RESEARCH ARTICLE

RESEARCH ON THE APPLICATION OF BLOCKCHAIN TECHNOLOGY IN THE CONSTRUCTION OF EDUCATION CREDIT SYSTEM

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ABSTRACT

Under the background of COVID-19, the process of education informatization, digitalization and intelligence has been greatly accelerated. Block chain technology has the characteristics of decentralization, distributed data storage and high data reliability. Its application in education domain is conducive to solving the problems of data barriers, information security and trust crisis in the process of education informatization. It is of great significance for integrating education data resources and systems and building an education credit system. For students, teachers, schools and other four types of education credit subjects, this paper analyzes four scenarios and specific functions of block chain technology applied to education credit information collection and recording, information interconnection and sharing, information transparency management and refined supervision of education credit system, and introduces two application cases. The application of block chain technology in the construction of education credit system is in essence to use technical means to promote the reconstruction of education governance thinking and governance mode and the innovation of education governance system, and finally to realize the modernization of education governance ability.

INTRODUCTION

Currently a new round of technological revolution and industrial transformation continues to develop in depth and spread across the world. The digital economy, supported and empowered by new technology such as the Internet of Things, artificial intelligence and block chain, is profoundly changing the production mode and lifestyle of human. As a relatively core disruptive technology in the new wave of technology, blockchain is gradually becoming "the place of origin[1]" of industrial technology innovation and model building. On October 24, 2019, President Xi Jinping, at 18thCollective Learning Meeting of Political Bureau of the Central Committee of the CPC, addressed that "the integrated application of blockchain technology plays an important role in the new technological innovation and industrial transformation. China should take the blockchain as an important breach for independent innovation of core technology, define the main direction of advancement and increase investmentso as to promote the application of blockchain technology in education, employment and other fields of livelihood. "Since 2020, the outbreak and normalized existence of the Covid-19 have changed the order and operating rules of our society. Under this background, we need to reconsider and interpret the adaptive channels and ways required by the needs of production and life.

One of the main ways is the application of new technologies such as the Internet, big data and artificial intelligence. In the context of the Covid-19, the process of education informatization, digitization, intelligence is greatly accelerating, and exploring the application of big data, artificial intelligence, blockchain and other technology in the field of education is a very important topic in education reform and development both at present and in the future. Duringthis process, there occur some problems such as lack of compatibility among different systems of education, duplication of data collection, and trust crisis in educational records. The characteristics of the blockchain, such as its decentralization, inaccessibility of data tampering, provide a safe and reliable way for solving the above problems, and also provide new technical support for further deepening education reform[2]. In order to accelerate the innovation of blockchain technology in colleges and universities and serve the national strategic requirements, Ministry of Education of PRC released the "Blockchain Technology Innovation Action Plan for Colleges and Universities" in May 2020, proposing that " to deal with the copyright confirmation, data trust, privacy protection and other issues faced by education management and service, we should study the blockchain-based technologies such as education resources sharing, education results evaluation, students comprehensive evaluation, education archives storage and tracking,

information flow control and privacy protection, as well as build a blockchain-based collaboration platform of education management and service that can be applied in basic education, vocational education, higher education, continuing education". This paper focuses on the application of blockchain technology in building an education credit system. Constructing an interconnected, shared and co-governed social credit system is the key to promoting the modernization of China's system and capacity for governance. The construction of the social credit system can not only make full use of informatization, big data and other means to break the information silos and departmental barriers, realize social co-governance, improve governance efficiency, but also achieve fine-tuned supervision through trustworthiness incentives and untrustworthiness punishments so as to improve the efficiency of supervision. On July 9, 2019, the General Office of the State Council issued "Guiding Opinions on Accelerating the Construction of Social Credit System and Building a New Credit-Based Supervision Mechanism", which proposes that strengthening credit supervision be given the first priority, a new regulatory mechanism that runs through the entire life cycle of market entities and connects all before, during and after supervision links bebuilt. Now the construction of China's credit system has ended up the phase of "top-level design" and entered the phase of "intensive cultivation", the construction of the public credit system for for-profit corporation and nonprofit corporation people has been basically completed, and the construction of local and departmental credit systems has just begun with a series of major achievements in government affairs integrity, business integrity, social integrity and judicial credibility made.

