BLOCKCHAIN TECHNOLOGY AND GAMIFICATION - CONDITIONS AND OPPORTUNITIES FOR EDUCATION

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TECNOLOGÍA BLOCKCHAIN Y GAMIFICACIÓN – CONDICIONES Y OPORTUNIDADES PARA LA EDUCACIÓN

Resumen:

El documento se centra en dos soluciones que apoyan la educación. Uno de los aspectos muestra el potencial del concepto moderno de blockchain, mientras que el otro se refiere a las formas de trabajo basadas en la necesidad natural de los estudiantes de competir, la gamificación. Ambas áreas se han desarrollado intensamente como parte de la implementación de las TIC en la didáctica detallada, incluida la educación de adultos. La presentación de ambas soluciones mediadas por las TIC es el resultado de la participación de los autores en el proyecto Smart Ecosystem for Learning and Inclusion (Ecosistema Inteligente para el Aprendizaje y la Inclusión).

Blockchain technology and gamification – conditions and opportunities for education

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Abstract:

The paper focuses on two solutions supporting education. One of the aspects shows the potential of the modern blockchain concept, whereas the other refers to the forms of work based on the natural learners' need to compete, namely, gamification. Both areas have been intensely developed as part of the implementation of ICT in the detailed didactics, including adult education. The presentation of both ICT-mediated solutions is the result of Authors' participation in the project Smart Ecosystem for Learning and Inclusion.

Key words:

Blockchain, new trends, gamification, adult education.

Introduction

Recent global high-tech trends concentrated on four areas of groundbreaking technologies, comprising of Artificial Intelligence (AI), Internet of Things (IoT), Augmented Reality / Virtual Reality (AR/VR) and Blockchain technology. These technologies have great impact on human lives in recent years. For example, Blockchain has been applied in education (Ocheja, Flanagan, & Ogata, 2018), finance (Wu, & Liang, 2017), health (Ito, Tago, & Jin, 2018), commerce (Yuan, et al., 2018), etc. The application of blockchain to support teaching and learning is quite new and promising. This study therefore summaries existing solutions of educational blockchain.

New ICTs are successfully used in both school and adult education (Potyrała, 2017). In addition to the traditional networking of knowledge, like in the case of the blockchain method, implementation of the ICT enables also changes in the learning and teaching dynamics. A model example of combining the ICT and the natural human needs of competition in the learning process is gamification. Transferring the mechanisms found in computer games into the learning-teaching process increases motivation to meet the desired didactic objectives (Yévenes Subiabre, 2018).

Gamification provides the opportunity to awake the ludic characteristics in the process of knowledge acquisition. Using game elements strengthens focus, orients towards the goal and creates new educational spaces. This method is effecitvely used in both, school-based teaching and adult education or business team management

(Buckley et al., 2019). The gamification technique is based on overcoming challenges which are, at the same time, the operationalisation of the detailed objectives (Woźniak, 2017). Gamification (presented in more details in the second par of this text) allows to eliminate routine activities from the education process. However, implementation of every solution presented herein requires understanding the components of the concept and its determinants (Chapman, & Rich, 2018).

Brief history of Blockchain

The unknown Satoshi Nakamoto published in 2008 a paper, titled "Bitcoin: A Peer-to-Peer Electronic Cash System", where he gives the blueprint on how to establish a secure and transparent digital currency that is not managed by a bank or a central body. Nakamoto coined the term "block chain", later used as blockchain (Nakamoto, 2009). Ten years ago, Bitcoin was the blockchain. Ethereum built on top blockchain what is now known as "smart contracts" in 2015, which allowed other financial instruments such as loans and bonds to be represented, segregating the blockchain technology from being used exclusively for Bitcoins. More industries have joined the blockchain technologies since like healthcare and education.

Definition of Blockchain

Blockchain is a secured distributed ledger technology that offers opportunity for digital recording and sharing of information over a computer network. The type of information differs in contexts but may include digital signatures, certificates, asset transactions, smart contracts, identities etc. (Grech & Camilleri, 2017; Piscini, et al., 2016). In education context for example, information such as graduation certificate, test report, learning achievements, performance metrics, academic profile, career interest etc., can be authenticated and transmitted mutually. Information entered in the ledger is communally transparent, permanent, and accessible on the network. In fact, the ledger being a chain of blocks represents a unit of data that multiplies over time at each update. Defined protocol is used to decide how new entries are initiated, validated, recorded, and distributed (Piscini, et al., 2016). Trust and immutability is ensured within the blockchain ledger through consensus protocol that allows participants to run complex cryptology algorithms to authenticate the integrity of the entire system.

Characteristics of Blockchain Technology

Traceability is the ability to track a specific transaction within the blockchain network. Inspecting the block detailed information of each transaction will reveal useful facts for tracking the transaction, since blockchain are time-order arranged, and each block is connected with the other closeby blocks.

