

# The Key Technologies of Blockchain and the Design of Smart Education Platform

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**Abstract:** Blockchain technology has the characteristics of decentralization, immutability, traceability, high transparency, high credibility, etc., using key technologies such as blockchain identity authentication, learning records, resource innovation, copyright protection, etc., to cope with the challenges faced in the design process of the current smart education platform, and puts forward the overall design framework that reflects the resource layer, data layer, network layer, consensus layer, contract layer, service layer, and application layer, forming a blockchain to empower smart education resource protection, sharing management, property rights management, knowledge currency, credit conversion, The design ideas of certificate certification and other aspects will surely provide strong support for the design of the smart education platform, and also provide a better path choice for the agglomeration and development of private higher education in the Guangdong-Hong Kong-Macao Greater Bay Area.

**Keywords:** Blockchain technology, Smart education platform, Private higher education, Agglomeration development.

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## 1. Introduction

Blockchain technology is leading the great changes of data storage and resource exchange in smart education, smart cities and other industries, and its trusted mechanism will further lead to new educational model changes. Since 2019, China has taken blockchain as an important breakthrough in independent innovation of core technologies, defined its main direction, and accelerated the development of blockchain technology and industrial innovation.

At present, while blockchain technology has attracted the attention of all walks of life, the education industry is also using blockchain technology to explore and solve educational problems and promote the innovation and development of the education industry. For example, The MIT Media Lab Laboratory (2021) of MIT developed the learning certificate platform and the corresponding mobile app [1] by using blockchain technology; Nusantoro H et al. (2021) think that the advantages of blockchain technology, such as security, traceability and data transparency, point out the development direction for the development of wisdom education [2]; Sathya A R et al. (2021) deeply studied the challenges faced by blockchain in education, and thought that blockchain technology could provide solutions for digital signature in smart education [3]; Sanmi et al. (2021) proposed that blockchain technology can not only store information in the form of confidential text safely, but also protect the rights and interests of original knowledge and achievements [4]; Rafalam et al. (2022) proposed a solution to problems related to online education based on blockchain [5].

To sum up, the research and development of the new models of "blockchain+education" and "blockchain+learning" has become increasingly mature. Under the important development trend of higher education agglomeration, it is very important to strengthen the research of key technologies of blockchain and improve the performance of smart education platform. Based on the key technologies of blockchain, this study puts forward the framework, ideas and strategies of high-quality resource

allocation of smart education, with a view to providing path selection strategies or suggestions for the agglomeration development of private higher education in Guangdong-Hong Kong-Macao Greater Bay Area from the perspective of smart education platform performance.

## 2. The Main Characteristics and Key Technologies of Blockchain

### 2.1. The Main Features of the Blockchain

The blockchain is actually a fully distributed peer-to-peer ledger database, through a special algorithm, the information within the block, arranged chronologically, and the use of encryption technology to connect the block data, thus forming a sustainable growth and can not be forged and tampered with the distributed ledger. Blockchain technology mainly includes the following three characteristics.

(1) Decentralization. Decentralized is the most essential and significant feature of the blockchain, which is also the biggest difference between the blockchain and the traditional distributed database, its significance is no longer dependent on a traditional management agency or hardware facilities for data storage and management. For example, when paying with PayPal, data management and storage still rely on the PayPal company's data platform, while in the blockchain, all data is stored in each block of the network node. Each time a new transaction is generated, all the network nodes participating in the block will update the data, and each network node updates and maintains the same set of ledgers to achieve the purpose of data decentralized storage. At the same time, all network nodes in the blockchain rely on the consensus mechanism to maintain a clear historical transaction record.

(2) Cannot be tampered with and new data can only be appended. The blockchain is a chain structure based on "block + chain", as shown in Figure 1. Its data structure is composed of ordered units of all blocks inside, Each block encrypts all the information in the block through the Hash algorithm, generates a hash value, and the block header of each block

contains the hash value of the previous block, and these hash values are nested layer by layer, and finally all the blocks are concatenated to form a blockchain. Due to the deterministic, pseudo-random, one-way function and anti-collision characteristics of the hash algorithm, each hash value in the

blockchain is unique and irreversibly derived, and it is through this linkage mechanism that the blockchain ensures its own reliability, and once the data is written, it will form a blockchain structure that cannot be tampered with and can only append new data.

