Education application of blockchain technology: learning outcome and meta-diploma

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***Abstract*—This paper proposes an education blockchain technology based on learning outcome, which is based on graduation requirement index of university, with professional certification and uses automated evaluation software as a tool. The course-learning outcome achievement values, which is based on the quantitative and qualitative combination of grades, process and evidence, the course name, learning outcome name (graduation requirement indicator) and the weight of the course, etc. are all record in the block. The conversion from evaluation of students' achievement to the post-job competence evaluation results is completed, and counterforces of student competency evaluation is send to the curriculum, which realize the continuous improvement of the curriculum.**

Keywords—teaching space; professional certification; block chain; OBE education

I. INTRODUCTION

Block chain technology has been widely studied and applied in the global finance, business services and other fields, but there are few mature cases and research literatures in the field of education and teaching. As we all know, educational institutions have long monopolized the function of learning certification, while learners, teachers and fellow learners have almost no autonomy for the learning process and results. However, the traditional school centered classroom learning is slowly changing with the development of technology, correspondingly, lifelong learning, online learning, mobile learning and distributed learning based on project or realistic problem is becoming more and more common [1]. In recent years, with the development of network, digitalization and globalization of the learning environment, traditional educational institutions tend to lack the necessary means, resources and ability to verify learners' knowledge, skills and achievements in management, certification learners learning activities, processes and results, etc.

Assessment of students' learning outcomes is an important factor could affect students' approaches to learning. Electronic Learning Contract (ELC) is a continuously renegotiable working agreement between students and lecturers for assessing the outcomes of students. It focuses on group decision making by electronic meetings for the learning outcomes, and the Group Support System (GSS) can support as a platform to assist the processes for discussing, negotiating, formulating, re-negotiating and revising the content of the ELC among students and lecturers. In this contract, what to learn, when and how the work will be finished, and what the criteria of assessment will be have been identified [2].The fuzzy multi-criteria decision model is adopted as the contract making method to describe the subjective selection of assessment criteria and the weightings of criteria for each decision makers, and to obtain the optimal choice according to the score of each scheme [3].

In the current environment, based on the new technology of block chain and online learning space of World University City, the education blockchain and the smart contract model could be used to improve the implement of ELC. On this foundation, this paper proposes an education block chain technology based on learning outcome. According to the "Washington Agreement", the graduation requirements index of the university that have passed professional accreditation are unified, and the corresponding support points of each course determined, which will be taken as the consensus mechanism of education block chain (POA), the combination of quantitative and qualitative assessment of students' grades, learning process, and evidence is achieved [4] The name of the course, the name of the ability (index point name), the achievement of the course, and the weight of the course are recorded as data in the block, which make it possible that transform students' course achievement evaluation of academic grades in traditional into capability index evaluation result(a kind record of dominant data).

II. THE SPECIFIC APPLICATION OF LEARNING OUTCOME BLOCK CHAIN

A. Definition of learning outcome block chain

The learning outcome block chain consists of two side chains: the students' ability chain and the course chain. The students' ability chain on behalf of graduation requirements index before graduation, spread teaching around students' ability according to the index, and could transform knowledge into ability, until students graduation will the ability works. The curriculum level chain refers that in the process of evaluating students' outcomes, the evaluation of students' ability is used as a verification of course achievement degree. Because of that results adversely affect conditions, the continuous improvement of the curriculum has been formed, the object of improvement is curriculum, the achievement degree is evaluated by students, and thus, the quality of the courses taught by each teacher can be identified [2].

978-1-5386-2129-5/17/31.00 ©2017 IEEE
DOI 10.1109/ICPADS.2017.00114

B. Block construction

- (1) Data acquisition of achievement degree evaluation capability

  At the end of a course, the teacher makes a comprehensive check of the student based on the scores of the test paper, the class performance and the usual homework, which is evaluated according to the different graduation requirements index and course objectives index required by the course learning. When the course comes to end, once the average of students' final score exceed threshold, that is, to achieve. The achievement degree evaluation of each course is generated in the teaching space, and the automated collection of relevant data such as the ability that students obtained can get from the automated evaluation software.

