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BLOCKCHAIN IN EDUCATION: INTRODUCTION AND CRITICAL REVIEW OF THE STATE OF THE ART

BLOCKCHAIN EN EDUCACIÓN: INTRODUCCIÓN Y CRÍTICA AL ESTADO DE LA CUESTIÓN

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ABSTRACT

The Blockchain is spreading its influence beyond the field of digital currency to other areas. Also in education, although shyly, appear some applications of it, even if the majority of them have a pilot character. Nevertheless, those piloting and -some big - expectations around them, are raising the lead to some questions regarding what exactly is that technology, what is it used for, how would this be used in education as well as, what opportunities, challenges and risks, represents. This state of art attempts to provide references and links that help to know better and reflect about this new technology, as well as to contribute starting the indispensable debate about how education would implement this, and in what terms.

KEYWORDS: Blockchains, Smart contracts, Adaptive learning, Curriculum, Certification.

RESUMEN

La tecnología de las cadenas de bloques (blockchain) abandonan el terreno de la moneda digital para invadir otros campos. También en Educación, aunque muy tímidamente, aparecen aplicaciones todavía con un carácter piloto. Pero las expectativas que están levantando llevan a plantearse qué es esa tecnología, para qué se usa, cómo podría aprovecharse en Educación y que oportunidades y qué amenazas puede suponer. El análisis del estado de la cuestión aprovecha para proporcionar numerosas referencias y enlaces que deben llevar a conocer y reflexionar sobre esta nueva tecnología.

PALABRAS CLAVE: *Cadenas de bloque, Contratos inteligentes, aprendizaje adaptativo, Curriculum, certificación, acreditación.*

1. INTRODUCTION

The digitization of those issues that fundamentally underlie our societies turns out to be the most characteristic feature of our era. Among these issues, money, and market supported by money, has been one of the main challenges, because currency and market are based on the most basic assumptions of our social transactions: confidence, security, and equivalence.

Initially, the concept of "digital money" was based on a central server that, supposedly, would ensure non-fraudulent use (Chaum, 1983). However, three decades later, and despite the advances in cryptography, centralization, and anonymity, the prevention of fraud is still not compatible. In comparison, Bitcoin has consolidated itself as the most well-known digital currency and the only one that works - a decentralized, anonymous system based on tests that are recorded by all users (Back et al, 2014; Wright & De Filippi, 2015).

The technology working behind Bitcoin is the "chains of blocks" (Blockchain), a complex, evolving technology with tremendous potential and no less associated risk level (Pilkington, 2016), whose main promise is a world without intermediaries (Gupta, 2017). The problem is that the interpretation of that non-intermediation oscillates between two poles with the same burden of complexity: a world without intermediaries depending all of a few centers of power, or a supportive and “horizontal world”. That is to say the world without intermediaries can be U2D (Up to Down) or P2P (Peer to Peer).

However, once the technology - which scans an issue as complex and critical as currency and market - has been consolidated, the obvious question is whether the mechanisms that support it would be able to intervene or to operate in other contexts equally complex and crucial, such as education. This is not really a single question; it is many and very important questions.

Hereunder, we will try to briefly address the fundaments and developments of this technology - including some of them in the specific education sector-, and we'll try to insinuate a reflection and a debate which should address in the near future the impact, or not, of Blockchain in education.

2. THE TECHNOLOGY

2.1 Chains of blocks (blockchain): what it is and how it works.

Blockchain (BC henceforth) is the name of a technology that allows you to keep decentralized and distributed records of digital transactions. The first implementation took place in 2009 in the context of Bitcoin as a digital currency, and although the BC technology is no longer only in Bitcoin, it is the example that we will use as a paradigm of BC.

In Bitcoin, transactions occur between anonymous users (their identity does not appear in any place) using public key cryptography, that is to say, each user has a private key that only he or she knows, and a public key, which is shared with other users.

All transactions are communicated to all nodes on the network. The Nodes check transactions and group them in blocks. Each block is identified by a hash: a cryptographically unique value calculated on the contents of the block and includes a reference to the hash from the

previous block, so that, blocks are linked. This chain of blocks is thus a record of transactions or a public accounting book (ledger), shared by all the nodes in the network (Dwyer, 2014).