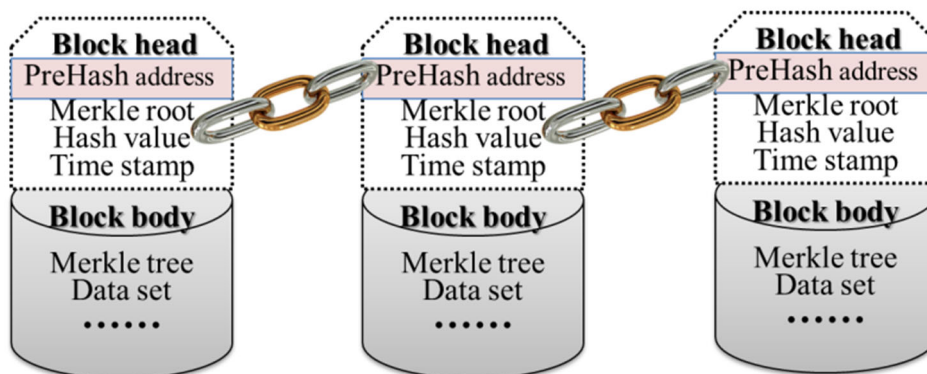


Figure 1. Schematic diagram of chain structure of blockchain

(3) Timing and transparency. Each block header of the blockchain contains the timestamp when the block is generated, and the automatically generated timestamp makes the information more credible, because it not only makes the time series relationship between the block and the block very clear, but also enhances the immutability of the blockchain data. Blockchain technology is open source, in addition to the private information of the transaction party, all data on the blockchain can be accessed, this information can be accessed through the open interface, the application can also be developed through the open interface, the transparency of the entire system is very high.

## 2.2. Key Technologies of Blockchain

### (1) User Identity Authentication Technology

When users of the smart education platform register on the blockchain, an identity information profile is created. Different types of users create different identity information, for example, when a student user registers, a file including name, school, school number, major and other information will be created; when a teacher user registers, a file including name, school, work number, title and other information will be created; when an employer registers, an enterprise file including enterprise name, social unified credit code and other information will be created. After the identity information is audited and registered successfully, the user will get a pair of public and private keys. The public key is open to all members in the blockchain, similar to our email address, while the private key is the key to identity verification in transactions, equivalent to our email password. The asymmetric encryption algorithm is used to encrypt the user's identity information, which can effectively prevent tampering with the identity information.

### (2) Learning Data Recording Technology

The Smart Education System records and preserves all the learning data of each learner during the self-learning process. With the accumulation of learning data, in the smart education resource platform, personal learning big data will be slowly formed, and these process data cannot be tampered with, can be traced, and help students to evaluate learning ability and certify learning outcomes. Because the intelligent education

system is mainly composed of cryptography and code, with its own defense system, each node is a center, and each node is a scattered individual, if you want to destroy the data recorded on the wisdom education chain, you must attack the system composed of all nodes at the same time, and defeat all nodes at once to delete the data recorded inside. If you can't defeat all the nodes at once, after the attacked node is restarted, the data will be re-passed from the other nodes to save the record. This mechanism of recording data through the devices of each node solves both problems such as data security and data trustworthiness.

### (3) Resource Innovation Mechanism and Copyright Protection Technology

The key to measuring the value of smart education platforms lies in the quality, diversity and sustainability of their educational resources. The educational resources mainly originate from the original creation of each teacher in the alliance chain, due to the characteristics of blockchain decentralization, all teachers and students in the alliance chain can create or obtain educational resources according to the actual situation, thereby enhancing the innovation and diversity of high-quality educational resources. Markdown can also be embedded in the platform client, so that resource creators can easily import Word, PPT, PDF, pictures, audio and video and other format files, and can edit and publish the resource online in real time. Markdown has an auto-layout feature that allows asset creators to focus on the content and not worry about the design of the layout. At the same time, because the blockchain is composed of distributed data blocks with information, each time data information is added, it must first be verified and then recorded according to the time series of the addition. This mechanism solves the copyright dispute in the process of sharing educational resources, and uploaded educational resources will automatically generate timestamps when they are written to the blockchain, and the author's digital signature will be added, and finally linked to the blockchain.