Credit is the cornerstone of human society. Education is a social practice that promotes individual development, social progress, and civilization inheritance. The establishment of credit system in education domain is of great significance, since sound education integrity can promote social integrity. Campus integrity system construction, teachers' ethics, and students' integrity education are the key points of integrity construction in education domain. At present, there have been some credit-related regulations on teachers' ethics construction, student academic certificate, student loan, examination and graduation thesis management, campus safety management, private school finance supervision, but these regulations are far too fragmented and hardly executable. In the context of comprehensive promoting the construction of the social credit system in China, we should integrate existing education data resources and systems and build an education credit system with the help of blockchain, one of the new generation of information technologies with high reliability, openness and autonomy, which is of great significance to realize modernization of capacity for education governance: First, it can improve the systemic and synergistic nature of education governance, and promote the coordination between different areas and departments education administrative management; secondly, itcan improve the efficiency and effectiveness of education governance and solve weak enforcement of education-related laws; thirdly, it can expand the coverage of education governance, solve the problem that some education-related subjects run out of the supervision of education administration; fourthly, it can promote co-sharing and co-governance of social governance and solve the specific education problemsthat cannot be settled by the public credit system.

ANALYSIS

Evolution, development and characteristics of Blockchain

Blockchain, also known as distributed ledger technology, is an accounting technology thatis jointly maintained by multi-party. Blockchain technology uses cryptography to ensure transmission and access security, and can achieve consistent data storage, inaccessibility of data tampering, and denial prevention. As one of the representative achievements of the fourth industrial revolution, blockchain technology is the core one that has "the most potential to trigger the fifth wave of disruptive revolution". On November 1, 2008, an individual or organization named Satoshi Nakamotopublished an article titled "Bitcoin: A Peer-to-Peer Electronic Cash System" on the cryptography mailing list on *metzdowd.com* website, marking the birth of the underlying technology of Bitcoin - the blockchain. Blockchain 1.0 era. People are used to calling the Bitcoin blockchain the era of blockchain 1.0. Essentially, the study of Bitcoin technology can be traced back to an article "How to Make A Mint: The Cryptography of Anonymous Electronic Cash[3]published by several cryptography experts from the US National Security Agency (NSA) in 1997, in which the idea of Bitcoin transfer network was proposed the first time in the world, and the Bitcoin blockchain that appeared at the end of 2008 can be regarded as the engineering practice made further based on this article's theory design.

Blockchain 2.0 era. The emergence of Ethereum in 2013 marked the entry of blockchain into the 2.0 era.The key difference between Bitcoin and Ethereum-style blockchainis the introduction of "smart contracts". The Ethereum-style smart contractisin essence a piece of program code the function of which is to preset a transfer script that sets what kind of transfer to perform under what conditions.The transfer script is deployed on the Ethereum blockchain. When the transfer conditions are triggered, the miners on the blockchain calculate the transfer results, and then the entire network state of the entire Ethereum blockchain is reset. From a technical point of view, the process records collections of the Bitcoin blockchain and the state transition records collections of the Ethereum blockchain, are the fundamental differences between the two generations of blockchain systems. Therefore, Compared with Bitcoin, Ethereum cannot be simply interpreted as the inheritance and evolution of the blockchain system, but rather regarded as a new start. Therefore Bitcoin and Ethereum coexist in the token financing market without Bitcoin being replaced because of the birth of Ethereum, and Bitcoin is stillthe most popular token in the international token market while Ethereum cannot be its match. Blockchain 3.0 era. Since 2018the concept of blockchain 3.0 has been proposed. Its connotation is to provide technicalmeans to realize the on-chain virtual mapping of physical assets, that is, the concept of digital bills. With this concept, the technology industry (especially the domestic industry) proposed for the first time"blockchain governance", and actively considered to accept it and integrate it into judicial governance and social governance. From the perspective of the author, this is indeed a significant progress since the blockchain entered in the

public view for over ten years. Meanwhile, in terms of production and research, the technology industry has begun to gradually reflect on and face the practicability of the existing blockchain technology, and commit to overcoming high concurrency and low energy consumption, parallel distribution, as well as consider abandoning the mining mechanism. Also the industry considered its compatibility with technical fields such as the Internet of Things, artificial intelligence, cloud computing, big data, edge computing, in order to significantly improve the performance of blockchain operation and establish a safe, intelligent, standardized ecology of production and research, which enables the technology to be promoted in more application fields.