Transparency permits all members within the blockchain to control the transactions since transactions are broadcasted and publicized as at when inputted. It is possible for members within the network to detect and reject distrustful transactions, thereby creating a sense of openness, transparency and security. Information on the blockchain cannot be altered without the consent of other participants, therefore building mutual trust, reliability and durability against internal or external attacks.

Decentralization allows the delivery of data processes such as input, transmission, verification, update, storage on the blockchain network are established according to the distributed structure. This ensure that the risk and responsibility of program execution and data processing are transferred from centralised systems to decentralized blockchain networks, where the trust between the network nodes are established through strong encryption and decryption techniques.

Immutability property ensure that the data and logs of transactions that are created mutually within the blockchain network are consistent at all times. Therefore, validated transactions or committed blocks cannot be modified or deleted.

Advantages of Blockchain technology

From the aforementioned characteristics of blockchain, we can derive some advantages of using blockchain in education.

Reliability: The failure of a single node in the network will not affect the whole network thanks to the decentralization characteristic of a blockchain network. This avoidance of single infrastructural point of failures allows the system higher reliability as opposed to centralized ledgers.

Trust: Instead of few institutions in charge of educational data, the trust of which we usually take for granted, blockchain technology allows all the nodes in the network to act as trust bearers with decentralized ledgers.

Security: The use of the hash function, which change a variable-length string into a fixed-length binary sequence halts any apparent relationship between the input and the output. The process is hard to reverse as it is impossible to trace back to the variable-length input from the binary output. This adds up to the newly generated nodes having to follow a linear sequence of time in the chain.

Efficiency: All data added to the blockchain undergoes a set of predefined procedures, this results in reducing the labor time as the number of involved intermediaries is reduced, which subsequently improves efficiency.

Authenticity of documents and certifications: All transaction within the blockchain network are legal and protected against fraudulent manipulation. Therefore, educational documents such as certificates, transcripts, and skills records are authenticated and validated.

Existing educational solutions/application of Blockchain

Blockchain technology has been applied to different aspects of education. Nowadays, researchers have been exploring the use of blockchain to provide solutions for many education problems. For instance, blockchain technology have been used by universities to manage the record of students' examination, verification of answers, maintaining record integrity, security and consistency (Sharples and Domingue, 2016; Hoy, 2017). A system that utilizes blockchain technology and internet resources in an online quiz system to verify students' answers with a public key was pre-

sented by Shen et al., (2018). The system aimed at making the answers in an online examination accessible to relevant stakeholders but not allowing alteration. The application of this technology in higher education institution can ensure transparency, trust and justice in evaluating students learning progress.

Similarly, the application of blockchain technology in hannesting data from learning management systems (LMS) around the world being used by educational institutions, organisations and industry, to achieve a centralized knowledge base has been proposed Ocheja et al. (2018). For example, the technology is capable of locking all learning data from LMS about an individual's learning history so that evaluation os such individual can be effectively done. Interestingly,, blockchain technology provide the opportunity to manage educational data centrally, ensure data consistency, immutability and security across the globe. This approach uses block, which contain the content that point to learning data, secured with ownership and access policies while the nodes represent the learners and learning providers (Ocheja et al., 2018). In the aspect of teaching, the goal of developing a smart contact-based learning activities that aid the educators to facilitate teaching can be achieved with blockchain technology. Several existing solutions of blockchain application are presented in Table 1. Most of these solutions are either prototypes or under development.

Table 1: Existing solutions of blockchain in education

Author(s)	Type of blockchain technology and Platform	Solution
Alexander Mikroyannidis, John Domingue, Michelle Bachler and Kevin Quick (2018)	Smart Contracts	The European Data Science Academy (EDSA) investigates the use of Smart Blockchain Badges to support in advancing the data science career of their learners. It issues badges into the blockchain containing information on data science courses completed (or partly completed) and skills acquired by the learners.
Cheng, Lee, Chi, & Chen, (2018)	Smart Contract for Digital Certificate	A solution to the problem of forged certificates based on blockchain technology. The system provide digital certificate with anti-counterfeit, anti-fraud, authenticity, and verifiability. The solution also use QR-code and inquiry string code attach to the paper certificate.
Sony Global Education (2017)	IBM Hyperledger (Smart Contracts)	The solution allows school administrators to manage students' educational data from several schools, as well as their records and digital academic transcripts with more trustworthiness.
MIT Media Lab, Learning Machine (2015)	Smart Contracts	This open source project focuses on developing the required technical resources for developers to use in their blockchain projects, rather than providing custom implementations.
Ocheja, Flanagan, & Ogata, (2018)	Blockchain Based Learning Analytics Platform	Proposed a blockchain based approach for connecting learning data across several learning platforms, institutions and organizations
Han et al. (2018)	Smart Contracts	Proposed a blockchain-based technique for creating an environment where individuals can be the owners of their official education records and can easily share those records.
Farah et al. (2018)	Tamper-Evident Learning Trace Repositories	The application of smart contract technology for developing an architecture that uses blockchain technology to sign and validate learning traces for authenticity.
Gilda, & Mehrotra (2018)	Blockchain for Student Data Privacy and Consent	A solution based on smart Contracts, hyperledger fabric and hyperledger composer, to develop a nested authorization that permits a data administrator to grant authorization rights for educational consent rights.