### **3. The Current Challenges in the Design of Smart Education Platforms**

#### **3.1. Challenges to the Certification of Learning Outcomes in Smart Education**

In the traditional educational environment, people's learning results are usually stored in different educational institutions in the form of documents, and when it is necessary to find verification, it is not only time-consuming and laborious, but also often has the risk of loss and damage. Each learner has little autonomy over the learning outcomes and learning records at all stages. Because there are structural contradictions, imbalances in the proportion of human resources allocation, etc., when the employer verifies the learning experience and learning results of the learners, it lacks efficient and convenient technical means, resulting in the authenticity of the learning experience being difficult to verify, and the authenticity of the academic certificate is also difficult to identify. If the proliferation of fake academic qualifications is caused by poor verification technology, then learners are unfair in competition for employment and promotion, and the credibility of education is greatly challenged.

#### **3.2. Challenges of Personalized Learning Data Sharing**

In the learning society, smart education takes MOOCs as the main way of diversified learning, and the content of learning covers major professional fields and multiple aspects of social life. According to official Chinese statistics, as of the end of February 2022, the number of online MOOCs (large-scale open online courses) in China has exceeded 52,500, the number of course selection has reached nearly 800 million, the number of registered users has reached 370 million, and the number of MOOCs and the scale of application have ranked first in the world[6], and have maintained a rapid growth trend, with more and more learners of different ages joining the globalization process of MOOCs. Therefore, the smart education system should adhere to the "learner-centered" education concept, support learners to freely choose personalized modules to customize learning resources according to their own development needs, and support teachers to design targeted teaching models through personalized data on learners' behavior patterns, preferences and styles. At present, the data islanding phenomenon between various online education groups and learning platforms is very serious, learning data is discretely stored in different education platforms and institutions, lack of transparency, how to achieve cross-platform, cross-institutional personalized learning, so that learners' learning data, become personalized learning data that can be shared, which is a challenging topic that current smart education must face.

#### **3.3. Challenges to an Open Educational Environment**

In recent years, for the vigorous development of smart education, Internet platforms such as Wikipedia, Baidu Encyclopedia, and Khan Academy have provided massive and diversified educational resources for educators and learners around the world. However, in the environment of smart education, although it provides many conveniences for

each learner to carry out personalized independent learning, due to the lack of a sound intellectual property protection mechanism, issues such as the authority authentication of educational resources, the ownership of knowledge copyright, and the efficiency of knowledge services are still very prominent, which has caused great distress to educational institutions, educators and learners. In the process of learning, academic papers written by educators, creative works produced and published, and various electronic materials such as learning summaries and teaching summaries are easily stolen due to the lack of effective protection measures, and intellectual achievements such as ideas and ideas informally published in the online learning community are often abused, which seriously affects the enthusiasm of educators and learners to create.

### **4. The Blockchain Empowers the Design of the Smart Education Platform**

Blockchain technology can better solve the problems of digital resource confirmation, educational resource quality, learner dynamic monitoring and lack of authenticity of learning records in the process of resource sharing of smart education platforms, mainly because blockchain technology has the characteristics of distributed decentralized storage, point-to-point transmission, collective maintenance, information disclosure, and immutability. In the three types of blockchain, public chain, alliance chain, and private chain, the alliance chain has both authorized nodes and public nodes, and its consensus management mechanism can ensure the quality of smart education resources, while also taking into account the security and reliability of the platform. Therefore, the design strategy of the smart education platform can build the overall design framework based on the alliance chain, and deploy the whole from different levels such as the resource layer, data layer, network layer, consensus layer, contract layer, service layer, and application layer, as shown in Figure 2.

(1) Resource layer: It mainly includes the information system of the production, packaging, uploading, review, broadcasting and other aspects of smart education resources and the data generated.

(2) Data layer: The basic data composition is shown in Figure 3, the basic data is stored in the data layer with a data structure unique to the block, the hash algorithm is adopted, the time stamp is stamped, and the data transmission mechanism between the blocks is used to work.

(3) Network layer: Through the authentication mechanism, node permissions, etc., combined with the peer-to-peer distributed network protocol, the blockchain data is transmitted and stored in each node.

(4) Consensus layer: mainly using Proof of Stake (PoS) or Delegated Proof of Stake (DPoS) [7], based on the consensus mechanism of interests, proof of equity represents the proof of resources, the node that can have the right to book in the blockchain system is the node with the highest rights and interests, and also the node with the most resources, this mechanism gives the education department, colleges and universities more rights and interests, higher authority, and even the blockchain participants can be reviewed.