The operation mechanism of the blockchain is to change the traditional accounting bill that is uniformly recorded and managed by the central agency into a one that is open across network and jointly maintained by each node. In the new bill each transaction information can be notified to all users, and information in the ledger can bechecked by all users, so that the transaction can get credit guarantee even in the absence of a third-party credit subjectso that the authenticity and reliability of the information can be ensured[4]. What blockchain technology realizes is a map of value data, which is characterized by decentralization, openness, independence, security, anonymity. Up to the present, the understanding and practice of the concept of blockchain in foreign countries is advancing towards the direction of reshaping finance anchored in the paper "How to Make a Mint", and its related important technology innovation and development basically go forward around how to adapt to financial applications, such as bitcoin financing, bitcoin credit, etc. While it has been determined in China that the technological innovation of blockchain should move towards the direction of improving the real industry. Therefore, in terms of domestic blockchain technology development, when it comes to referring foreign experience, we must uphold the principle of sublation and view it dialectically.

Application cases of blockchain technology in education credit system constructing

Blockcerts Blockchain Learning Certificate: Blockcerts, launched in 2016, was jointly developed by the Massachusetts Institute of Technology and a company called Learning Machine and is now still being updated and replaced. Blockcertsaims to create an open infrastructure so that a graduate student's graduation certificate can be easier to be verified by an employee. For university graduates in many countries and regions, the credible release of their diploma on the website can greatly compress the shorten the time needed in certificate application and certification, as well as save costs. The core of Blockcertslies in that it achieves extension to Open Badges, which is a diploma issuing method widely used by U.S. colleges and universities. Blockcerts hereby verifies that diploma is tamper-proof and credible. Technically, Blockcerts does not create or maintain a new blockchain, but by connecting with the Bitcoin blockchain or the Ethereum blockchain, realize the security of blockchain technology against the system. The working principle of Blockcerts certificate issuance is as follows. Firstly, use the blockchain and strong encryption to create a certification infrastructure that can control complete achievement and results records, and a digital file containing basic information about the certificate, such as recipients

name, issuer name, issue date; secondly, use the private key to encrypt and sign the certificate; then create a hash value to verify whether the content of the certificate has been tampered with; finally, use the private key again to create arecord on Bitcoin blockchain to prove whom the certificate was issued to at a certain time. While in practical applications, the above-mentioned work can be finished with "one click operation". The organizational structure of Blockcerts consists of four parts. The first is the publisher. A university create digital academic certificates, which can include personal skills, achievements or characteristics, and register this information on the Bitcoin blockchain. The second is the certificate. It is important that the certificateis open and compatible, as openness is becoming an IMS standard. The third is the verifier. Anyone can become a verifier, not requiring the permission of the issuer, and the verifiable content includes the certificate has not been tampered with; the certificate is issued by a specific authority; the certificate is issued to a specific user. The fourth is the wallet. Individuals can safely store their credentials in wallets and share with others. Currently, MIT already uses Blockcerts as the channel for issuing certificates to graduates. Since the year 2019, the University of Bahrain has adopted Blockcerts to issue diplomas. Now MIT is promoting Blockcertsto become an open standard for issuing, sharing and validating digital academic certificates.

Campus Blockchain Project of Central University of Finance and Economics: College students often need to verify some information when applying for a job, such as academic information, rewards and punishments. Also, in practice there are problems such as complicated procedures for academic certification, difficultyin proving the authenticity of awards and the relevant qualifications. To confirm these records one by one practically not only consumes heavy manpower and material resources, but also requires a high certification expense. In China, the Central University of Finance and Economics has launched a "Campus Blockchain Project", which was jointly developed by 21Vianetand Microsoft and aims to use blockchain technology to help students record relevant documents and form a long-term effective, non-tampered, non-forgery, and decentralized credit chain. This project recorded and stored all of students' academic achievement, making it convenient for recruiters to obtain and verify them at any time. The "Campus Blockchain Project" of the Central University of Finance and Economics is built on Microsoft's Azure cloud platform. Furthermore, 21Vianet provides the basic blockchain protocols, and CUFE-21Vianet Blockchain Joint Laboratory supplies with blockchain technology services. The Azure cloud platform boasts ofadvanced capacities such as diversified storage, flexible network deployment, secure data management, and easy-expanded platform architecture and intelligent big data management, establishing technically a multi-center trusted node for the formulation and deployment of campus blockchain protocols.

