Papers

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Blockchain-based Cross-Border Educational Transaction System

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Abstract: *Cross-border education can be termed as the movement of student, research, academic exchange programs and institutions across national borders with the provision of international education programs. In this case, the secure and speedy education credit transfer and exchange of student records are the important factors for the cross-border education system. Thus, this paper proposes a system called "Blockchain-based Cross-Border Educational Transaction System" for the higher education industry.*

Blockchain technology is one of the megatrends for recent years. It is potentially a revolutionary means of secure and transparent data sharing and processing in a wide variety of sectors including the education sector. The important concept of blockchain technology is a combination of secured distributed ledger, cryptocurrency and smart contract system. That concept is very appropriate at creating trusted and secured information processing for large and heterogeneous sets. Therefore, the blockchain-based cross-border educational transaction system enables the education industry to transfer and exchange the secure education credit and academic records for students, and other stakeholders such as government organizations, companies, and other institutions. Besides, maintaining educational records in the blockchain can protect from an unexpected natural disaster.

This paper will propose and discuss the system framework that consists of three layers. The first layer would be an interface layer for application development. The second layer provides smart contract service, core service of blockchain, for generating trusted education credit, grading and certificate transaction, as well as for secure agreements of exchange and collaborative educational processes. The last layer is a data storage layer including database methodologies and distributed computing methods.

The proposed system would overcome the barrier of traditional cross-border transaction system by allowing the globally secure, transparent, and reliable education transaction services and collaborative processes among universities in different regions.

Keywords: Blockchain, Cross-border transaction, Blockchain-based cross-border educational transaction, Cross-border education

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Introduction

With the improvement of new and widely-available technologies, the global and local education industry has developed in recent year. Likewise, the movement of students across the national and international universities is growing unexpectedly. Thus, in a modern education system, cross-border education has been greatly popularized. Cross-border education can be termed as the movement of a student, research, academic exchange programs, and provider/institutions across national borders with the provision of foreign education programs. Now cross-border education plays a vital role in the nationwide capacity building process to fulfill the demand of advanced higher education.

As cross-border education is the subset of the international education system, the provision of education services still need to be speedy processes, especially in managing the speedily delivery of academic records to the relative students, researchers, and trainee, and the collaborative processes with foreign university partnerships, and a heavy regulatory burden. Furthermore, the secure education credit transfer and exchange of student records are the issues for the cross-border education system.

For these issues, the authors propose the system called "Blockchain-based cross-border educational transactions system". The system would overcome the barrier of traditional cross-border transaction system by allowing the globally secure, transparent, and reliable education transaction services and collaborative processes among universities in different regions. Besides, the proposed system would help to reduce data management costs by eliminating many manual processes, including credential verification.

Cross-border education

Cross-border education plays an important role in the higher education industry in the process of building capacity in teaching and learning environments. Satu et al. (2004) studied the combining traditional and virtual teaching techniques in the cross-border higher educational environment between Finland and Russia by giving a realistic solution for equal collaboration between different systems and offers attractive study programs and provides a wide range of educational services worldwide.
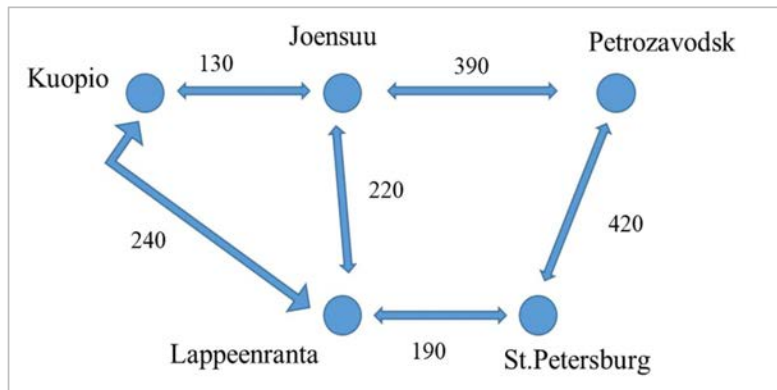
[2]

Figure 1. The core network of three Finnish and seven Russians universities [3].