(5) Contract layer: Include the laws and regulations related to the copyright of educational resources, the credit scheme for obtaining academic qualifications, the learning process

and the evaluation criteria for achievements, etc. into the smart contract of the blockchain, and then perform the regulatory functions of the resource platform by setting trigger conditions and response actions in advance to improve the efficiency of supervision.

(6) Service layer: In the process of platform operation, the service layer builds a database on the basis of collecting basic data, transaction data, learning data, etc., and then provides

users with basic data management services, personal learning big data analysis services, resource sharing services, course completion verification services, and copyright dispute confirmation services.

(7) Application layer: mainly through the construction of a smart education resource platform, to provide services for education departments, universities, employers, teachers and students, to break the barriers of traditional online education.

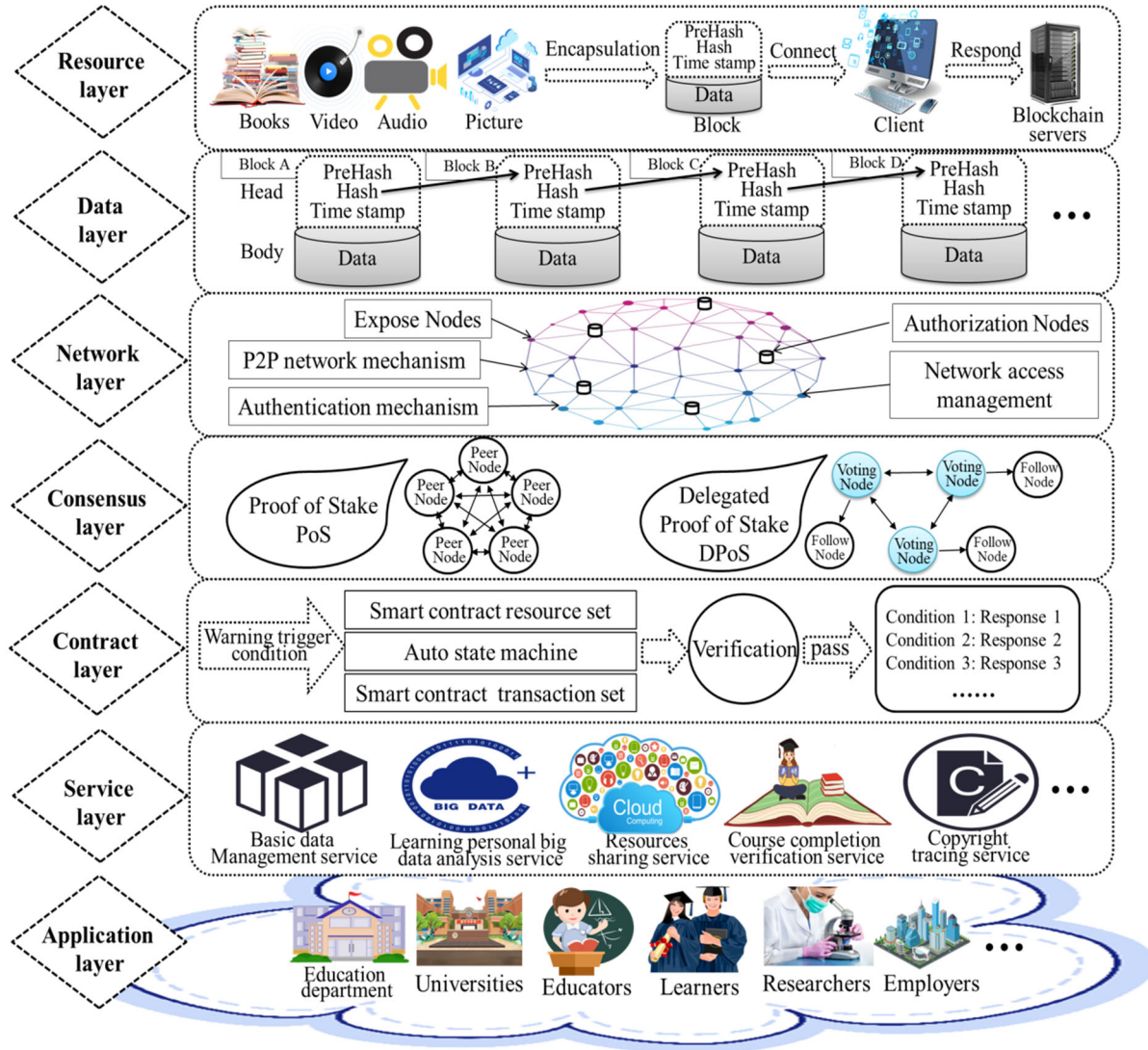


Figure 2. Overall framework of intelligent education platform design

## 5. Strategies for Blockchain Empowering Smart Education Platform Design

### 5.1. Resource protection and sharing management of smart education platform

Blockchain technology is suitable for solving problems such as data sharing, identity authentication, access permission, privacy protection, data security, and timeliness and traceability of data exchange, reducing the complexity of the system, improving the reliability of resources, and promoting the continuous improvement of data sharing. Through blockchain technology, more educators, learners, educational institutions, etc. can be absorbed into the shared network, so as to achieve a wider range of data sharing and

resource protection.

(1) Blockchain empowers resource protection. At present, for innovative knowledge and original resources, the smart education platform is creating a new protection model based on blockchain technology, which can automatically save, track and protect the various views expressed by learners. Blockchain-based distributed storage and traceability not only help stimulate learners' enthusiasm for innovation, but also generate visual knowledge network diagrams. With the continuous deepening of knowledge perspectives, an expandable group wisdom network is finally formed. Using blockchain technology, the establishment of a complete and smooth information flow and immutable signature authentication, in the smart education system, this resource protection mechanism, through the blockchain technology to create a knowledge network block, the formation of