- (2)Block record

  After completing the data collection of the course fulfillment evaluation, for each student who does not need to be repaired again, based on the quantitative and qualitative combination of grades, process and evidence to make out each learning outcome achievement value of the curriculum standardization support. Then, the achievement value together with the course name, learning outcome name (graduation requirement indicator), the weight of the course and other information will be shaped as a record. And it will be uploaded into a block (note that only qualified records can be packed into the block). Finally, the Meckler tree, hash function, digital signature, timestamp and other technologies will be used to add the record to the blockchain [5-6]

- (3)POA Consensus Mechanism (Prove Of Accreditation)

  The learning outcome based on education block chain that proposed in this paper, adopts the quantitative and qualitative formula mechanism for each course, achievement degree evaluation of each course is not subject to the teacher's subjective willing, but through a consensus mechanism, which make it convincing. First, take the test scores and other real records of student learning process quantitative indicators as the support of achievement degree evaluation, and take it as a quantitative standard, which associated with the qualitative assessment from students and employers to evaluate achievement of students' ability objectively. Secondly, the achievement degree of the course is tested and reversed by the graduation requirements degree and training objectives achievement degree, and continuously improved on this basis to ensure the consensus of the system. In addition, the person in charge of the evaluation is the professional certification team but the Instructor of this course. What's more, the evaluation system of certified profession has been verified by experts and authorities, and it is credible. on the contrary, the profession failed in the certification is lack of consensus mechanism. This mechanism is conducive to the effective communication among different universities, between universities and industry, and even in different countries and regions, what makes the university activities more open and inclusive, and the expected learning outcome achieved, and even an opening and sharing future engineering education system reconstructed [4]

III. CASE ANALYSIS

Here to take the "information security" professionals in Xiangtan University that has passed the preliminary accreditation of engineering education in 2017 as an example. This paper analyzes the compulsory course, that is, "information security", since the education block chain is universal, this analysis applies to other courses as well.

First of all, teachers aim at solving complex engineering problems, and successively reverse the design of curriculum objectives, classroom goals and teaching activities, the teaching space is used to link the online and offline classes to carry out the OBE (outcome-based education) teaching, using automated achievement evaluation software to achieve the analysis of curriculum goal achievement degree, which effectively boosting students' ability to solve complex engineering problems. The following table is the "information security" evaluation in each project that from 5 selected students.

TABLE I. "INFORMATION SECURITY" EVALUATION IN EACH PROJECT

Num.	blank	short answer	reckon	complex	Homework grade
1	6	16	12	34	87
2	17	8	5	26	83
3	18	17	12	37	92
4	14	13	14	36	90
5	7	10	12	34	93

Num.	class performance	spatial performance	test	total score
1	95	80	94	75
2	85	95	96	66
3	85	80	96	86
4	85	85	92	81
5	85	85	98	72

According to the information security evaluation in each project of the 5 students in Table 1, analysis of the requirements for graduation has been reached. For every student who has passed the exam and no longer needs to be rebuilt, based on a combination of quantitative and qualitative with whose scores, processes and evidence to obtain the achievement degree goal value of each learning outcome item that supports the curriculum standardization, and the achievement target value, course name, learning outcomes (graduation requirements index) name , the course weights and other information will be constituted as a record, all of the records of students that involving achievement degree evaluation in this batch consist of a block called "the 2017 semester information security course block".

TABLE II. CONTENTS OF BLOCK RECORD

Num. \ Index	Index name (Target value of achievement degree)				
	3-2	6-2	6-3	7-1	7-2
1	0	1	0	1	1
2	1	0	0	1	1
3	1	1	1	1	1
4	1	0	1	1	1
5	0	0	1	0	1

Finally, based on Merkel tree, hash function, digital signature and time stamp technology, the 2017 semester information security courses block will be packaged into blockchain, this case could be extended to other courses, and packaged into blockchain together to form a complete education block chain, the framework shown in Figure 1, and the multi course block chain records are shown in Table 3

