Creating student’s profile using blockchain technology

V. Juričić, M. Radošević and E. Fuzul
Faculty of Humanities and Social Sciences, University of Zagreb, Croatia
vedran.juricic@ffzg.hr, matea.radosivic@ffzg.hr, efuzul@gmail.com

Blockchain technology offers advantages such as integrity, anonymity, credibility and independence of the institution and time because of its decentralized nature. One of the current areas for tackling challenges and potential application of blockchain technology is education. Higher education is a complex system with various challenges that could be potentially improved by introducing this technology. This paper shows a brief overview of current systems, their current state and a direction of their development, but also proposes specific guidelines and upgrades for current systems, that would enhance them and, consequently, the area of education. It also proposes blockchain integration levels in higher education that, combined with data extraction, can expand and deepen the area of education for the benefit of institutions, employers and students.

Keywords - blockchain; data extraction; education; student’s profile

I. INTRODUCTION

Blockchain is an emerging technology that is based on decentralized and anonymous architecture which confronts current technological systems and the usual network topologies. It is based on a distributed ledger, i.e. a database on a peer-to-peer protocol [11]. Blockchain technology records a series of transactions between nodes in the network, grouping data into blocks and using special cryptographic methods to create an infinite array of blocks. The technology is anonymous and protects its user’s identity, unchangeable and trustworthy due to its decentralized architecture.

Network anonymity is achieved due to lack of exposure of private data in the network and by using encryption to identify and authenticate users. The network of trust marks blockchain technology as the unmistakable true source of information. Cryptographic methods involved in block creation as well as in linking blocks make each blockchain transaction stable and immutable. The consensus algorithms presented in the blockchain maintain functionality and truthfulness of the network by rewarding their users who contribute and validate transactions. Decentralization is a great advantage of blockchain technology compared to current systems, because it removes a central unit or central node in a network that maintains, monitors, and most frequently charges network usage services. Centralized systems generally control all streams of information within the network and user data, and the stability and functionality of the entire system depends on the main central node. Blockchain works on a series of equally important nodes that maintain the network and in a case of a failed node, the network is not compromised. Copies of the database, i.e. ledger, are distributed to all nodes of the network and can be accessed at any time to see the last state of the database.

Many states, institutions and organizations have launched blockchain initiatives and are developing their own technology that will potentially improve the current one [1]. Although blockchain technology is mostly connected of cryptocurrencies, it can be applied to a lot of different areas.

II. BLOCKCHAIN SYSTEMS IN EDUCATION

As a very promising technology, blockchain has found high-quality applications in the field of education. Today's systems and networks in the field of education have largely been centralized, have full control over their students' knowledge and are largely bureaucratized and nonautomated. Blockchain systems applied in the field of education offer a turn of ownership. Due to its characteristic of equality in the network nodes and the exclusion off a central node, students would have full independence of their personal data. It will allow total independence of the students towards the institution and with complete control over their data. Data stored on the blockchain is permanently recorded and encrypted using cryptographic methods to ensure integrity, immutability through hash functions, authenticity and anonymity.

The blockchain's potential in education goes much further, opening the student's opportunity of anonymity over their personal data, independence of institution, immutability of records of official documents and certificates with a complete confidence in the truthfulness and infallibility due to networks architecture. With the emphasis that the student manages all his data. Blockchain opens up a new approach to education. Using this technology, it is possible to reduce the administrative costs and the cost of the study since most of administrative work would be automatized. It also opens an opportunity for a different approach in paying tuition and gives opportunities for more customized and online studies. [22][25]
Although it is currently in its experimental beginnings, the potential of the distributed education system does not remain unnoticed. Many universities, organizations and companies are launching their own blockchain initiatives and exploring the benefits and applications in the field of education [14][18]. There are numerous publications addressing the potential applications and a large number of projects and co-operations in the field of education.

