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Parallel-Education-Blockchain Driven Smart Education : Challenges and Issues

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Abstract—Recently education blockchain driven smart education has become focus of attention, and related system frameworks and key technologies are presented. However, problems of difficult to model, difficult to experiment, and difficult to optimize in education blockchain need to be further solved, and driving mechanisms, application scenarios and other issues need further analysis. This paper first introduces education blockchain, challenges and issues, then based on introduction of parallel intelligence theory and parallel blockchain, it proposes parallel education blockchain, and its driven mechanism, function distribution, data transfer, application scenarios and related issues are elaborated; At last, several questions are raised for discussion.

Keywords—Education Blockchain; Parallel Education Blockchain; Parallel Intelligent Theory; Intelligent Education; Driven mechanism

I. INTRODUCTION

Smart education has three challenges such as data security, evaluation security, application security, and education blockchain provides solutions for data security based on distributed storage, evaluation security based on consensus mechanisms, and security based on smart contracts. Therefore, various educational blockchains and their driven smart education system frameworks have emerged and become hot spots of concern.

Various Education Blockchains have emerged ever since 2017. Paper[1][2] proposes educational blockchain system structure and its challenges, Sony International Education Corporation (SEG)'s blockchain education system OKLink[3], and South Korea's "New Oriental" Educo-op[4], provide services to record learning data and thus assessment methods for evaluation agencies, and Kai provides blockchian to protect original art work[5]. EduCoin platform provides a global online education platform, and as an open ecosystem, participants from all over the world can provide services and share content[6].

So far most education blockchains focus on official learning and teaching record and provide related services. With publication of 《China Student Development Core Literacy》, literacy education enter fast tracks. How to record huge amount of literacy education data is a headache since it might occur at any time at or out of schools. How to assess various literacy is another challenge since literacy assessments might involve human's factors inside. How to apply these assessments safely in graduation and other scenarios is also a tricky problem. An educational blockchain which could cover and collect full data from formal learning and informal learning is a way worth exploring.

Because blockchain technologies can only rely on real-world "chain" incremental "trial and error" experiments, sandbox supervisions and other empirical decision-making methods to optimize itself, education blockchains generally have problems in modeling, carrying out experiments and optimization on data recording mechanisms, consensus mechanisms and contract mechanisms. That explains why recently blockchains become attacking target, for example, DAO was attacked and transferred millions of Ethereums. So if there were a platform for blockchains to model, experiment and optimize at all levels, DAO event might not happen.

Next, this paper first presents a whole education blockchain model which could record official records and literacy data, then based on introduction of parallel intelligence theory and parallel blockchain, proposes parallel whole education blockchain and analyzes its key technologies; Finally, system framework of smart education driven by parallel education blockchain is put forward; Some thoughts are put forward at the end of the article.

II. PARALLEL EDUCATION BLOCKCHAIN

A. Model of Whole Education Blockchain

Functional model of Whole Education blockchain (as referred to Whole-Edu thereafter) proposed by this paper is shown in Figure 1. It consists of three layers, which are data layer, logic layer and application layer, corresponding to educational process, evaluation process and application process of smart education.

At data layer, Whole-Edu provides a distributed + central dual storage mechanism for educational big data generated by formal education and informal education. While distributed storage mechanisms for storing achievements, credits and

rewards generated by formal education, distributed + central storage mechanisms is designed to record achievements, credits and rewards from informal education due to huge amount of video, audio data, image data involved. Distributed + central storage mechanisms means data address is on chain, while real data is saved in a central database.

Similarly, at logic layer, Whole-Edu provides a dual mechanism based on consensus and non-consensus mechanisms for evaluation of certificates, certificate recognition, credit recognition, and grade certification in education. Depending on different situations, formal and informal education could apply both non-consensus mechanism, if there exist accurate, objective and official assessment standards, and consensus mechanism if there are no related standards. Mostly, formal education processes could employ non-consensus mechanism since they involve standard tests with standard answers, while informal education process could employ consensus mechanism since they involve creating thinking with multiple answers.

At application layer, Whole-Edu offers smart contracts for "various transaction" for formal education and informal education, such as creativity transferring, credit transferring, and grade transferring. Once smart contracts are set up, original and creative work will be protected and transferred among different schools or be applied by companies under certain contracts, and credits could be transferred among different schools or even different countries, ideally, students could be transferred freely and globally.