The workflow of the blockchain system can be roughly concluded as follows. Firstly, relevant applications, devices, and data sources send events ordata is sent to the message relay station, namely the message service bus. Then the distributed ledger technology user logic application extract data from the service bus and sent to a transaction generator that builds and signs transactions. Signed transactions, by special ledger-based logic application connector, can be

routed to the blockchain service layer. The service layer is based on the Ethereum blockchain network. Secondly, the blockchain data manager captures block and transaction data from configured transaction nodes, decoded events and attributes, and then send the data to the configured target. The message relay station sends the ledger data to the business applications and chaineddatabasein use. Finally, by means of linking to the chained database, the stored information can then be analyzed and visualized. Based on this campus blockchain, students can query their learning results records through related services on the school website, and present them to agencies if required. After receiving the student's resume, the enterprise can also use the system to check the student's diploma and awards. The application of this system simplifies the process of authenticating and validating student's relevant information for schools, individuals and organizations. The data security of the campus blockchain is very high, not subject to be tampered by any individual or institution, and can be permanently maintained as a public record. Even if the academic certificates and paper records are lostor the school's grade records are damaged one day, data stored on the blockchain would not be lost. Campus blockchain is a brand-new attempt of blockchain in education domain, providing significant convenience for college graduates, job seekers and employers as well as reducing the cost of job seeking and recruitment. In the longer term, the construction of campus blockchain will accelerate education informatization and promote the integration of online space and real space.

Application scenarios and functions of blockchain technology in building an education credit system

Education credit subjects mainly include teachers, students, schools, and other subjects. Among them, the construction of teachers' credit system shouldincludecredit management of teachers' morality, education and teaching, academic research, and social services; the construction of student credit system shouldinclude credit management of school work, academic qualifications, employment, student loans, internship training; the construction of school credit systemshould not only focuson the construction of the credit system of private schools, especially that of enrollment and finance of private schools, but also on that of various schools' governance decisions, education and teaching, scientific research, social services, campus safety. The construction of other credit subjects systemincludes the credit management of organizers and relevant education service entities (Figure 1). The application of blockchain technologyin the credit systemconstructionof the above four types of education credit subjects, should mainly coverthe following scenarios and functions.

The authenticity and traceability of education credit information collection records: Information is the basis for the establishment of a credit system. In an unfamiliar society, the authenticity, verifiability, and traceability of the credit information are basic requirements for building a trusted mechanism. Information fraud is a main problem that destroys the economic and social trust mechanism, as well as the primary problem that needs to be solved for constructing a education credit system. A background check company of U.S. found in a survey that in about 86 percent of companies job seekers were hired through fraudulent academic qualifications. According to the 2017 *White Paper on the Current Situation of Chinese Students in the U.S.*, Among the dismissed Chinese studying-abroad students, 33.47 percent were dismissed due to academic dishonesty. Up till now, China Higher Education Student Information (CHSI) has established a complete system for querying and verifying student status and academic qualifications, and Service Center for Studying Abroad Ministry of Educationhas issued *the Announcement of Dishonest Behaviors in the Certification of Overseas Academicqualifications and Degrees.* However, academic qualifications fraud, resume fraud, and academic fraud occurred among students and teachers still repeated. In cases of certificate loss, file damage, job hunting, performance evaluation and job promotion, the employee still needs a higher cost to prove the trustworthiness of some specific information, the employer also needs to spend a lot of time to verify the authenticity of the information. The emergence of blockchain technology has built a secure, reliable and non-tamperable algorithm trust based on mathematics science and digital algorithm, which strengthens and optimizes existing social personality trust and system trust and has the characteristics of low cost, inaccessibility of data tampering and traceability[5].It has natural edges in verifying the authenticity, accuracy, traceability and traceability of credit system information. At present, there are schools or educational institutions both at home and abroad trying to record the students learning certificates, learning records and even the evaluation resultson the blockchain, such as the digital certificate of MIT, the campus blockchain of the Central University of Finance and Economics. If having education credit information recorded on blockchain, first you should create a digital file containing the basic information of the credit subject, including name, certificate orcontent of study record, name of the granting party, the granting date. Secondly, the body of the message should be signed with the private key. Then use the private key to create a digital record on the blockchain, and schools use their own private key to sign a digital certificate with the entire information record and generate a hash as a watermark for verifying whether the content of the certificate was tampered with. The process, not complicated, was easy to be operated in the user interface. The application of blockchain technology has changed the recording, verification and sharing mechanism of educational credit information, the subject of the information does not need a complex self-certification process, and norworry about the occurrence of loss, damage or tampering of certificates or records. The employer only needs to use the blockchain verification tool to verify the authenticity of information, which reduces the cost of recruitment and improve the credibility of education data. For some untrustworthy information records required to be traced or verified, the initial record state of the information and the responsible subject can be easily traced through the above-mentioned blockchain record, to ensure the authenticity and effectiveness of uplink information.

