

# *Research on the Model and Implementation Mechanism of Online Learning Achievement Authentication Based on Block-Chain Technology*

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**Abstract:** Research on the implementation mechanism of block-chain technology to confirm and authenticate online learning results, in order to improve the liquidity and credibility of learning results data. Aiming at the problems existing in the certification process, such as low adaptability of the recognition concepts, single composition of recognition subjects, ambiguous recognition process, and poor flexibility of the recognition method and weak liquidity of the recognition results, a learning outcome certification model integrating block-chain technology was proposed. The model uses the "master-slave multichain" architecture to realize the classified storage of data, reduce the redundancy of block information, promote the two-way evaluation of online learning results and course quality, and solve the problem of fairness and credibility of certification results caused by the absence of course quality evaluation.

## 1. Introduction

In recent years, the depth integration of information technology and education and teaching practice has developed rapidly. From "Actively exploring effective ways of intelligent learning effect recording, transfer, exchange and certification based on block chain, big data and other new technologies" in 2018 Education 2.0 Action Plan, to "establishing and improving national credit bank system and learning outcome certification system" in 2019 China Education Modernization 2035, in 2022, "Strengthen the application of big data, cloud computing, artificial intelligence[1], block-chain and other technologies to drive the deeply integrated development of publishing" in the Implementation Opinions on Promoting the Deeply integrated development of publishing. The development trend of block-chain technology is shown in Figure 1.

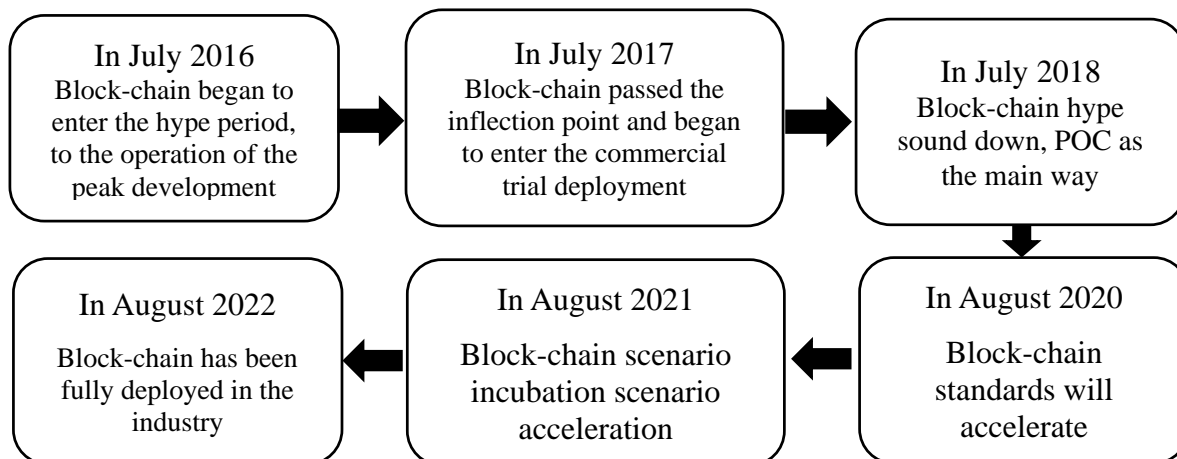


Figure 1: The development trend of block-chain technology.