However, Whole-Edu introduces three type of problems. First, data storage mechanisms. Although Whole-Edu provides dual distributed and central data storage mechanisms, there is no clear lines between when to apply all data on chain and when to apply data both on chain and in database. For a certain blockchain with certain structures and certain amount of nodes, for a certain kind of data, how much data can it afford while maintaining high efficiency of data access and storage? What if chain structures change? What if

amount of nodes change? What if data types change? What are relationships among all these factors such as types of data, amounts of data, chain structures and amount of nodes? How could we optimize data storage mechanisms under these relationships? Obviously, for different educational scenarios with different scales, it is necessary to model, experiment and optimize structures and data storage methods of Whole-Edu to ensure the real-time data storage, extraction and maintenance.

Similarly, consensus mechanisms. As we all know, there is room for improvement in the efficiency and fairness of consensus mechanisms. For example, POW, which relies on computing power to gain rights to vote, and POS, which relies on number of tokens to gain power, in both cases, computing power and rights will eventually be concentrated into nodes which have abundant resources, and finally rights will only be in hands of a few people, which totally violates concept of decentralization of blockchains. If POOL is used and each node has right to vote, then how to define range of voting nodes to ensure validity, fairness and efficiency of voting results? Choice of consensus mechanisms is related to nature of evaluation processes (professionalism, subjectivity and objectivity). If objectivity is strong, no consensus mechanism is needed. If subjectivity is strong and professionalism is poor, then all nodes vote. If subjectivity is strong, professionalism is strong, then only part of nodes vote. Then how to pick nodes and how many nodes would fit? Obviously, a "test field" is needed to bring together above factors, through computation experiments, iterative optimization, and finally forms a suitable consensus mechanism to achieve balance between efficiency and fairness.

Therefore, from storage mechanisms of data layer, consensus mechanisms of logic layer to contract mechanisms of application layer, it is necessary to analyze, experiment and optimize according to specific application scenarios. Next, this paper will introduce parallel intelligence theory, which is a systematical way to tackle modeling, experimenting and optimization for complex systems, to make Whole-Edu modelable, experimental and optimizable.
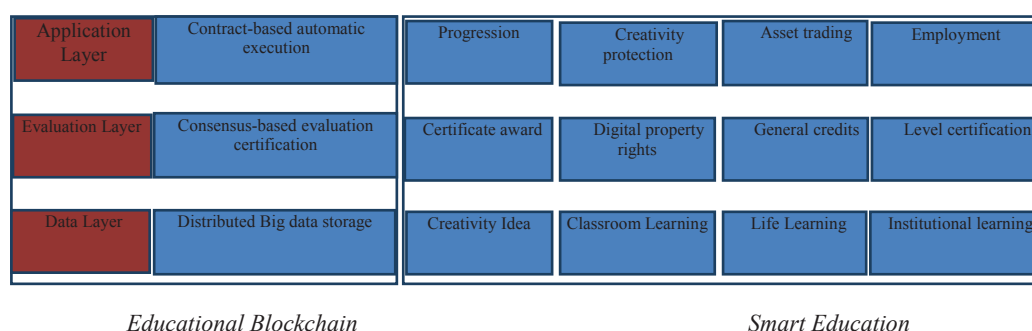

Educational Blockchain   *Smart Education*

Figure1 Educational block chain

B. Parallel Intelligence Theory and Parallel Blockchain

Literature [7]-[12] first proposes parallel intelligent theory based on ACP (A: Artificial Society + C: Computational Experiments + P: Parallel Execution) for

CPSS (Cyber-Physical-Social Systems) and provides a set of theories and methods for modeling, experimentation and decision making of complex systems.

Through Artificial systems (A): establish multiple artificial systems of actual management and control objects, which is used to reflect actual system's state and operation

law, and realize "equivalent" between artificial systems and actual systems; Computational experiments (C): establish calculation models to experiment, analyze and evaluate actual systems to grasp evolution of complex systems in various scenarios; Parallel execution (P): realize management and control of actual systems through parallel execution and coordinated evolution of artificial systems and actual systems.

Based on parallel intelligence theory, parallel blockchain was first proposed by [13]-[15], which provides a set of computable, achievable and comparable description modeling, predictive analysis and guided optimization methods for blockchains technology. As shown in Figure 2, A: Build artificial blockchains through formal description of static characteristics and dynamic behavior of core elements of blockchain ecosystems (computing nodes, communication networks, consensus algorithms, contracts, etc.), C: Conduct trial and error experiments and optimization by computational experiments on specific blockchain application scenarios, P: Realize decision-making optimization and parallel tuning through interactions and closed-loop feedback between artificial blockchains and actual blockchain system.