Take the collection and recording of students' education information for instance. Students education records at different stages of education include academic and degree certificates, comprehensive evaluation results, awards, internship experience and etc. For these records, some of them are placed in student files and kept by school, while some are kept by students themselves. There are various problems that need to be solved urgently at all stages of a student education career such as entering into a higher grade,

school transfer, employment, and studying abroad. These problems include how to ensure that the various education records offered by students are authentic and effective; how to obtain supplementary certificates if education records are lost or damaged, how to ensure that the disciplinary violation and dishonesty of a student would not be tampered or covered; how to transfer relevant learning data when a student transfer schools; how to identify the authenticity of the content of students' resumes and etc. However, the existing solutions may have loopholes and blind spots, or involve human interference, cumbersome procedures, or high costs. One of the most important functions of the blockchain is to provide an immutable distributed record of data. Blockchain can realize the security and tamper-proof of data information by means of asymmetric number encryption technology and consensus mechanism, and realize the traceability and permanent storage of data through timestamp, thus providing the best way to solve the security, permanence and reliability of education records. As regards the use of blockchain technology to record the academic and degree certificates, grade credits, comprehensive evaluation results, competition and scientific research experience, internship performance and awards, Firstly it can realize the effective recording of a student's studying experience and learning performance, forma distributed, non-tamperable, permanently stored student's education record chain and studying credit system, so as to ensure that theirallkinds of education records are authentic and credible and save the check and certification costs of education administration, employers and students themselves. Secondly, it can realize the authentic record of domestic and overseas education experience of a student, improve the efficiency of education certification and education quality supervision, so as to break identification barriers of education certificates and promote the optimal allocation of global education resources. Thirdly, it can promote education innovation via the learning outcomes identification of new education models. For example, one of the bottlenecks in the development of MOOCs is the lack of credibility of course certificates. Inorderto solve this, it is suggested thatto construct a blockchain-based MOOC alliance certification platform on-chained by MOOC platforms, universities, enterprises and authoritative institutions. Then distributed records and joint certification in identity certification, cause certification and learning certification will be realized , which can improve the credibility and recognition of MOOCs.

Safe Sharing of Educational Credit Information Interconnection: As education informatization continuously advances in depth, education departments, schools, education enterprises and education-related social service organizations at different levels have built their own databases and information systems to collect and analyze education data according to their own business requirements. The big data with explosive growth has improved the scientificity and accuracy of education decision-making, but also caused a series of problems: Firstly, how to guarantee the users' privacy? In the era of big data, the demand for resource openness is in conflict with the protection of individual privacy, the probable improper use of collected education data and improper disclosure of the stored education data make it more difficult to protect the privacy of education subjects; secondly, how to ensure the security of the education information system? In the process of the development of big data technology, the security risk caused

by the loopholes of the education information system itself, the failure of traditional border-based security protection technology during system opening and endless cyber-attack methods going alongside with new technologies upgrading, pose challenges to education informatization; thirdly, how to reduce the repeated collection of education data? As for data management, now the problems like fragmented management and multi-collection still exist, and there is a lack of unified integration among various information systems. The above problems restrict the upgrading of education informatization, and also affect the effective operation of the education credit system.