The most up to date university project is Blockcert, an open-source software developed by Media Lab at MIT university and the Learning Machine company [2][21]. The project seeks to expand existing systems and create a universal software that is applicable to all educational institutions which issue certificates. The Blockcert system allows educational institutions to issue academic certificates and give users full control of their own official documents and personal data. Such system offers the sovereignty and independence of a third party after the issuance of the certificate since all data is written on a blockchain. User data as well as all other documents are the exclusive property of the user and the user can make decisions about sharing his personal data. Without questioning absolute truthfulness of the data provided by the systems such as Blockcert, the user does not need to provide insight into a range of other private data to support the integrity of the certificate. Since every transaction on a blockchain has two anonymous parties who are participating in transaction, personal identity does not need to be revealed since it is connected with the participants public key.

Blockcert is currently based on Bitcoin blockchain, using unique identifiers to store the hash of a certificate, or to be more precisely hash of certificates. This allows systems to store any kind of certificate or any kind of data to the blockchain because it is not storing document, but only its hash. Previously Blockcert delivered certificates to all attendees of a workshop by hashing document content and then hashing the group of documents which is known as the Merkle root. The institution issues a certificate through its own system which, upon issuance, records the evidence on the blockchain about the specific certificate, data about the person to whom the certificate was issued and the time it was issued. After the issuance, the user and all the third parties with whom the user wishes to share the obtained certificate can verify the certificate through the Blockcert verification system. Blockcert allows users to control and retrieve certificates through a mobile application. Blockcert creates an opportunity for institutions to deliver and safely store all official documents in an easy way without the risk of forgery or document loss, all while not exposing private user data.

Currently, only the Massachusetts Institute of Technology, the University of Nicosia and the University of Birmingham research center develop their own systems based on the Blockcert specifications. The University of Nicosia is the first university based on blockchain architecture [9]. Besides offering a degree program on cryptocurrencies and providing students with tuition fees in cryptocurrencies, they offer a free online course and issue academic certificates on the blockchain. For the students who successfully complete the course, the faculty issues a digital certificate that is recorded on the blockchain. Every certificate is separately hashed and then included in the index document. Afterwards, the index document is hashed and its hash is placed on the blockchain.

Sony Corporation and Sony Global Education have developed a certification education system using blockchain technology. The system is used to authenticate, share and store documents generated through education [10]. Woolf University is the first university completely based on blockchain technology [19].

The technical capabilities of each system differ depending on various factors such as selecting platforms, tokens, etc.

III. IMPROVEMENT PROPOSAL

The current development of blockchain technology in education is mostly focused towards issuing academic certificates to ensure integrity, trust and availability regardless of institution or time. Furthermore, in combination with a variety of available services, issuing certification can be further improved.

Systems that offer biometric identification, protect copyrights, archive documents [15][16][17], etc. surely open question just how broad and applicable area in which technology together with education comes in, and to the which extent we can apply blockchain technology and the all benefits it can bring.

In the case of issuing official records on a blockchain, current systems can expand their functionality and in combination with other technologies could enable much more features. There are three main processes involved in issuing a certificate: institution issuing a document by recording it on a blockchain, verification of a document, and sharing the document with all interested parties.

A diagram of components and their interconnections in an educational environment in Blockcert system is shown in figure 1.

![Diagram](Image)

Figure 1. Components of a blockchain in an educational environment

Figure 1 shows a blockchain that is used by certain university, its students and employers. The university issues students’ diplomas, uses hashed certificates and then adds them to the blockchain. Employers, who also
have access to this blockchain, can use it to search and verify students’ diplomas.

But blockchain technology offers much more than just easier verification of diplomas. Technology is regularly new, but its benefits are proved in many fields, although it requires certain adjustments, not just in technical aspects but also in management and organizational aspects. Our proposal for improvements in educational institutions is based on multiple various dimensions and each is discussed in a separate section.

A. Division to courses

In most educational systems the only proof of fulfillment is the final diploma. However, during the years of studying, students acquire different key performance indicators which in sum result in a degree and the aforementioned document representing it, the diploma. In order to allow students a more modular approach to education, the diploma may be deconstructed down to a smaller collection of key performance indicators, i.e. grades and ECTS points. If the diploma is deconstructed and students have the ability to retrieve only aspects of it, it would allow a more flexible educational system.

One of the problems in the mentioned approach is the increase of issued documents which the faculty must handle. However, by introducing modern blockchain systems the problem would be solved through automation, all while keeping the integrity of certificates.