In this way, all nodes can verify that the keys used are correct and that the bitcoins transferred are from a previous transaction and they had not been spent already. However, a transaction is only considered confirmed when it is part of a block added to the chain. To add a block, it is necessary to undermine it, in other words, calculate its hash, which requires solving a unique mathematical problem of great difficulty that consumes some very considerable computing resources, especially when we know that the difficulty of the resolution of the hash will be adjusted periodically in order to adapt itself to the processing capabilities of the network. As the power of the connected computers is increased, the difficulty of the problem grows.

As a result, modifying the content of a block would modify its hash, so the link to the next block would fail and would break the chain, which, combined with the difficulty of repairing it, and with the fact that the rest of nodes have a copy of the original string, makes the information contained in the blocks unalterable.

2.2 Blockchain utilization

Although, as we have said, the technology of BC is famously linked to Bitcoin, in the past two years, its utilization is extending.

As expected, the financial world has been the first to approach. An example of this are hybrid systems such as the Bank of England (Allison, 2015), Visa (Arnold, 2016), Santander, UBS, BNY Mellon, and Deutsche Bank (Gallen, 2016), streamlining and improving the safety of real estate transactions. As well as such as the Swedish property registry (Rodríguez, 2016), or the BC utilization for improving transparency in public accounts (Goswami, 2016).

There are many uses of BC to certify the authenticity of all kinds of objects and events. In the case of Estonia, who will use it for legal acts including marriage (although in fact the first legalized marriage under Ethereum was formalized in Williamsburg, Brooklyn (Woods, 2015)). The alliance between Everledger and Allianz to combat fraud (Imtiaz, 2015). The Provenance that tries to control the life and history of their wines to allow the consumer to know all the way up to their table (Parker, 2015). The specific case of Ujo Music that seeks to ensure the management of music copyrights (Capps, 2016). As well as the reliability of medical records (Perez, 2016). Even at a private level, it is possible to certify a document in the chain of blocks of Bitcoin by paying the equivalent to a few Euros (https://proofofexistence.com).

The BC technology is being used to provide a non-counterfeited digital identity to immigrants or refugees who have lost their documentation or those whose documentation has been stolen (https://refugees.bitnation.co/blockchain-emergency-id-be-id/), at the same time that the ONU is using the chains of blocks of Ethereum (an alternative to Bitcoin) to send money to refugees in Syria (A.S., 2017).

Other key technologies for certain BC utilizations are smart contracts. These are implemented in automatic mode (the registration of BC) when the specified conditions are met and agreed to the contract.

In general, the opportunities grow exponentially if they are linked to the Internet of things. For example, if we buy a product, payment will only be carried out automatically when the package arrives at home, or when it is installed and functioning - saving time, paperwork and costs. The same is being applied to the car rental or leasing business, where the control of the car is automatically linked to payment, which at the same time reduces the flexibility and customization of those contracts to arguably recommended levels. Imagine, for instance, that upon completion of the contract, the company system automatically blocks the employee office entrance, or a home, if we fail to pay a share of the mortgage.

3. BLOCKCHAIN IN EDUCATION

3.1 Promises: solution to what problems

Education is facing major challenges that go beyond the mere optimization of the teaching-learning processes (Bartolome, 2011; Bartolome & Grané, 2013), and respond to the changes produced by technologies to the knowledge that, as per the Frankenstein's Syndrome state (Postman, 1991), change not only our customs but also our way of thinking.

Now, can BC technology provide a solution to some of the problems arising from these changes? Let us try to analyze two cases in some detail.

Learning is no longer an activity that is performed during an initial period of formal mode, and which is enriched by experience in professional and vital practice. Life-long learning has become a labor necessity (Longworth, 2005), according to the mode of human learning (Bruer, 1999), a requirement of the twenty-first century citizenship (Martin Ortega, 2008), which affects both the social framework in which we move, and biographical social learning (Alheit & Dausien, 2002).

Learning exceeds the limits of a time and a place. New concepts such as mobile learning (M-learning) and ubiquitous learning appear (Cope & Kalantzis, 2010; Burbules, 2014), generating a vast bibliography during the years of the twenty-first century (Hwang & Tsai, 2011).