Forment, et al. (2018)	Blockchain, Smart Contracts	Discusses the need of privacy in learning analytics contexts, and suggests the reliance on blockchain or smart contracts to support in such mission. The solution that has yet to be implemented is a software that can run along with Moodle LMS. (The proposed solution is not yet implemented but is part of an ongoing PhD project at the university of Salamanca, Spain).
Arenas & Fernandez (2018)	CredenceLedger	The study present a decentralized verification of academic credentials based on blockchain. The system stores compact data proofs of digital educational credentials for easy verification.
Turkanovic, et al. (2018)	Ark Blockchain (Smart Contracts)	Suggests and provides a first prototype of EduCTX, an alternative to European Credit Transfer and Accumulation System (ECTS) based on the blockchain technology. A higher education credit, and grading system offering a globally unified viewpoint for students and higher education institutions.
Wu & Li (2018)	Blockchain based Digital Education Operational Skill Competition System	A blockchain based competition mode Application to support gaining operational skill.
Liu et al. (2018)	Hyperledger - Education-industry cooperative system	This system is in prototype phase, uses IBM's hyperledgers and implements a blockchain-based education-industry cooperative system where students share data with employers.
Duan, Zhong, & Liu, (2017).	Learning outcome and meta-diploma solution	The study focused on the blockchain technology based on learning outcome.
John Rooksby & Kristiyan Dimitrov (2017)	A blockchain system based on Ethereum	Exploratory design and implementation of blockchain system for use at the university to store student grades
Hölbl, et al. (2018)	EduCTX, Managing Digital Micro-credentials based on ethereum	An ethereum based platform that enables managing, assigning and presenting credentials for educational stakeholders
Gazali, et al. (2018)	Smart Contracts, Ethereum	Dedicated to student loans, it can help the Malaysian National Higher Education Fund Corporation (PTPTN) better track the status of borrowers and collect back their payments. The borrowers are able to track their transactions and current arrangements with multiple organizations in the platform.
Jirgensons & Kapenieks (2018)	OpenBlockChain	An ethereum based blockchain platform created by UK's Open University Knowledge Media Institute (KMI)
Shen & Xiao (2018)	Online quiz scheme based on Double--layer Consortium Blockchain	The online quiz system help to solve the problem of non-transparent scoring process by providing open verification of the test records.
Farah et al. (2018)	Smart Contracts	Another application of blockchain in learning analytics. It suggests a blueprint for a system that uses blockchain technology to validate the authenticity of learning traces from online learning activities which are stored across multiple locations.
Bai et al. (2018)	Smart Contracts	The system proposed here is called Researchain. A system that helps in Scientific Project Research Management SPRM.

Gamification

Gamification has been used all over the world. It is most often implemented as: short exercies without an online help, MOOC, blended / flipped learning, e-learning platforms, gamified platforms / systems or mobile applications. All the above mentioned solutions share a common characteristic – they reward students for their engagement in different educational tasks (Mahfuzah Mohamad et al., 2018).Most teachers who use this method emphasise greater engagement and motivation regard-

less of the level, subject, stage of education and cultural context. Gamification is based on the assumptions behind the computer games, specific characteristics of which are transferred into the educational environment. The investigators of the educational processes say that gamification is the answer to the changes occurring in the detailed didactics, which include the shift of focus from teachers to learners in the process of knowledge acquisition. It has been noticed that this solution is also the answer to the social transformation which shifts learning and teaching towards the ludic and less formalised forms. When discussing gamification, we should pay particular attention to rules as limitations resulting from the participation and scoring are crucial. Thus, gamification combines several perspectives: social rules, ludic character, innovation, competition typical for market environment (e.g. labour market) and natural human needs (Dymek, 2018). Other, equally important but often neglected aspect is the high saturation of individual users and education institutions with the ICTs. The technological revolution noticeable, among others, in almost unlimited Internet access, individual users owning modern and fast miltimedia devices (like smartphones) or access to user-friendly and highly useful educational e-solutions (like Kahoot) provides the natural base for using the ICT in didactics.