As the underlying encryption technology, blockchain encryption technology can effectively ensure data security, change the status quo in which the current data leakage is easy to be disclosed and exploited. In *The White Paper of Privacy Protection and Data Security* released by Ant Financial in 2019, it can be learned that Alipaylaunched the MORS Esecure computing platform (MORSE). Through combining with blockchain technology, under the premise that multi-party data is not out of the domain MORS Ecan perform encrypted computing and compliant to realize the "availability but invisibility" of data, so as to ensure that the original data cannot be obtained by any counterparty ora third party, thereby effectively solving the privacy protection problem in government services data sharing. Blockchain can permanently expand list of records (all records are traceable), thus more effectively avoiding tampering. Data on the blockchain is distributed amongpeer nodes so that each user are enabled to generate and maintain a complete copy of the data, thus avoiding the problem that a single subject's being attacked would cause system crash. Therefore, the application of blockchain technology to the existing education information system can improve the competence of education management informatization in supporting education affairs management, government services, teaching management, and ensure that the securityof key information related to teachers, students and schools would not be disclosed.

In addition, the applicable value of blockchain in the education credit system also lies in its ability to establish a mechanism characterized by "multi-subject participation and flat decision-making"[6] , which can solve the bulky information interaction between higher and lower governments, as well as run exactly in line with the flat thinking of credit supervision. *Education Informatization 2.0 Action Plan* proposes to promote the integration of education-related government affairs information system with the goal of "interconnection, information sharing and business collaboration ". Also, it proposes to establish big data of education-related government affairs information resources, break data barriers and realize the goal of one number with one source and accompanying data collection. The education credit system based on block chain technology not only connects the information isolated islands within the education system, but also interconnects with the social credit system, which can avoid repeated collection of education data in different fields, and summarize the credit construction-related specific issues and key concerns in the education domain, so that the industry credit system and the public credit system are interconnected, and the effective sharing of education-related information data in a graded and layered manner can be truly realized.

Transparency and fairness of education credit information management: Although China's social credit system has initially established a unified information sharing platform, government credit in the fields of public decision-making, financial budget, education and medical care and social security, is undermined by low transparency and lack of effective supervision[7]. The top reason is information asymmetry, including the low transparency and easy accessibility of information tampering. The existing education management system still bears the stamp of strong bureaucratism and thus there hides the risk of big data power control. The implementation of the information disclosure system has given citizens the right to know, but when facing the massive data, the performance of citizens' substantial participation in social governance needs to be measured. Diversified governance, mutual cooperation, mutual supervision is more conducive to the scientific nature of decision-making. Blockchain, through the distributed records of each node on the chain, characterized by high openness and high transparency can realizemulti-subject governance. In the education credit system, the data on the uplink especially the dishonest records of education subjects, will be fully disclosed and cannot be tampered with, and the credit supervision process of government departments will also be transparent and open to the public, which can improve the deterrence of dishonesty and increase the cost of dishonesty; Moreover, it can strengthen the government credibility and achieve openness, fairness and justice of education governance; Meanwhile, to construct an education blockchain that governments, schools and different social parties participate in, is beneficial for governments to promote the transformation of educational administrative functions, so that the traditional governance model of government being the only strongest can be transformed into a multi-center governance model that is governed by governments, schools and different social parties, and participated by teachers, students and parents. From the perspective of technical composition, the peer-to-peer distributed structure built by the blockchain excludes any mandatory factor that interfere with the fairness of the protocol, making all nodes in the system equivalent. Therefore, blockchain technology and its applications lay more emphasis on security-based open sharing. Through this function, any education institution and learning organization on the chain can record the learning process and learning results by cross-system and cross-platform, and optimize and integrate the gigantic education resources with learners at its center. These resources come from online or offline, academic or non-academic, and domestic and foreign education institutions. Therefore, from the perspective of the learners, different learners with his unique personality, hobbies, qualities and potentials, and development backgrounds can build their own personalized learning blockchain, and their learning results obtained in different ways can be recognized. From the perspective of education administrators, the integration between education and industry, in the broad sense, includes the social practice concerning elementary education, the integration between education and industry concerning vocational education, and the collaboration between university and industry concerning higher education. If using blockchain to evaluate the above-mentioned activity traces and process evaluation, the equalization and integration of school education information and other types of education information can be realized, and reduce the unreasonable weight of exam scores in evaluating students which is the common fault of the traditional