Formal education systems have soon transferred part of their programs to the temporary "post-formal" space; post-graduate studies and refresher courses became upgrade and specialization programs. Other alternative and complementary systems of such training appear: boot camps (Smith & Bickford, 2004), MOOC (Breslow, et al., 2013), the videos of the Khan Academy (Thompson, 2011) or just Youtube (Das, 2011), among others, all of them with the intention to complement the skills and abilities of people.

The question that arises for years is the overcoming of the distinction between formal education- and therefore with a regulated accreditation- on the one hand, and informal education - both with a lack of such accreditation - on the other hand (La Belle, 1982; Tuijnman & Boström, 2002). For them, the need to demonstrate the competencies is obvious (skills, knowledge, even attitudes) of subjects beyond the formal ambit, while the systems have serious limitations.

However, the accreditation of learning is not only complicated because of the diversification of fields from which training is offered (formal, non-formal and informal), but it is increased by teaching and curricular elements which are materialized in an ideal pursuit for a long time:

personalized learning. Each one of the personalization forms introduced in the itineraries (programmed teaching, teaching machines of Skinner, personalized education, schools without degrees, tutorials, smart tutorials, intelligent agents teachers… even the current adaptive learning based on data mining) is exacerbated by the massive irruption of new subjects favored by the democratization processes of the educational system. This multiplies the number of possible learning itineraries (including possible acquired competencies and skills) and makes difficult the public and standardized accreditation of such knowledge.

In this context, the formal academic qualifications (degrees, postgraduate), even with the supplements implemented in processes such as the European Space for Higher Education are insufficient to describe the capacity and knowledge of the subject. The lessons learned in terms of "informality/non-formality", or in alternative and custom itineraries are not only needed and appreciated in the industry or everyday life, but today are recognized in "formal" instances, such as the recruitment processes of enterprises, through mechanisms pretty much traditional of testing in-situ.

It is common to request a Resume prepared by the subject itself, without this proving the truth of what is exposed. If it is complemented with the corresponding certificates, the compilation process on the part of the subject and the checking process on the part of who will review it is expensive and complex. There are two challenges: on the one hand, the guarantee that the information included in the CV is truthful (it has to include degrees or detailed experiences) and, on the other hand, the accreditation of complex and custom learning records.

The traditional solution for the first of these problems is to establish a central authority attesting the validity of the data. Institutional identifiers (such as the GREC system of Barcelona University) attesting the validity of the data represent a reasonably reliable system, but obviously do not solve the problem of skills and knowledge acquired outside the formal education programs.

Alternative systems, such as the case of Google Scholar (GS) for the accreditation of the scientific production (publications) of a subject, or the OrcID, the Researcher ID, or networks such as ResearchGate, Academia.edu, or Mendeley, among others, tend towards the automation path of such data collection, although mistakes are not rare. Some are packages, caused by the tool itself, and others even intentional, introduced by the subjects themselves.

In theory, BC would prove the elements of a CV prepared by the user, preventing the manipulation or alteration of data scattered across a distributed system without storing the data in a center vulnerable to attacks or violations of its integrity. It would work as a "test of intellectual work" and, going further, as a "local currency". It would be a technology that can ensure "accredited educational records faithfully combined with a negotiable reputation system" and the first benefit is obviously a trans-institutional accreditation system (Sharples & Domingue, 2016). This is a change that will have a great impact on the education system, but will also, according to some authors, take more than 4 years to be implemented (Sharples et al., 2016).

Possibly, the first attempt of working on this solution has been implemented by MIT Media Lab in 2015, when it began to distribute certificates to the participants in its scholarship

programs (Director's Fellows program) authenticated using BC technology (Raths, 2016). Devine (2015) defines it as a possible universal credit transfer between institutions.

However, even though this solution facilitates the movement of students between institutions and the transfer of reliable information to employers, there has been no progress in the warranty of contents (skills and abilities), whose validation remains centralized in institutions with a reputation also ratified by national or transnational authorities. The question is whether BC is configured as a technology that would keep a record of the itinerary which would be followed by a student in his or her learning and detail the skills and knowledge that have been acquired on an individual basis.