Next, based on parallel intelligence theory and parallel block chain model, this paper presents parallel Whole-Edu to tackle problems mentioned in 2.1.
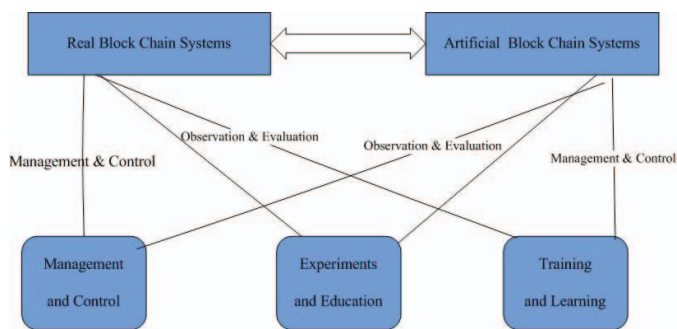

Figure 2 Conceptual Framework of Parallel Blockchains

C. Parallel Whole-Edu

As shown in Figure 3, conceptual framework of parallel Whole-Edu includes actual educational blockchain and artificial education blockchains. Usually, an actual educational blockchain can correspond to a plurality of different artificial educational blockchains. Based on actual Whole-Edu, by constructing several artificial Whole-Edu and performing computational experiments, descriptive optimization, predictive optimization, and guided optimization of storage mechanisms of data layer, Consensus mechanisms at the layer, contract mechanisms of application layer could be realized.

At data layer, parallel Whole-Edu aims at figuring out and optimizing data storage mechanisms. For different types of

data, by constructing artificial Whole-Edus and carrying out different data storage mechanisms experiments on them, feasible data storage mechanisms are obtained, then through interactions between artificial Whole-Edus and actual Whole-Edu, optimal data storage mechanisms are generated and executed.

At consensus level, parallel Whole-Edu is designed to address generating and optimizing of consensus mechanisms. In the same way, for certain scenarios and various consensus mechanisms, through computational experiments in artificial Whole-Edus and interactions between real and artificial Whole-Edus, most effective consensus mechanism is realized. Specifically, assessments of core literacy such as cooperative spirits, caring, artistic creativity and etc. would fit this case.

At application level, Parallel Whole-edu needs to address implementation and optimization of smart contracts. For various contract mechanisms, by carrying out computational experiments on artificial Whole-Edus and through interactions between artificial Whole-Edus and real Whole-Edu, most efficient contract-based applications are achieved for different scenarios.
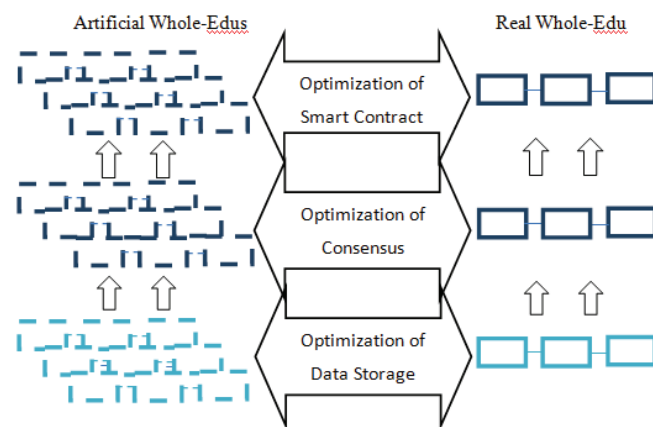

Figure 3 Concept Framework of Parallel Whole-Edu.