education model, so as to promote education fairness. Up till now, explorations in this field have been made both at home and abroad. Woolf University, the world's first university based on blockchain technology, was established in 2018 with the support of scholars from Oxford University. This university has no entity campus, in which any scholar can post their own accredited degree and teach the concerned courses. In this university, courses teaching, protocol management, tuition fees payments, academic records, degree certificates are all recorded on the blockchain. For instance, as for Fujitsu's Fisdom Online Courses in 2019, it is Sony's Global Education blockchain cloud service that holds responsible for recording student test results and course data. In 2017, the transnational inter-university alliances, which include Boston University, Swiss Federal Institute of Technology Zurich, The Australian National University, The University of British Columbia, TechnischeUniversiteit Delft, signed a resource sharing agreement based on blockchain technology, ensuring that various resources guaranteed by blockchain technology can be utilized by universities worldwide and their affiliated organizations.

Refined autonomy of education credit system supervision: *The Report of the 19th National Congress of the Communist Party of China* proposes to create in the new era a social governance pattern of co-construction, co-governance and co-sharing, and build an intelligent social governance platform. In the era of intelligence, education governance model at both the macro and micro levels requires a transformation from bureaucracy and vertical management to flat-styled management and multi-center collaboration, so as to realize the scientificity and efficiency of education administrative power allocation and service.

At present, China's education governance tools are facing the demand-technology-policy comprehensive transformation drive, with data governance becoming an importantapproach. In data governance tools, the technical characteristics of blockchain have natural advantages in promoting flattening of education governance structure, transparency in the process of governance and service, reliability and security of governance data, and intelligence in education and law enforcement. In terms of data security sharingin e-government, blockchain technology can provide a safe and trusted environment for interconnection and intercommunication of data, which is under joint supervision of education administration at different levels and departments. In addition, this technology can allow education departments to independently authorize visitors and access data, can record data calling and perform accurate accountability in case of data disclosure, greatly reducing the security risks of e-government data sharing, and avoid repeated collection and recording of data[8]; In terms of education risk warning and joint law enforcement, the blockchain can, through interconnecting different departments and using smart contracts, can realize intelligent warning and automatic law enforcement, and improve the governance effect; as for reform of government functions, blockchain introduces multiple subjects to share governance rights and shoulder governance responsibilities through the subject authentication, so that the government, schools, enterprises and social institutions can act as one of the nodes and effectively participate in education governance, express interest demands, and simplify the complex links characterized by different levels for certification, approval

and verification, and an education governance pattern of co-construction and co-governance can be thus built.

As education governance develops into a refined and dynamic one, the construction of the education credit system needs to adapt to the overall trend of the social credit system development, take differentiated regulatory measures according to the level of credit rating, and realize incentives for honesty and penalty for dishonesty, making the credit supervision became a hard constraint. It is observed that some education subjects have a fluke mentality over violating education laws and even risk danger in desperation due to that the relevant rules in education domain are still to be completed, the law enforcement team needs to be expanded, the law enforcement mechanism needs to be improved, the incentives for honesty are insufficient, and the penalty for dishonesty is weak and the cost of education illegal acts is relatively low. In 2019, the Ministry of Education issued *Proposals on Strengthening Education Administration and Law Enforcement*, which stipulates the key areas of education law enforcement, and those areas concerning credit include illegal running a school, illegal recruiting students, illegal charging fees and issuing academic degree certificates, evading school-running funds, and serious cheating in national education examination. The document also puts forward to strengthen credit supervision, establish honesty files within the education domain, and record illegal information of various school owners, and establish a joint publishment mechanism with relevant departments.