4. REALITIES: UTILIZATION OF BC IN EDUCATION

In reviewing the implementation of BC in education, the first thing to note is that it is about timely and recent utilization. The starting point is the accreditation of the curriculum vitae, although there are other utilizations to portfolios, evidence of learning, insignias (badges) in qualified utilization, etc. It is possible that years have to pass until a relevant implementation in education occurs. However, don't be fooled: changes are taking place very rapidly, and the speed of deployment is possibly going to be more conditioned by the rapid social adoption of technology rather than by the success of these experiences.

4.1 Interoperability of certification

The field dynamism makes it difficult to present an updated list of organizations that are experimenting with BC.

In Cyprus, the University of Nicosia has already offered accredited courses through verifiable certificates with BC Http://digitalcurrency.unic.ac.cy/free-introductory-mooc/academic-certificates-on-the-blockchain/) and other non-official institutions, such as The Holberton School (mainly devoted to the training of engineers) provides them with accreditation from software companies, but without accrediting itself as an institution of higher education (http://www.networkworld.com/article/2997220/careers/software-engineering-school-uses-bitcoin-blockchain-to-authenticate-graduates.html).

At the moment there is, in our view, only one remarkable case as an initiative based on BC for certification: The Blockcerts project.

Blockcerts, a project of Medialab from the Massachusetts Institute of Technology (MIT) (Schmidt, 2016), takes the form of a platform and standards that enable institutions to implement BC in educational programs (http://www.blockcerts.org/guide/).

Blockcerts includes four basic components:

- **Issuer** or the institution that creates digital certificates.
- **Certificates** adjusted with the requirements of the Open Badges initiative of the Mozilla Foundation, which contain a wide range of statements about skills, achievements, or characteristics of the student, all recorded in a chain of blocks.

- **Verifier**, that is, someone who, without having to depend on the "distributor", verifies that the certificate has not been altered, and that it has been issued by a particular institution, and that it corresponds to a particular individual.

- **Wallet** of each student where they store their certificates by sharing them with others, for example, with employers.

Examples of events that have been certified to their participants with Blockcerts include:

- The MIT Media Lab in its course "Lab's 30th Anniversary" of 2015.

- The Laboratory for the City, in Mexico, in its workshop in September 2015.

- Learning Machine, which has provided certificates in Human Resources to its staff.

- The field of Global Entrepreneurship work (Global Entrepreneurship Bootcamp) held in Seoul in March 2016.

4.2 Diversified learning accreditation

The Knowledge Media Institute (KMi) of the Open University (OU) in the United Kingdom, for its part, has launched the OpenBlockchain project. Although on its website (Http://blockchain.open.ac.uk) we find ideas, publications, videos, and events that have been organized in its year of life, they do not show specific experiences, only demos.

In this case, this is not a bet on the certification operability, such as MIT's bet, but there is a further reflection and discussion of utilizations that respond to the problem of certification customization, or rather the accreditation of custom learning.

A platform that abounds in this type of solution and poses a future based on BC is "Learning is Earning 2026" (http://www.learningisearning2026.org). This basic curriculum model design responds to a fragmentation of the program in small blocks (read activities, units, lessons…) that the student runs according to their own needs and skills. Each unit is translated into a smart contract that will be resolved when the subject has acquired the knowledge or skills (or attitudes?) in a satisfactory manner.

However, the utilization goes further. Devine (2015) explains how the trajectory of the student (and the teacher) can be exposed in a transparent way, favoring, for example, the mobility of students by offering them an open and verifiable system in which to show their academic achievement in the form of a "currency" or exchange unit. Devine also points to the example of learning recognition in a peer-to-peer network (peer-to-peer learning network).

The OU is also working on the implementation of BC to its study accreditations, applying their open learning badges (OpenLearn Badges). However, it must be understood not as a mere record of formal qualifications, but as an authentic record of accredited learning (Sharples & Domingue, 2016).

5. A CRITICAL VIEW

It would be a mistake to think that we are dealing with a technology of immediate application, or that changes can be implemented in the coming years. We are rather in a prior exploratory period and, indeed, it may never be developed with these technologies or in this direction. The fervor with which some sectors of the education system have been pursuing BC has raised alarms, both by the origin of the enthusiasm, as well as for the consequences that a literal application of the technology as we know it could have.