III. PARALLEL WHOLE-EDU DRIVEN INTELLIGENT EDUCATION

Functional model of parallel Whole-Edu-driven smart education is shown in Figure 4. Parallel Whole-Edu provides technical support and driving services for data storage, evaluation mechanism and application mechanism for smart education in data layer, logic layer and application layer respectively. Table 1 lists functional relationship between parallel Whole-Edu and smart education. At teaching process level, smart education completes execution and optimization of teaching process, while parallel Whole-Edu completes optimization of data storage. In evaluation process layer, smart education completes generation of evaluation mechanism and its optimization, while parallel Whole-Edu completes technical support and optimization of secure
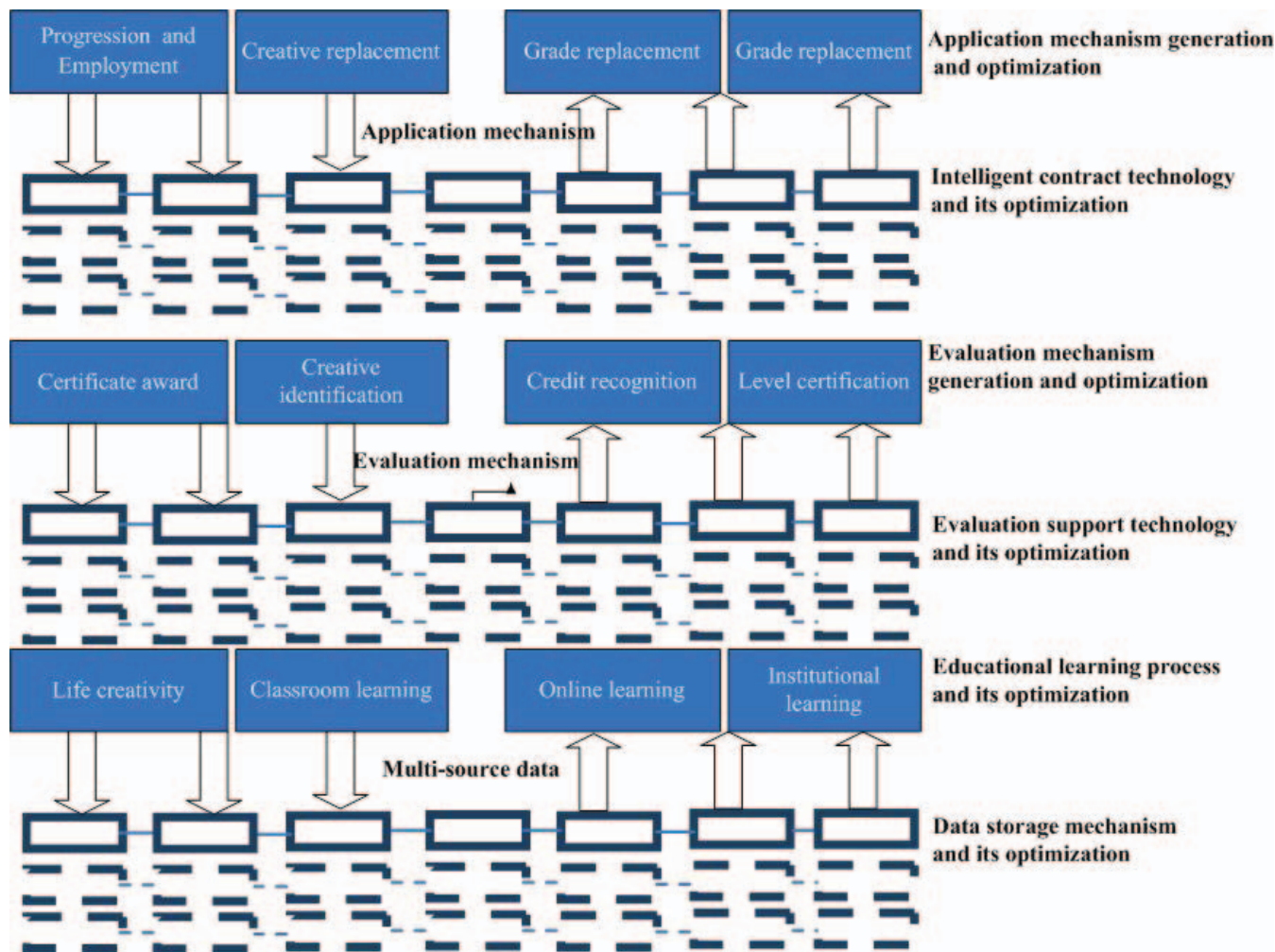
Figure 4 Parallel Whole-Edu Driven Intelligent Education.

implementation of evaluation mechanisms based on consensus mechanisms; At application process level, smart education completes generation and optimization of educational decision-making, and parallel Whole-Edu completes educational decision-making and its optimization based on execution of smart contracts.

Key technologies involved in parallel education framework are as follows.

➢ Heterogeneous data acquirement and analysis: It's fundamental to acquire multi-source heterogeneous data by employing technologies such as big data, cloud computing, Internet of Things, Virtual and Augmented Reality in processes of teaching, learning and education management, and then, based on big data above, carry out analysis of cognitive processes such as learning behavior, teaching behavior and etc.

➢ Knowledge maps building, teaching processes modeling, learning processes modeling: It's also fundamental to build knowledge maps for learning resources in various disciplines, model teachers

(guides) and learners, and thus develop educational robots and knowledge recommendation mechanisms.