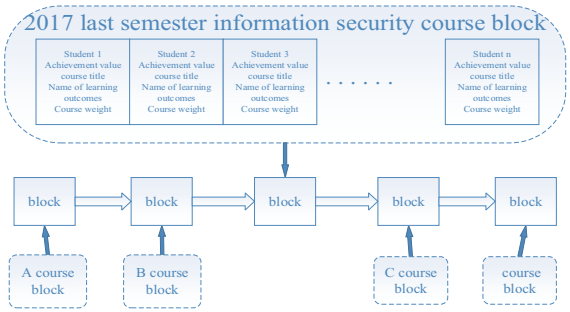

Fig. 1 learning outcome blockchain structure

TABLE III. MULTI COURSE BLOCK CHAIN RECORDS

Num. \ Index point	1-1	1-2	2-1	2-4	3-1	3-2	4-1	6-2	6-3
Information safety						√		√	√
Communication principle	√		√	√	√		√		
Circuit analysis	√	√	√						
Signals and Systems	√			√					

IV. EXPERIMENT RESULTS OF EDUCATION BLOCK CHAIN PLATFORM

Fig. 2 shows the new data recorded in education block chain platform per month since Dec. 2016，Since July was the peak period of the end of the semester, there was a peak in recorded data, the data records that are updated in the blockchain are shown in Table 4, It includes the record time, class, students' number, courses, achievement indicators, achievement degrees and other information. The learning outcomes blockchain platform is shown in Fig. 3.

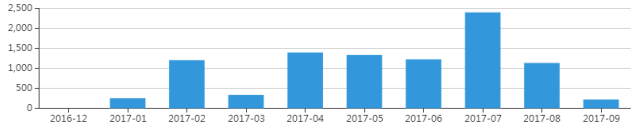

Fig. 2 Historical data record

TABLE IV. BLOCK ACTIVITY RECORD

Time	Class	Num.	Course	Index point	Agreement degree
13:10	13（2）	22	Communication principle	2-1	0.71
13:01	13（2）	21	Communication principle	5-1	0.72
12:59	13（2）	20	Communication principle	1-1	0.81
12:58	13（2）	18	Basic computer	1-2	0.74
12:58	13（2）	18	Basic computer	2-2	0.91

Tab. 5 shows a micro-diploma of a certain student who passes the graduation requirement of engineering education certification. Compared with general diploma, the micro-diploma of ability acquired by the record in the education blockchain contains indexes of graduation requirement derived from scores of 4 years. The construction of study process and ratification can be verified, and consequently the explicit of the difference between students can be reached.

TABLE V. ABILITY META-DIPLOMA OF A STUDENT

Graduation requirement / index point / result (target value; result value)		
Engineering knowledge	1-1	reach（0.65；0.75）
	1-2	reach（0.65；0.79）
	1-3	reach（0.65；0.90）
	1-4	reach（0.65；0.69）
Problem analysis	2-1	reach（0.65；0.76）
	2-2	reach（0.65；0.91）
	2-3	reach（0.65；0.92）
	2-4	reach（0.65；0.83）
…	…	…
Project management	11-1	reach（0.65；0.91）
	11-2	reach（0.65；0.87）
	11-3	reach（0.65；0.87）
Lifelong learning	12-1	reach（0.65；0.81）
	12-2	reach（0.65；0.82）

Fig. 3 Learning outcomes blockchain platform

V. CONCLUSION

In the chain of educational block, graduated students have not only diploma, but reached information which has constituted index capacity of graduate requirement during the learning process. Compared with the rough approval only decided by diploma before, it could approve the constitution of learning process, verify gold content of the diploma and make it externalization of different students who get the diploma. Then, learning outcome is basic of mutual recognition and credit transfer of higher education internationally and the foot-stone of internationalization of higher education and talent

flow. Learning outcome could come from different educational institutions, working practice experience, on-line study and other learning processes. On account of the educational idea of OBE outcome-oriented, when the index points of graduate requirements set by majors are finished, it reaches the graduate standard and could award diploma to learners. Hence, the previous closed teaching activities becomes open type now, which is convenient to build common school system not limited by space-time and adjust to developmental needs of era in the model of new economics which is characterized by share economics. In addition, conduct assessment for learning outcomes based on block chain record by the third party, learn interpretation of result, and supply learning content for learners which could reach graduate requirements and most suitable their interests and provide leading meaning for students' learning.

ACKNOWLEDGMENT

This research is supported by National Natural Science Foundation of China (NSFC) (No.61170191，61379063). The authors would like to show great thanks for the Collaborative Innovation Center of Wind Power Equipment and Energy Conversion.

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