Figure 1 shows the core network of three Finnish and seven Russians universities in two towns. According to Satu et al. s' research, the significant requirements of cross-border educational systems necessaries special technical and administrative arrangements for the smooth implementation of shared courses in both countries to keep the quality of education and the level of achieved knowledge on the highest possible level.

Santiago et al. (2005) carried out research into the cross-border transactions in higher education of Philippine by comparing with the education of Singapore, Malaysia, and China. The authors analyzed the situation higher education of Philippines and showed the approach to adapt the cross-border education in the country aimed at students that transfer knowledge from a foreign to a local university also helps the capacity-building processes and the Philippines to be an importer of education trade. According to this research, Hong Kong, China, Singapore and Malaysia already have cross-border transactions. Besides, the author pointed out a major concern concerning to cross-border education has to do with intellectual property right to keep international agreements and quality of education [2].

According to the survey of Lane, J. et al. (2015), the number of postsecondary students enrolled outside their country of citizenship doubled from 2.1 million to 4.5 million, and an annual average growth rate of 7 %.

Stephan (2006) proposed an approach for building capacity through cross-border tertiary education. The author explains why to incorporate cross-border education into a capacity-building strategy is to increase the quantity, the quality, or the variety and relevance of domestic tertiary education provision. Cross-border education could contribute to building capacity in higher

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education with the movement of student and staff to access better quality courses and research facilities abroad and return with enhanced skills and experience. Table 1 shows the types of cross-border education activities.

Table 1.		
Types of cross-border education activities[3]		
Type	**Main forms**	**Examples**
1. People		
Students/ trainees	Student mobility	Full study abroad or part of the academic partnership and exchange programs
Professors/ trainers	Academic/trainer mobility	For professional development as part of an academic partnership and employment in a foreign university
2. Programs		
Educational programs	Academic partnerships E-learning	Joint course or program with a foreign institution and e-learning programs
3. Institutions		
Universities Training centers Companies	Foreign campuses Foreign investments	Foreign branch campuses and the establishment of foreign-branded institutions

Yoshiko et al. (2011) carried out a part of a research project of the Japanese International Cooperation Agency Research Institute (JICA-RI) entitled "Cross-Border Higher Education for Regional Integration and Labor Markets between Malaysia and Japan to develop high-level human resources for their nations. Japanese ODA has been supporting cross-border higher education activities in engineering fields since 1993 to meet the needs of the Malaysian manufacturing sector in which Japanese firms have a substantial presence (OECF 1991; 1992; 1999a; and 1999b) [4].

As described in the previous paragraphs, cross-border education plays an important sector in building educational capacity processes. To promote a centralized learning environment into a peer-to-peer learning environment, to reduce daily manual transactions of student affair management works including manual verification of grading, score and transcript, to store student's academic records permanently and securely and to consume the benefit of cost reduction, blockchain technology emerges with enormous opportunities to support higher education.

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Blockchain Technology

The main aim of applying blockchain technology to higher education is to allow high security, reduce cost, enhancing students' assessments, and enhance authentication and trust.

Blockchain can be defined as a decentralized distributed network confirming security and transparency by retaining transactional records in a distributed ledger. Once a block has been added to the chain of blocks, nobody can change the block. This is the main concept of blockchain technology. Each block contains a unique hash code, a small amount of data, and a hash code of previous block. In other words, blockchain is a combination of three components. Those are secured distributed ledger, smart contract system, and cryptocurrency.

A. Secure Distributed Ledger Technology

A blockchain can be referred to as a distributed database that chronologically stores a chain of data packed into a sealed block in a secure and immutable manner. The chain of blocks, also called a ledger, is constantly growing, thus new blocks are being appended to the end of the ledger, whereby each new block holds a reference to the content of the previous block [1]. In other words, the blockchain will be distributed to the appropriate node for "proof of work" and "proof of authority"[5].