To reiterate, the certificate is an evidence of individual’s learning. The first, almost logical, upgrade to current systems could be the dissection of a degree down to individual courses. The courses are constituent units of the curriculum whose successful graduation results in a diploma. By using blockchain technology or systems such as Blockcert, the process can be improved by recording and grouping certificates of all successfully passed courses instead of delivering a single diploma. Systems that function on the principle of saving hash to blockchain can generate any form of certificate because the blockchain does not record the contents of the document, but only their hash and thus is primarily used for verification.

For each course, the system would generate a new certificate that would be recorded on the blockchain and sent to the student. The user interface would consist of a series of passed certifications, i.e. courses. Certificates would be generated similar to the current system, hashed or in the index document, but with additional data that could be grouped.

B. Employer benefits

By recording the courses, it is possible to gain a deeper insight into the knowledge gained during the course of the study and create a student profile by listing all the courses and grouping them into categories. The course categories can refer to semesters, years or levels of study, and issuing a certificate for each course would open a possibility for the validation of a specific subject. Another possibility would be grouping the course as a defined set of knowledge that the student has acquired through the study and as a factor in assessing the knowledge of the particular area. With the extension of the system, employers would receive, apart from the diploma itself, information on the passed courses.

In this way, the employment process could be more improved. Adding a course to a student profile would allow the search of required courses, i.e. the required courses or category of courses for the required position, and thus the better filtering of potential employees. In addition, students who are in the process of acquiring a diploma or have not completed a degree, but have a number of passed courses, this would allow qualification on positions based on acquired knowledge, despite the lack of a diploma. It could also be a potential motivation for more active students. Such an approach would yield a more just system.

Furthermore, splitting diplomas into smaller objects can go much further and the student profile can be elaborated in more detail. Courses are comprised of conditions and activities that the student must successfully pass in order to pass the course. Courses can thus be divided by the formal obligations that the student performs through the semester. A number of smaller units such as presence, assignments, performance ratings, home works can bring a much wider picture of the quality of the acquired knowledge. All of the above-mentioned conditions in the course represent the total of knowledge gained through the study. Although these course units are already defined as a set of obligations and requirements in the course, they can be always be reevaluated, reused on other courses and further dissected.

C. Data ownership

In a system without a central authority, students are becoming rightful owners of their data. Applying blockchain technology in a field of education is a step to a more privacy-oriented system. Private data is no longer collected and contained and there is no central point where data can be exposed. All the data in the blockchain is associated with user’s public key and only way it can be accessed is through a linked private key. Private key is in an exclusive ownership/property of a student and without its private data remains encrypted to all third parties. Current systems [2][9] are not recording student’s personal data on a blockchain but only hash values of a certificate. Due to this one-way function it is impossible to retrieve original information. In blockchain terminology public key stands for public address which is linked to a student’s identity. Once a certificate has been issued and recorded on a blockchain, the student holds all means of controlling the certificate. The university no longer has to hold any information about the student. Once a hash value is stored on a blockchain and student has received his certificate, university could cease to exist but the student will still be able to verify his acquired knowledge. The right to be forgotten is the most difficult part regarding blockchain technology since once the data has been hashed and stored on the blockchain, it cannot be removed. However, the student is the sole owner of the private key needed to unlock and access the data, therefore all private and personal data covered via the GDPR directive is truly and solely owned by the individual.
D. Introducing smart contracts

One of the most important features of blockchain architecture are smart contracts, which enable an execution of its functionality. Smart contract is an executable program that is triggered when system’s state satisfies contract’s conditions or requirements [12]. Although they are not so present in the most of current education systems, their implementation greatly shortens administrative tasks and increases level of trust in the entire education system. Along with the current proposals, by introducing smart contracts, it is possible to deliver all the previous items by fulfilling the conditions. Specifically, the diploma could be delivered to the student after the passing of all courses or by obtaining the required ETCS score. The smart contracts in education could be triggered after the fulfillment of all conditions required from the course, without any need for manual revision. As an example, students would automatically receive a certificate upon acquiring a positive grade in the final exam, attending 80% of lectures and completing 25 exercises defined by the course.