## 2. Problems Existing in Online Learning Achievement Certification

### 2.1. The Prevalence of Educational Standards Has Resulted In Low Adaptability of the Concept of Recognition

The low adaptability of the recognition concepts caused by the prevalence of educational standards is mainly reflected in the lack of a clear recognition concept of informal learning outcomes and the lack of establishment of an informal learning outcomes recognition systems. In terms of the unclear concept of the recognition of informal learning outcomes, at present, in the concept of the recognition of learning outcomes in Chinese colleges and institutions, the understanding of the subjective status of students is not enough, and the evaluation standard of academic education is still used[2]. Universities and institutions in China have yet to form the identification concepts centered on students' development. In the actual identification process, students' technical skills and experience cannot be fully recognized, they cannot plan career development for learners, and the identified learning results cannot be recognized in the labor market. In terms of the non-establishment of an informal learning outcome recognition system, the main body of recognition is school teachers, and there is a lack of participation of other stakeholders. It is difficult to accurately evaluate the achievements of non-academic education because the criterion of recognition is mainly academic education. The identification method is single and rigid, with lack of flexibility and richness; the social recognition degree is low and it is difficult to realize the mobile conversion in the whole country[3].

### 2.2. Low Stakeholder Participation Results in a Single Body of Identification

The low participation of stakeholders leads to the single composition of the subject of identification, which is mainly manifested in the lack of government personnel and the lack of industry personnel. In the lack of government personnel, participation, mainly reflected in the lack of government personnel identification standards and the lack of government personnel unified identification level two dimensions[4]. The lack of participation of industry personnel is mainly reflected in the lack of professional personnel to control the identification process and the lack of industry personnel to participate in the evaluation process. Therefore, in the evaluation group for accreditation materials, a panel of 3-7 experts shall be set up according to different qualification levels of applicants. The panel shall be composed of academic personnel and external experts, and a certain proportion of industry and enterprise personnel shall join the accreditation group[5].

### **2.3. The Delayed Construction of Laws and Regulations Leads to the Ambiguity of the Identification Process**

The fuzzy identification process caused by the lag of laws and regulations is mainly reflected in the lack of relevant national legislation and the lack of relevant national policies. The lack of relevant national legislation mainly includes the lack of provisions on credit accumulation and conversion in the national education law and the lack of provisions on credit accumulation and conversion in the national special law. The lack of relevant national policies mainly includes the lack of clear requirements for the qualified developers and the lack of quality supervision and management rules of identification results. In our country, in order to ensure the qualifications obtained by learners in educational institutions are recognized by society, we need to strictly audit the identification quality of education training institutions. This link should be achieved through the curriculum audit and the organization audit[6].

### **2.4. Lack of Experience of Organizational Personnel Resulting In Poor Flexibility of the Identification Method**

The lack of experience of organizational personnel caused by the flexibility of the identification method is mainly reflected in the lack of experience of the identification personnel and the identification method of the single two aspects[7]. The inexperience of certificated personnel is mainly manifested in the lack of advanced foreign experience learning and regular training of certificated personnel. As for the unitary value of the recognition method, it is mainly reflected in the limited recognition materials submitted by learners and the imperfect construction of the relevant information platforms.

### **2.5. Weak Foundation of System Operation Resulting In Weak Liquidity of Recognition Results**

The weak foundation of system operation leads to the weak liquidity of recognition results, which is mainly manifested in two aspects: the difficulty in the construction of cooperative mechanism between regions and departments and the difficulty in the credit management of institutions or institutions. We are actively practicing the national qualification frame system and the national credit bank system at present[8], which requires our country's education system to implement the credit management system reform. This reform is not achieved overnight, but based on the introduction of credit bank, strengthen the application of block-chain technology in the credit bank, and store students' learning experience, such as academic performance, practice training, training experience and work experience, in the national credit bank, so that learners, educational institutions and employers can view relevant information anytime and anywhere[9].

## **3. Construction and Internal Mechanism of Online Learning Achievement Certification Model Based On Block-Chain Technology**

### **3.1. Principles of Scheme Design**

In view of the above problems existing in the current practice of online learning achievement certification, this paper intends to build a block-chain-based online learning achievement certification model, as shown in Table 1.