The blockchain, equipped with a smart contract mechanism, can embed programmable functions into the blockchain. When conditions are triggered, the concerned functions will be implemented automatically. In the city of Guiyang, Guizhou province, big data technology and identity technology were used to embed the punishment function of the joint punishment cloud platform into the business system of different departments, so as to ensure that the information of the defaulters can be accurately corresponded in different departments and business scenarios, and realizeself-processing of dishonesty notification, dishonesty punishment, information feedback. This application of blockchain offers useful ideas for filling the blank of education supervision and education law enforcement. The education credit system can use blockchain technology to link the credit information disclosure with risk prevention and control, and realize automatic warning, automatic push, automatic interception, and automatic punishment. The data recorded by the blockchain, characterized by completeness, detailedness, dynamicness and continuity, can accurately describe the recorded so as to realize the classification and stratification of education governance and realize the hierarchical supervision of education credit. For example, the honest schools, identified and analyzed by blockchain, can be automatically exempted from inspection and have the school license period automatically extended; the dishonest organizers of schools can be pushed by blockchain and their application for running schools in other places will be automatically intercepted. As for foreign practices, some national or regional education administration have introduced blockchain to assist education governance. Kazakhstan, after introducing blockchain to manage kindergarten admission, has solved problems such as information storage errors in the original information system and non-transparency in the admission process. Then parents in Kazakhstan can use the data disclosed on the blockchain to learn the rating and service characteristics of the kindergarten, and choose the suitable ones. Through this social supervision, the quality of kindergartens get improved. While as for domestic practices, the Municipal Education Bureau both of Langfang and Guangzhou have made useful attempts in blockchain application. In February 2019, the Municipal Education Bureau, Langfang, established the education data monitoring platform, in which blockchain technology was applied to education data collection, monitoring and analysis, monitoring of high-quality and balanced development of compulsory education, comprehensive quality assessment of elementary education, quality monitoring of elementary education, data recording of students and teachers, etc., and achieved district-level data collection and analysis of each application system as well as processing of various education affairs at any time. In December 2019, the Education Bureau, Baiyun District, Guangzhou issued education cards for more than twenty thousand teachers and students, realizing the unified authentication of legal identity, education identity and network identity. Building a "trusted education identity chain", is currently anew form generated by the integrated application of sophisticated internet technologies in education domain, such as blockchain technology, cloud computing and big data.

CONCLUSION

Building a credit system in education domain involves not only establishing a black and white list system for various education subjects, but also the reconstruction of education governance thinking and governance model; the application of blockchain in the education credit system is not only an application of information technology, but also an institutional innovation to realize education governance. This paper proposes the basic connotation and development direction of the credit system construction in education domain. That is, firstly using a new generation of information technology to establish a credit system which is based on credit information resources sharing and covers schools of different types and levels in the whole society; secondly improving the credit service market system in education domain and innovating the education supervision system and mechanism based on credit.

Blockchain, through integrating the technologies such as consensus mechanism, cryptography principle, distributed storage, time stamp, smart contract, blockchain, has the advantages of transparency and trustworthiness, security and tamper-proof, multi-center, traceability, automatic execution, which can better resolve the conflict between openness and security, autonomy and trust in education transformation and to provide a more reliable record carrier for build a learning society in which everyone can learn anytime and anywhere. The application of blockchain in education domain can largely solve the problems in the process of education informatization, such as data barriers and information security and credit crisis. However, meanwhile it is also necessary to realize that the blockchain is not a panacea or suitable for each area of education informatization. Blockchain should be applied primarily for high-value data processing[10]. Today China has already constructed CHSI, student status management system, teacher management system, education management system. In the application

practices of blockchain, there exist the conflict between distributed storage and data expansion, the conflict between existing database and blockchain compatibility, the conflict between decentralization and subject supervision, the conflict between transparency and privacy protection, which all need to be resolved one by one. In terms of China's practices, the application of blockchain in education domain is still on the exploration phase, mainly focusing on recording and certification of student's learning outcomes, career training of employees, education data collection and analysis in some certain regions, etc. As education informatization develops in depth continuously, in the future blockchain will further integrate with education big data, artificial intelligence, cloud computing. To sum up, big data is the general driving force, cloud computing is a centralized construction, and education blockchain is a peer-to-peer network architecture. The integration application of them can contribute to mutual complementation of centralized maintenance and collective maintenance complement, giving full play to their respective advantages and jointly promote the realization of education modernization.

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Conflict 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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