Employers would also have many benefits. Such an approach would allow them to search and verify candidates on a lower level, with precise criteria, including students who have only passed a certain course, regardless of their other knowledge or their diploma.

The question is not to what extent it is necessary to analyze studies and courses and divide them to smaller units, because technically this is entirely possible. The question is to determine an ideal level of granularity, in order to achieve the maximum effectiveness for students and potential employers.

E. Extraction of skills from courses

The next proposal relates to the extraction of features or skills that students acquire through the course of studying. By using machine learning algorithms and clustering techniques, it would be possible to extract knowledge and achievements [3] from a particular course and improve the student profile. Profiles would be much more individualized by combining the list of formally acquired skills predefined from the course syllabus, and the extracted skills from the course syllabus using machine learning. By combining these factors, it would be possible to gain insight into the entire student’s study and the competences it has acquired. The process and result could be further extended by including additional information dissected from the final grade, such as percentage of attendance and other performance indicators defined by the course.

From a perspective of an employer, it would be possible not only to filter potential employees by courses, but to search by defining specific sets of knowledge. This would ease the process of hiring by allowing the search queries to be more flexible due to the extracted informal features generated by machine learning algorithms.

The next step in development of technology could lead in the direction of cognitive skills especially in the direction of modern cognitive abilities. The current educational system is rigid and non-adaptive to the everyday needs defined by potential employers. The current system within its course syllabus define formal skills such as mathematical competency, logical reasoning, etc., while potential employers search for a combination of skills which also include collaboration and teamwork efforts, creative thinking, public speaking, adaptiveness to new situations, etc. [4][5]

The required skills could be extracted by the aforementioned machine learning algorithms by extending the data observed in them, specifically by inserting job descriptions and intersecting them with previous results. Skills could provide an insight into a different perspective on access to education, creating a focus not only on adopted knowledge but on ways of acquiring knowledge. They could show student skills beyond the courses, and profiles would gain breadth and individuality in describing the student.

Blockchain student cognitive profiling, along with all the features of blockchains such as anonymity, integrity, independence, offers a different approach to employment and employee selection, and offer the fullest and widest approach to education.

F. Extending student’s profiles with different sources

The traditional education system presumes that all needed competencies and skills may be acquired through the defined curriculum. However, in practice this proves wrong in many cases due to many factors, from bureaucratic problems of changing the curriculum to the inability to support all the new skills presented. As a result, students nowadays refer to multiple locations in order to achieve the most out of their professional education. Additional sources include extracurricular studies, private schools and courses and online free courses which include certification, e.g. the popular online learning platforms.

By allowing the students to be full owners of their own data, in this case certificates and diplomas, if all of the certificates are registered on the blockchain and implement the same process as mentioned in previous sections, the final product would be an extensive profile of students’ skills, courses and education located and owned by the student and verifiable from the same source - the blockchain.

Benefits for the employers in such scenarios are obvious and extend the previously mentioned. A single source of truth presenting all of the competencies which a potential employee has presented, a combination of traditional course outcomes and modern soft skills, would allow the student to be fully showcased and would greatly benefit the end-employer in its searching and selection process.

IV. CONCLUSION

The blockchain technology opens a new to approach to education widening the possibilities of user protection data ensuring authenticity and security to various academic records, transcripts and certificates. With decentralized access to that kind of valuable information it becomes truly independent as its issuers and allows open secured access to it.
The number of projects and ideas is growing as well as the number of members and organizations involved and their mutual co-operation. It is difficult to predict in what direction and how far technology will be faced with everyday new implementation and adaptation proposals, but also on many challenges in terms of scalability, security, application of different consensus algorithms and different platforms. Although for the most part the system of crediting students through blockchain is in the test phase, the potential for applying this technology in the field of higher education is limitless considering value of secured data. Blockchain technology allows students more flexible education and creates a different approach to employment and employee selection.

Possibilities of blockchain technology has not yet reached it’s full potential but it's decentralized nature, security and independence are becoming more valued in various industries and institutions that stress most value on the authenticity and credibility of certified data.

V. REFERENCES