Table 1: Problems of the existing online learning achievement certification model and solutions of this model

Type	Existing Problem	Model Characteristics and Corresponding Schemes
Result certification	The authentication business process is complex	smart contract
	Open online courses vary in quality and standards	"Master-slave multi-link" data architecture
	Credit credibility and validity are not high	
	There are difficulties in learner identity authentication	Real name authentication based on block-chain
	Only the learning input is emphasized, while the learning output is ignored	The credit transfer method is evaluated according to the double standard of "learning quantity" and "learning outcome"
Privacy & Security	Security of user information	Crypto tree storage structure, imtamper of block-chain
	Learning data is susceptible to manipulation	
	Authenticity of learning outcomes	
	Diploma fraud	
Interoperability and accessibility	Lack of adjustment rules for unexpected situations	Editable block-chain based on chameleon hashing technology
	Database stress caused by access	Distributed and decentralized
	Learning outcomes are not traceable	Uniqueness and traceability of blocks

### 3.2. Model System Architecture

The nodes are mainly involved in the system architecture of the model include: user end (learners), resource end (universities, course resource providers, and other organizations), and inquiry end. In a block-chain network environment, all process operations operate on these three ports and are automatically executed according to smart contracts (See Figure 2).

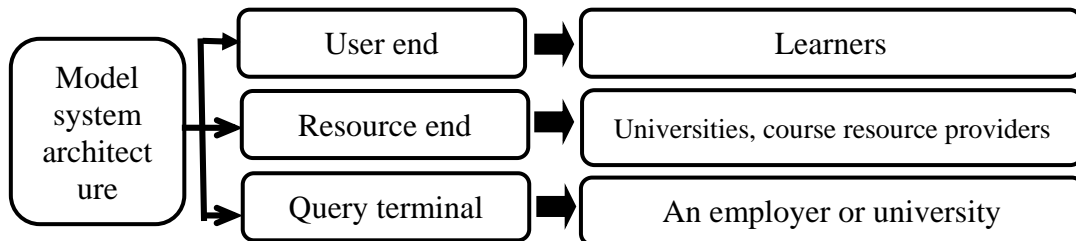


Figure 2: The nodes mainly involved in the system architecture of the model.

#### (1) User end

When learners register to join the system platform, they need to enter the corresponding personal information and send it to the third-party regulator for verification. Because in the block-chain network, all data information is encrypted and stored. Therefore, the storage and transmission of personal information is difficult to tamper with or steal with a certain degree of security. Only after

the verification is passed can the learner join the block-chain network. At this time, the system will create a unique block chain address and corresponding public and private keys for the learner. After successfully joining the block-chain network, learners can independently choose courses for learning, each course has its unique ID, and will be stored in the main block chain along with learning behavior data, exam results and other information[10].

(2) Resource end

The resource side is mainly composed of the educational resource (course) provider and a certificate issuer, which is not only the maintainer but also the supervisor of the system. When a new resource node attempts to join the block-chain network, it also requires certain qualification information and sends the information data to other regulators for review. When the verification is successful, the system will generate the corresponding block chain address, public and private keys.

(3) Query terminal

When an organization (such as an employer or university) needs to query the learning achievement of a learner, the learner sends his/her private key to the enquirer. On the basis of obtaining the private key and matching the public key, the enquirer can query the learner's personal information and the proof of learning results. In addition, through the same process as above, the enquirer can also verify the authenticity of the learning certificate provided by the learner by comparing the signature message, block address and other contents on the achievement certificate.

### 3.3. Data Model Structure Design

This paper designs a "master-slave multilink" data link architecture. The main chain is the learning outcome chain, and the student information chain and the course information chain are subordinate chains. The three chains are organically combined to form the data model of online learning outcome certification. This model classifies and stores all kinds of data, which not only evaluates students' academic performance, but also evaluates the quality of courses.

## 4. Implementation Mechanism of Online Learning Achievement Authentication Based on Block-Chain Technology

In this paper, the identity information and learning results are authenticated by a hybrid consensus mechanism which combines the proof of equity mechanism and the practical Byzantine fault-tolerant algorithm. Course quality evaluation is realized by using "master-slave multichain" data link architecture and smart contract. Some information in block-chain network is optimized by using chameleon hash technology. Multiple signatures are used to ensure the security and authenticity of the authentication process (See Figure 3).