knowledge network graph, can achieve decentralization or multi-centralized accurate traceability and full trust.

(2) Blockchain empowers shared management. Since the distributed ledger technology of the blockchain can achieve decentralization, in terms of educational resource sharing, the traditional resource library that relies on intermediary institutions can be transformed into a distributed open sharing model, and the acquisition of resources directly adopts point-to-point operation, the process is more convenient, and the

further opening and sharing of educational resources is effectively promoted. In terms of educational resource management, educational resource transaction records can be safely and transparently recorded in the blockchain by carrying educational resource registration, educational resource review, and educational resource transaction smart contracts, and various automated management of educational resources can be carried out. Schematic diagram of intelligent contract work is shown in Figure 3.

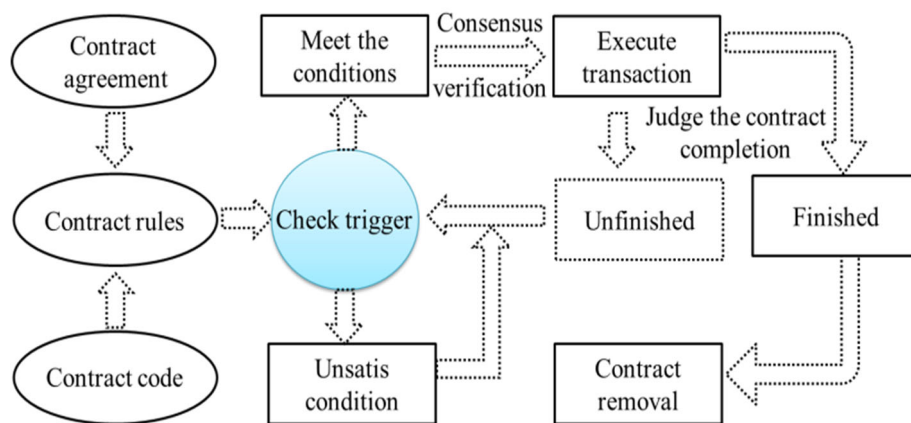


Figure 3. Working principle of smart contract

Through the automatic operation of smart contracts, the intermediary platform can be removed, the efficiency of resource management can be greatly improved, and the cost and error rate of smart education management can be greatly reduced, so as to create a green and low-cost resource management process and build a new form of sharing high-quality educational resources.

## 5.2. Property Rights Management and Knowledge Currency of Smart Education Platform

Blockchain is a new technical concept and technical means. The blockchain has the characteristics of immutability, encryption algorithm, openness and transparency, and process traceability, which is organically compatible with the generation, protection and circulation of digital intellectual property rights, and provides a new breakthrough for the protection of digital intellectual property rights. In the context of digital technology, blockchain has laid a key foundation for distributed collaboration and promoted the development of smart education, which is of great significance for intellectual property management, protection, innovation and development.