Gamification may also be used in mass education based on distance learning platforms (Aparicio et al., 2019). Considering the fact that the principles of this teaching form are partially derived from the digital world of computer games or Problem Based Learning, it is somewhat a natural solution which can be implemented for Moodle, OLAT and other platforms. The results obtained based on the completion of tasks give users the opportunity to verify their knowledge and develop skills individually (self-monitoring) and also allow teachers and trainers to compare the results in the group against the set objectives.

Gamified learning is a new approach that brings hope for an increase of the learning effectiveness. Students-gamers have different personalities and learning syles. This fact also determines the effectiveness of gamification. Achieving high results thanks to gamification, however, raises the question about the relation between the way gamification is perceived (e.g. openess to the positive impact of gamification) and learning styles. The initial research confirm that the existence of the above mentioned correlations (Abdollahzade, Jafari, Bagher, 2018). Thus, designing tasks using gamification requires considering not only the operational goals but also the characteristics of the learners, including their individual features.

This assumption has been proved right by the initial studies (N=41 students particpated in the study for 7 weeks). The experiment revealed that there are differences in the results achieved by using gamified learning, which depended on the type of players and gamification components like: achievements, the ways scores and rewards could be obtained, structure of the game e.g. unlocking the content, level achieved and obstacles, types of gratification, team selection and the history of cooperation in the group, the level of motivation. The game is also diversified internally in terms of its components which were evaluated by students as: liked, not liked and neutral. The results of the research indicate that: (a) players may obtain different results and engage differently depending on the project features in the gamified learning, (b) different mechanisms in the gamified learning attract students depend-

ing on the type of player, (c) the elements which trigger different group processes in gamification differ depending on the individual attutide towards the game, (d) selection of the gamification components and the context of using them in the education influence the characteristics of learning (Kocadere, Çağlar, 2018).

In the literature of the subject shares some concerns regarding the application of gamified learning, for example in human resource management. There is a discussion whether using forms such as gamification leads to neglecting the important components of the corporate processes like earning the real remuneration vs. the virtual one (Kim, 2018). Therefore, when analysing the problem of gamification, it is worth to be aware of this method's limitations also in the moral aspect, especially regrading the methods of managing the adult workers.

Gamification elements have been also increasingly used to accelerate the creative proceses in commercial organisations. The initial research results suggest there is a correlation between using gamification and the early stages of innovations, diveristy and intensity of engagement in the creative process, building the "team spirit", reaching consensus within the team, transfer of knowledge, triggering creative thinking and productivity (Patrício et al., 2018).

Gamification is the innovative teaching strategy of using digital games in the educational environment, which serves primarily as a learning support tool. The recent publications about the gamification in group and individual learning clearly confirm that implementation of this form strengthens comptencies, autonomy, collaboration and, first of all, motivation. Gamification is one of the elements of reversed education (Ling, 2018) which assumes that students, regardless of age, have the basic skills and knowledge allowing them to solve problems and explore other areas covered in the curricula – not only through the traditional, direct instruction.

The potential of this method is also seen in the fact that gamified learning is introduced into educational activities regardless of the stage of education. Implementation of gamification at the higher stages of the formal or voluntary, non-formal education is more and more popular and is included in the repositories of the so called good practices (Schefer-Wenzl, Miladinovic, 2018; Osatuyi et al., 2018; Khan et al., 2017; Steinert et al., 2018).

Conclusions

ICTs have become the common and noticeable fact in different areas of the social life. The prevalence of the ICT-based solutions irrevocably changes the functioning of individuals and organisations (Szpunar, 2017). ICTs have been increasingly implemented in the educational environment as well. Today, the common access to the new technologies is used not only to transfer knowledge via websites or mediated communication. It also assumes more and more complex forms like MOOC, distant learning, self-education in highly specialised fields or international cooperation in implementation of complicated and complex edcuational objectives (Lamanauskas, 2017; Frania, 2014;). ICT also changes the didactics, adding the whole range of new forms and methods (Eger, 2015). This is a global trend. Tranformations take place in the school-based as well as adult education (Veteska, 2016). Two examples presented herein: blockchain and gamification are only a small excerpt from the oppor-

tunities offered by the ICT-based educational environments. As technical limitations are diminishing, the challenge that remains is the ability to use ICT effectively and adequately depending on the specific goals determined by the didactic rules or the attitudes of educators at every educational stage (Makarova, Makarova, 2018; Velickovic, Stosic, 2016). Other important aspect which is not sufficiently addressed in this text is the idea of understanding and studying the processes that accompany the use of gamification or the possibilities of the blockchain method. The influence of the ICT on the learning and teaching process, inlucing improving the efffectiveness of both, is still discussed and oftentimes yields contrary research results. Despite this, we can observe the growing number of coaches or teachers who intuitively and efficiently use different ICT-based solutions (Frania, 2016).

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