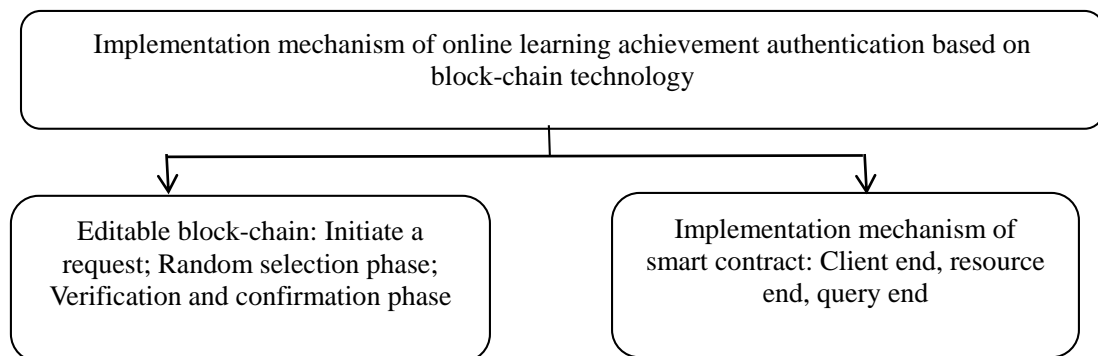


Figure 3: The realization mechanism diagram of online learning achievement certification based on block-chain technology.

## 4.1. Editable Block-Chain

In most cases, the data on the block chain should be unmodified, but in some specific cases, making changes to the history of the problem is conducive to the stable operation of the system. To this end, the model uses chameleon hashing technology to make changes to some problematic data in the block chain. The process is mainly divided into three stages.

### (1) Initiate request

When a user sends a modification request, the system obtains the block address of the user and broadcasts the modification request to the whole network. After other users in the block-chain network receive the request, if more than half of the users agree to modify the request, the system will record the user's request signature and broadcast it.

### (2) Random selection phase

When the modification request is determined, the system will adopt a distributed random number generation protocol, so that multiple parties can jointly generate a random number. This random number determines to whom (a certain user) permission to modify the block is assigned. In this process, we introduce the random number generation protocol to ensure that every user has the same chance to obtain the permission to modify the block, to avoid attacks against users with the permission to modify the block in advance.

### (3) Verification and confirmation phase

The user who has the permission to modify the content changes and other nodes verify whether the changer is the selected node and verify the changed block information. If the validation is successful, the latest block information is saved; if the verification fails, the distributed random number generation protocol is reused to modify the selection of users with permissions, and the above process is rerun.

## 4.2. Implementation Mechanism of Smart Contract

The implementation of smart contract mainly lies in the matching and verification of learner information and learning results, as well as the automatic recording and supervision of learning process data and learning results. In this model, three types of smart contracts are designed from the perspective of contract subject, as shown in Figure 4.

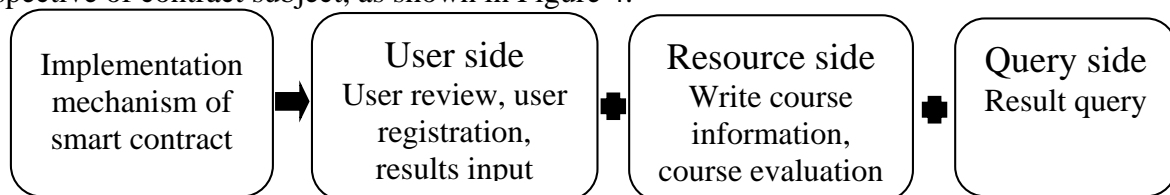


Figure 4: Smart contract of online learning outcome certification model.

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