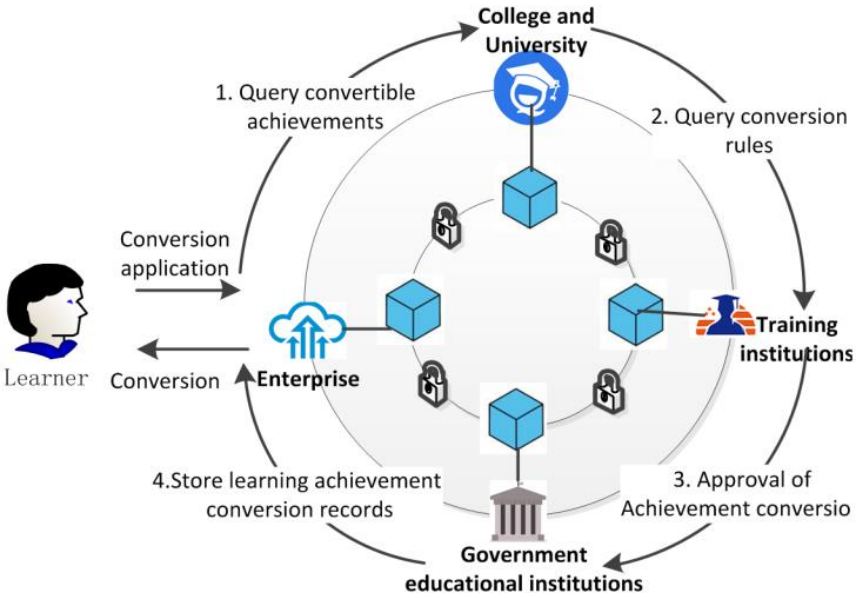

Figure 7. Learner credit conversion process.

4. Conclusion

Using block chain of decentralization, tamper-proof, traceability technology, personal learning account, learning achievements, accumulation and conversion data into block chain, for each learner to establish lifelong learning electronic archives, technically solve the multicenter institutions, low credibility, low efficiency, data security problems, for the development and application of credit bank provides a reliable technical support [14, 15]. This paper studies the key technologies such as the system architecture, workflow and credit accumulation and conversion based on blockchain. The next step will carry out application demonstration for a certain region or a certain university to form mature cases for promotion By collecting feedback information and summarizing experience, blockchain will become an important support for the construction of the credit bank platform and provide advanced technical support for the large-scale application of the credit bank.

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Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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