➢ Parallel intelligence based parallel education: Under guidance of parallel intelligence theory and ACP methods, parallel education systems including multi-artificial teaching and learning systems and real teaching and learning systems are constructed. By parallel interactions among real systems and artificial systems, digital portraits and performance evaluations for learners, guiders are generated for further analysis.

➢ Computational experiments based learning scene design and educational innovation: By employing computational experiments in artificial education systems, a variety of learning scenes and educational innovation programs are designed to guide learning, teaching and management innovation effectively by providing personalized and adaptive services.

Smart education and blockchains complement each other naturally. On the one hand, smart education provides possibility of fairness, openness, security and efficiency in

educational processes. On the other hand, blockchains provide possibility of fairness, openness, safety and efficiency in educational outcomes. Imagine in smart buildings composed of smart education and blockchains, smart education provides various kinds of filling materials such as "bricks" and "stones", while blockchains provide crisscrossed reinforced concrete skeletons. Thus, wisdom of smart education mansion can be reflected in every corner and every structure. Learners, who study and live in this mansion, can enjoy lifelong, personalized education services.

For one thing, smart education, as transformation of educational process, educational technology, and educational methods, changes way of "production" and "cultivation", changes productivity, and changes way of talent cultivation in new intelligence technology era. For another, blockchains, which brings about changes in relationships of production, change how talents are selected based on neat protection of ideas, creativity and digital assets.

Parallel blockchains and parallel smart education will bring profound changes in lifelong cultivation and selection of talents, since they together change productivity and relations of production. Smart education brings a decentralized personalized lifelong education model, and blockchains bring all-centralized or decentralized global "trading" models for talent selection

TABLE Ⅰ FUNCTIONAL RELATIONSHIPS BETWEEN PARALLEL EDUCATION AND PARALLEL EDUCATION BLOCKCHAINS

Education Process	Smart Education	Paralle Whole-Edu Blockchain	Whole-Edu Layer
Application processes	Generation and optimization of educational decision	Execution of educational decisions and optimization of implementation	Application Level
Evaluation processes	Generation and optimization of evaluation mechanisms	Execution of evaluation mechanism and optimization of implementation	Logic Level
Teaching processes	Generation and optimization of teaching processes	Storage of individual knowledge big data and optimization of storage	Data Level

IV. Discussions

Individual knowledge big data and blockchains

Individual knowledge big data includes data formed by both traditional and untraditional education and data formed in life. If all data is on chains, then positive result is to bring accurate personal portraits to each learner for precise usage of decision makers, educational service providers, and learning resource providers, providing personalized learning services for learners. Will it make learners' daily life and learning full of utilitarian colors? Is it possible to spawn a group of related service organizations, and instead increase burdens on learners? Therefore, what kind of data can and cannot be added to blockchains needs to be discussed.

Individual knowledge big data storage issues

What kind of data can be placed in blockchains? Big data on individual knowledge will be a huge data warehouse. If big data of each individual knowledge is placed on blockchains, it will greatly increase burdens and speed of consensus, and even cause network congestion. It is suggested that integrated storage methods of public and private chains can be adopted. Only storage address of each person is stored in public chains, while private data of each person is stored in private chains. Public chains are stored in system networks for maintenance and use, while private chains are stored in distributed data clouds, which can not only ensure real-time response, but also security and privacy of data to a certain extent.

Games between realities and dreams

Technical characteristics of nature of blockchains are equal freedom (decentralized organization), consensus co-governance (consensus mechanisms), and openness (cryptographic data protection mechanisms), which applies to Utopia style of society and application scenarios. Education is a century-old plan and foundation of countries, while educational forms of a country is matched to its social form. Does education in fact match above three characteristics of blockchains? This is undoubtedly a long-term game between ideals and realities. Radical blockchain technology also compromises traditional societies, resulting in a balanced state of the game.

From nowadays vigorous "school district" campaign to intensifying "early training class", learners are in "low-dimensional strike" state of three-body, multi-dimensional, interesting learners are downgraded into test machines. It is hoped that smart education mansion constructed by combination of blockchain technologies and smart education will reintegrate dimension-reducing education into full-dimensional education, combining literacy education with scores. Only if we could change same time, same places, same teachers, same paths, same textbooks, same ways, same scenes and same progresses (eight "same") into different time, different places, different teachers, different paths, different textbooks, different ways, different scenes and different progresses (eight "different"), learners could truly enjoy lifelong personalized education services.

Acknowledgment

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