(1) Blockchain empowers property rights management. Blockchain can track the use of intellectual property rights, monitor the credibility of intellectual property rights, and also accurately locate each user. Therefore, with the technical support of blockchain, the mode of intellectual property management will produce significant changes, and blockchain will become an important basis for managing, increasing, opening and protecting intellectual property rights. In the field of intellectual property management and protection of smart education, blockchain will not only record the date when the creator released the results of each learner's creation, but also automatically track the resources used in the creation of these results, as an important proof of the first release. This is an important basis for innovation and reuse of

educational resources, and the important significance of this mechanism is to allow educators and learners to have better copyright protection and more secure and efficient property rights management for the knowledge results they create.

(2) Blockchain empowers knowledge currency. In a smart education environment, the original works created by educators and learners should be permanently recorded, shareable and tradable. A wisdom education system based on blockchain technology can create knowledge transaction and knowledge currency blocks, similar to the Bitcoin mechanism. While eliminating intermediaries and reducing management costs, the traceability and high transparency of blockchain can also accurately track the degree of reuse of knowledge resources and allow the creators of knowledge to obtain a certain knowledge currency based on the reuse rate of resources. Similarly, among teachers and researchers, if such a reward system is introduced, then they can be rewarded based on the reuse rate of their knowledge resources, and even the reuse rate of high-quality resources can be determined based on the number of times the resources are automatically scanned, and knowledge currency can be automatically granted accordingly to reflect the economic value of knowledge.

## 5.3. Credit conversion and certificate certification of the smart education platform

Using Blockchain's Distributed Ledger Technology (DLT), learners' education and training data can be stored chronologically and in the form of blocks in a distributed manner in a smart education system. Relying on the advantages of decentralized data storage, synchronization and replication of DLT technology, each network node maintains a complete set of data copies, which can safely and permanently store personal information, learning results, and personalized development data such as enterprise training and project development on the network.

(1) Blockchain empowers credit conversion. It is difficult to identify and convert the credits obtained by learners through online learning, which is the biggest bottleneck of smart education at present. On the wisdom education platform, learners get credits and certificates through online course learning and examinations, which is the main motive for learners to learn online, but the identification and conversion of credits across platforms must ultimately rely on blockchain technology to solve. By building a smart education credit bank through blockchain's smart contract technology, the credit certification and conversion protocol is written as a credit identification and conversion smart contract in the contract layer, and the smart contract is automatically executed after reaching the target specified in the protocol to complete the accurate identification and fair conversion of credits. Most importantly, with the credit bank built by blockchain technology, learners can have consistent and effective credit records in different regions and schools, and they can also realize credit records, inquiries and conversion conveniently, quickly and at low cost.

(2) Blockchain empowers certificate authentication. Back in 2015, MIT created a learning certificate platform using blockchain technology that can certify various certificates owned by learners online[8], and the certification system provided by the Blockcerts Innovation Project currently released by the institution can be used to certify credits, professional certificates, transcripts, degrees, etc. The Holberton School of Software Engineering has been using blockchain to record learners' credentials since 2017, becoming the first university in the world to use blockchain to record academic credentials information[9]. This was followed by 2018, Yango University in Fujian, China, also issued a digital graduation certificate based on blockchain technology[10]. Blockchain a large number of use including hash algorithms, asymmetric encryption, digital signatures and other modern information security and cryptography technical achievements, when the demand side needs to carry out certificate authentication, by the smart education management platform to process the authentication information, and with the help of the blockchain to store digital signatures related to the certificate, in the certificate authentication only need to be compared with the digital certificate stored on the blockchain, you can verify the authenticity of the learner certificate, providing reliable, secure, credible proof.

## 6. Conclusion

In the field of smart education, blockchain technology relies on its characteristics of decentralization, traceability, high transparency, and high trustworthiness, which not only greatly promotes the trusted storage, trusted exchange, and open sharing of data, but also gives strong technical support to the emerging learning models that follow. With the innovative application and rapid development of blockchain technology in different fields, more applications based on blockchain technology will emerge in the field of education, and blockchain technology will also provide strong support for the effective allocation of smart education resources, and provide better path choices and policy suggestions for the agglomeration and development of private higher education

in the Guangdong-Hong Kong-Macao Greater Bay Area.

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