

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

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Abstract—This paper proposes an education block chain technology based on learning output, which based on graduation requirement index of university with professional certification and uses automated evaluation software as a tool to record the information like course learning output achievements based on the achievement, process, evidence and the combination of quantitative and qualitative evaluation, together with the course name, learning output name (graduation requirement indicator) as well as the weight of the course, etc. in the block. The conversion from evaluation of students' achievement to the post-job competence evaluation results was completed, and counterforces of student competency evaluation was sent 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., However, the blockchain technology, which is characterized by decentralization and trusting, will be able to solve the above problems effectively [2].

Based on this, this paper proposes an education block chain technology based on learning output. 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 student achievement, learning process, and evidence is achieved [2]. 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 OUTPUT BLOCK CHAIN

A. Definition of learning output block chain

The learning output block chain consists of two side chains: the student ability chain and the course chain. Inside, the student ability chain on behalf of graduation requirements index before graduation, and it around the ability to start teaching, as well as transforming knowledge into ability, until graduation will the ability works. The curriculum level chain refers that In the process of evaluating students' outputs, 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.

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 evaluated according to the 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 combination of

quantitative and qualitative evaluation of whose results, process and evidence to make out each learning output achievement value of the curriculum standardization support as well as the course name, Learning output (graduation requirements index point) name and the course weight and other information to form a record, and it will be uploaded into a block (note that only qualified records can be packed into the block). Finally, the Meckel tree, hash function, digital signature, timestamp and other technologies will be used to add the record to the blockchain.

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

The learning output based education block chain that proposed in this paper, adopts the quantitative and qualitative formula mechanism for each course, achievement degree evaluation of achievement 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 to associate with the qualitative assessment from students and employers, therefore, the evaluation of the achievement of students' ability is objectively evaluated. 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, among them, 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, which is conducive to the effective communication between different types of Universities, universities and industry, and even different countries and regions, it makes the university activities more open and inclusive, and achieves the expected learning output, and is even expected to reconstruct an open and shared future engineering education system^[3].

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 get the achievement degree goal value of each learning output 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 a record, all of the records of students that involved achievement degree evaluation in this batch consist of a block called "the 2017 semester information security course block".

TABLE II. CONTENTS OF BLOCK RECORD

Index	Index name (Target value of achievement degree)				
Num.	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

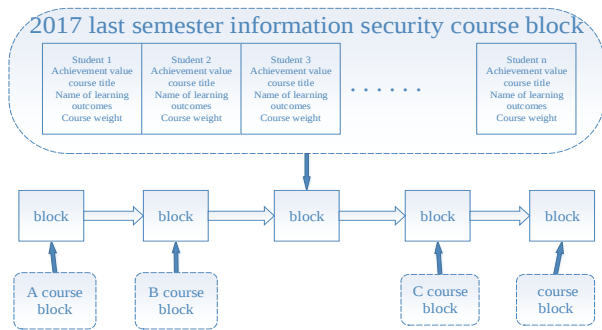


Fig. 1 learning output blockchain structure

TABLE III. MULTI COURSE BLOCK CHAIN RECORDS

Index point	1-1	1-2	2-1	2-4	3-1	3-2	4-1	6-2	6-3
Num.									
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 this 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 block chain are shown in Tab.4. It includes the record time, class, students' number, courses, achievement indicators, achievement degrees and other information. The output learning blockchain platform is shown in Fig. 3.

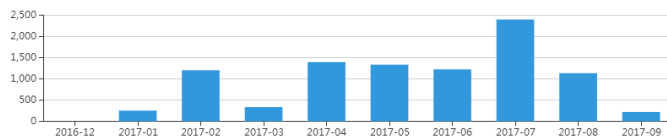


Fig. 2 Historical data record

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 Output learning 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, output of study is basic of mutual recognition and credit transfer of higher education internationally and the foot-stone of internationalization of higher education and talent flow. Study output could come from different educational institutions, working practice experience, on-line study and other learning processes. On account of the educational idea of OBE output-oriented, when the indexpoints 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 study output 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.

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APPENDIX

GRADUATION REQUIREMENTS AND INDEX POINTS

1. Engineering knowledge	Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to solve the complex engineering problems.
2. Problem analysis	Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. Design scheme	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4. Research	Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
5. Modern tools	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations.
6. Engineering and society	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.
7. sustainable	Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.
8. Professional norms	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. Individuals and teams	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
10. Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. project management	Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Lifelong learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.