B. Smart Contract Service

The most important service of blockchain technology is the Smart Contract service. It makes the trusted agreement between processes based on Repository Service for Legal Laws/Principles and Repository Service for Appropriate Users. Two functions of Smart Contract Service are: (i) Find the appropriate persons to work auditing processes; (ii) Make trusted agreement between processes [5, 6].

Blockchain-based Cross-border education

In this section, the design of the proposed framework is described. There are three layers in the framework as shown in Figure 2. Layer 1 supports application developers for front end applications. This layer is the most important layer for the proposed framework. Layer 2 is a supporting layer for blockchain technology and related services such as Distributed Ledger

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Service, and Smart Contract Service. This third layer is also a physical layer to support data center service. The database systems for the respective university are stored in the heterogeneous form in a distributed network. In this layer, all data system are storing into the data storage layer as virtual storage or cache storage. Some data are physically stored as well.
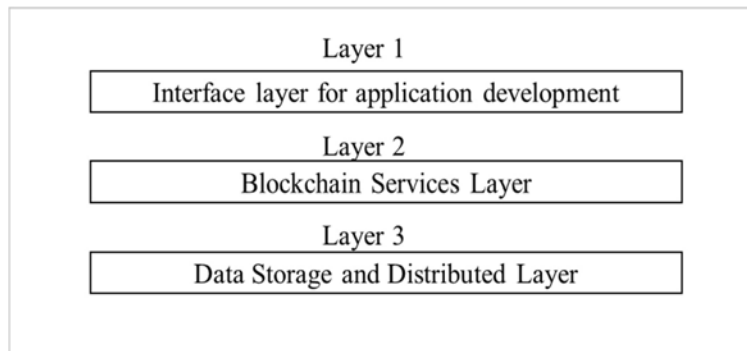

Figure 2. The three-layer architecture of the proposed system.

Figure 3 illustrates the process flow of cross-border educational transaction system based on blockchain technology. In this figure, it can be seen that the universities in both countries (country A and country B) have a network of cross-border educational environment giving access to research works, project, training, courses, e-learning and assessment. The blockchain maintains academic records (including certificates, credentials, transactions, and credits) of each education service in digital format permanently and securely.
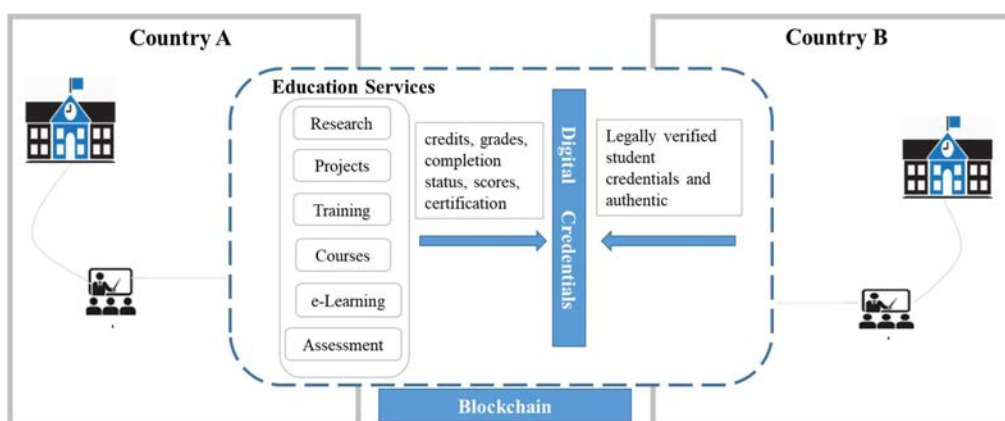

Figure 3. Process flow of cross-border educational transaction through blockchain.