At this time, speaking of the consequences of an implementation is to move into the field of speculation as much as the literature that is promoting it. Despite this, it wouldn't hurt to ask questions about the ideology and the agenda of institutions, enterprises, initiatives, or projects that are intended to be based on education using BC.

There is no shortage of criticism to the ideology that underlies the rhetoric as the design and functionality of cryptocurrencies. Golumbia (2015), for example, has described them as "right-wing extremism". That ideology matches perfectly, according to Watters (2016), with the "narrative of Silicon Valley", that is, libertarianism, neoliberalism, and global capitalism based on the "new economy" (Selwyn, 2013).

Watters (2016) quotes three key elements of the imagined future in the discourse on BC in education that deserve special attention:

- The anti-institutional disposition of BC;
- Its dependence on decentralization (technologically and metaphorically) that does not necessarily implicate democratize, but sometimes means dismantling the public sector;
- The invocation of trust (and mistrust) as the key social behavior mediated by technology.

Bellver (2017), for his part, has summarized the criticism of BC use in education on the following points:

- Usual relation with certification.
- They have an interest as state, international, or global shared repositories, but are limited to an institution that does not offer advantages with respect to the current electronic certificates.
- It is a technology in an experimental stage. The only consolidated implementation is the Bitcoin system.
- It is a technology with an overly complex implementation, based on the social implementation of terribly problematic matters (such as the use of public key cryptography) and with a considerable economic and energy cost.

- It ensures the validity of transactions, but the problem of the detailed certification and reputation of the custom learning would remain unresolved.

- If the transaction record is public and unchangeable, the user loses the right to privacy and to the definition of their own curriculum vitae. They cannot decide parties they would prefer to show it to or hide it from.

- Exaggerating the potential of BC to transform education implies reducing, once again, education to evaluation, and the evaluation to certification of competencies.

- The underlying ideology of BC is libertarian liberalism or libertarianism. Transferring this to education would give support to a global certification utopia with the participation of all in the same plan as the current educational institutions.

Among these criticisms, we can find some that collect the early development stage of technology. Its evolution in the coming years will show whether we are moving toward more economical and easy-to-use systems. Others refer to the use of BC to solve the first problem: the academic certification. Others raise some complex challenges such as the respect for the subject's privacy regarding elements of their curriculum vitae or the need to validate the accreditation that picks up the chain. Finally, we also find references to the underlying ideology that is allegedly behind this technology.

Ignoring those that cannot be adequately reflected in the current state of technological development, we believe that it is possible to summarize the major challenges posed by the BC in four points:

- It is not about easy and immediate implementation for social, technological, and economic reasons.

- It can lead to unacceptable consequences depending on the direction it is working and the intentionality with which it has been made.

- It presents challenges in areas such as privacy, transparency, functionality, and value of the certifications, as well as "official" and public institutions.

- It concern citizens who have seen in these years as some technological changes generates other changes not always desirable.

6. CONCLUSION

BC is a disruptive technology that, after a few years of implementation as the basis of digital currency, is showing itself to be an open resource with possibilities in different fields.

The key to the interest in this technology lies in its ability to move from a system of centralized data logging to a distributed system that ensures no alteration of the information and the maintenance of privacy.

For almost two years, MIT has been trying to apply BC to academic certification. If we take into account that in MIT, the OpenCourseWare project began, and the movement of the

MOOC has been incorporated, we must understand this application as a step towards an open system and comprehensive training. This, among other things, would call into question the exclusive authority enjoyed by today's institutions of higher education.

However, the concept of learning certification can also be applied in relation to training projects that strengthen the personalized itineraries for each student, and that, at the same time, try to solve some basic problems such as fair and equitable grades or the accreditation of the progress made.

It is likely that in the coming years we see a growing interest in this technology. For that interest to become contributions to the improvement of education, it will be necessary to open critical minds. An evolution of the technology and perhaps its replacement by other alternatives may also be necessary. And, of course, it would have to overcome the voices that come back to insist on old paradigms, such as the teachers who guide students passing on their knowledge.

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