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In training, courses and e-learning sectors, there is daily lecture including assignment, discussion and presentation, homework, and quiz of theoretical tasks. After finishing each lecturer, the blockchain protocol creates a new block including detail records of the lecturer and then adds the new block to the end of a chain illustrated in Figure 4.
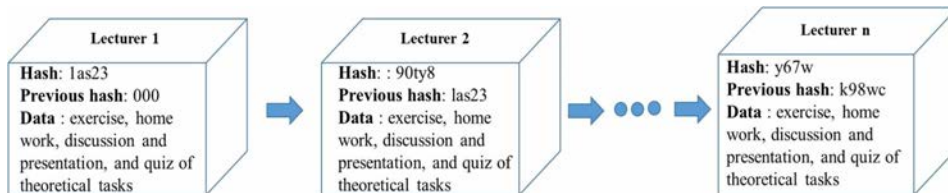

Figure 4. A chain of lecturer blocks.

Likewise, the progress and status of research and project will be recorded in a new block and added to a chain of the cross-border educational network. Student, teacher, and researcher can check their updated lecturers, courses and research work using single sign-on. The detain design of cross-border educational transaction in higher education is demonstrated in Figure 4.
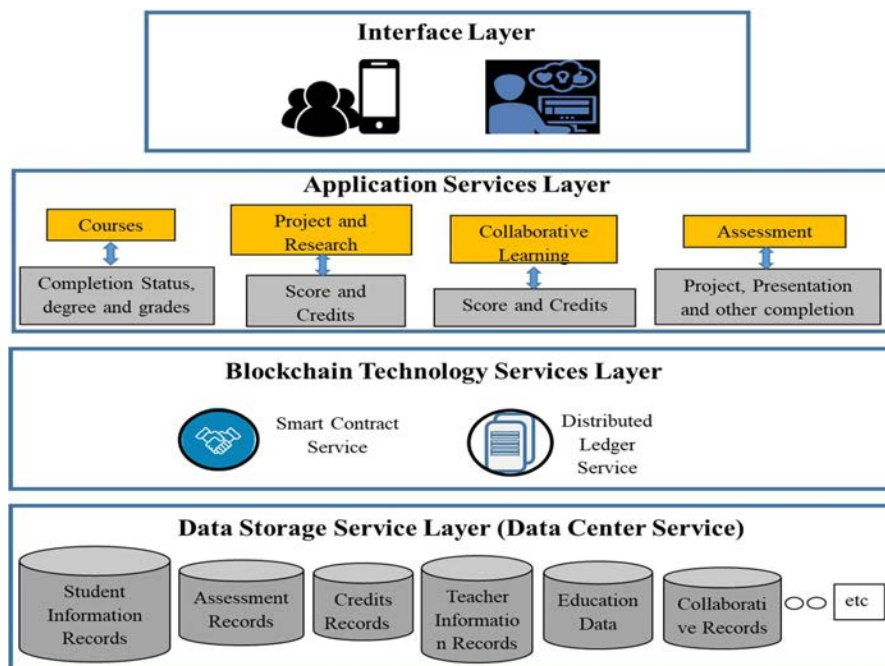

Figure 4. Detail design of propose framework.

[7]

Conclusion

According to the literal reviews of cross-border in higher education discussed in the previous section, it can be seen that, in Asia and Asia-Pacific region, cross-border is the main sector for increase in demand for high-level human resources for developing countries.

In the building educational capacity environment, a cross-border transaction in higher education is the mainstream of allowing meeting the demand. However, the education industry, especially in Myanmar, is still struggling with overload on student manual data management, and daily manual transactions of student affair management work including manual verification of grading, score, and transcript.

Thus, this paper propose a framework titled ' Blockchain-based Cross-border Educational Transaction System' aimed for promoting a centralized learning environment into a peer-to-peer learning environment, reducing daily manual transactions of student affair management works including manual verification of grading, score and transcript, storing student's academic records permanently and securely and consuming the benefit of cost reduction in higher educational environment.

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