Applications of blockchain technology to education Policy

ANDREIA DE BEM MACHADO
Department Of engineering
University Uniasselvi
Av. Getúlio Vargas, 63 - Centro 2, Brusque - SC,
BRAZIL
andreia.bemmachado@uniasselvi.edu.br

MARIA JOSÉ SOUSA
Department of Political Science and Public Policies
Instituto Universitário de Lisboa
Avenida das Forças Armadas
PORTUGAL
maria.jose.sousa@ISCTE-IUL.pt

FERNANDA DOS SANTOS PEREIRA
Department of Management
Instituto Politécnico de Beja
R. 1º de Maio, 7800-000 Beja
PORTUGAL
fernanda.pereira@ipbeja.pt

Abstract: - Blockchain technology can be applied to education, for both learners and teachers, in many innovative ways as for getting a diploma in management or for the achievements assessment, but also on formative evaluation, learning activities design and implementation, and keep tracking the whole learning processes. For this research, we will focus on analyzing the scientific production of Blockchain technology in education using bibliometric analysis. Then based on the analysis of the literature, identify some recommendations for policy in order to redesign the educational system based on the application of the blockchain technology.

Key-Words: Blockchain technology; learning; education; public policies

1 Introduction

Blockchain is a public ledger that automatically records and verifies transactions [1]. However it can also be used by Universities to improve learning opportunities, namely, through the transcripts, as academic credentials must be universally recognized and verifiable, and blockchain solutions allow the use of verification procedures and reduce fraudulent claims of free educational credits.

Moreover, blockchain technology has the potential to revolutionize the management of Educational institutions [2]. Using blockchain to its fullest potential for education requires that policy-makers secure awareness that the emergence of the blockchain may have a significant impact on existing and planned activities and strategies.

Reliably validate certificates automatically, being publicly available and verifiable by any user against a blockchain [3]. It can also be applied to intellectual property management, for the tracking of first publication and citations, without the need for a central authority to manage these databases. Blockchain-based cryptocurrencies are likely to be used to facilitate payments within educational institutions.

2 Materials and Methods

In order to answer the problem of this research, the study was classified as exploratory-descriptive in order to describe the theme and increase the familiarity of the researchers with the fact as well as to clarify the concepts inherent to the subject under study [4].

As a method of searching the literature, a systematic search was used in an online database, followed by a bibliometric analysis of the results. Bibliometrics is an information science methodology that uses mathematical and statistical methods to map the documents and publication patterns from bibliographic records stored in [5]. For the authors, bibliometrics allows relevant counts as production by region; timeliness of publications; research by area of knowledge; counts of literature related to the study citation; impact factor of a scientific publication. Mathematical and statistical data that contribute to the systematization of the result of research and the minimization of the occurrence of biases when looking at a specific theme.

For the bibliometric analysis, the study was organized in three distinct stages: planning, collection, and outcome. These steps happened in a convergent way to answer the guiding question of the research: What is the state of the art blockchain in education?

Planning began in June 2019, when the survey was conducted. In this phase, some criteria were defined as the limitation of electronic database search, not considering physical catalogs in libraries, given a large number of documents in the Web search databases. In the planning scope, they were stipulated as relevant for the Scopus database (www.scopus.com) due to the relevance of this base in the academic environment and its interdisciplinary character. Moreover, also because it is one of the largest databases of bibliographic summaries and references of peer-reviewed scientific literature and its relevance.

Considering the research problem, the search terms were delimited, still in the planning phase, namely: "blockchain and education" OR "education and blockchain." The use of the Boolean OR operator had the objective of including as many relevant studies as possible that address the theme of interest in this research. Also, the use of the trunking (*) occurred to potentialize the result seeking habitat and its variations written in the literature. It is considered that the variations of the expressions used for searching are presented in a broader context within the same proposal since a concept depends on the context to which it is related, depends on its historical trajectory and preexisting conceptual analysis. So as a fundamental principle for searching, we chose to plan the search for the use of terms in the "title, abstract and keyword" fields, without limiting temporal, language or any other restriction that may limit the result.

From the planning of the research, the data collection recovered a total of 120, indexed works which pointed to the record of 2017, first publication, until 2019.

3 Results

As a result of this collection, it was identified that these works were written by 77 authors, linked to 48 institutions from 112 different countries. We used 170 keywords to identify and index the publications that are distributed in 18 areas of knowledge and six types of publication. Table 1 presents the results of this data collection in general bibliometric analysis when mapping the theme instructional design in the Scopus database.

Table 1. General bibliometric data

Database	**Scopus**
Search Terms	"blockchain and education" OR "education and blockchain."
Search fields	"title, abstract e key words."
Total of recovered works	120
Authors	77
Institutions	48
Countries	44
Keywords	170
Knowledge areas	18
Type of publication	6

Source: Authors (2019)

The universe of 120 scientific papers composes the sample for a general bibliometric analysis of publications in the area of blockchain and education, without specific limitations, which allows setting the state of the art of the subject, from the database consulted.

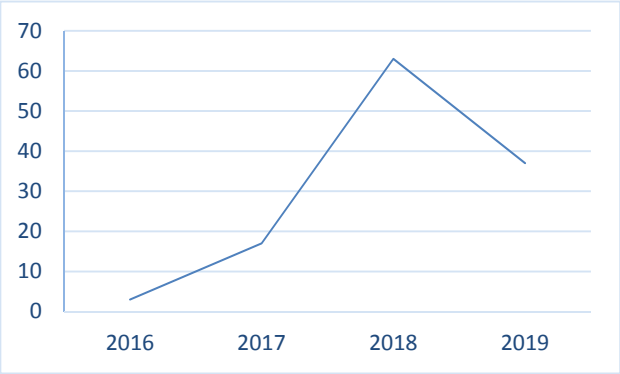
3.1. The scenario of scientific publications

The works analyzed are composed of 126, from the Scopus database. In order to evaluate the results in a more detailed way for the bibliometric analysis, this result was exported to a bibliographic management software called EndNoteWeb. These data provided the organization of the relevant information in a bibliometric analysis, such as temporal distribution; primary authors, institutions and countries; type of publication in the area; main keywords and the most referenced works.

3.1.1. Time distribution of studies

At first, the temporal distribution of the work was analyzed, identifying that the publications were unusually timid in 2016 with the number of 3 works in the area. As of 2017, research in the area has intensified reaching a total of 17 types of research in the area. This number increased in 2018 with 63 papers. In 2019, 37 publications, it is considered that this lower representativity is related to the period of the research that was in June of 2019. For better visualization, graph 1 was elaborated.

Graph 1. Time distribution of the works



Source: Authors (2019)

Three pioneering works were identified: Bitcoin forensics: A tutorial of the authors [6]; The blockchain and kudos: A distributed system for educational record, reputation and reward [7] and From Risk Management to Risk Engineering: Challenges in Future ICT Systems (Book Chapter) [8] published in the year 2016.

In the first article titled Bitcoin forensics: A tutorial of the authors discuss Bitcoin digital crypto-crash its use and the adoption of this tool in illegal activities.

In the second article, The blockchain and kudos: The distributed system for educational record, reputation, and reward explicates on 'blockchain' and the use as the central mechanism of the digital payment system Bitcoin. We also discuss the set of interrelated technologies: the blockchain as a distributed record of digital events.

In the third publication entitled From Risk Management to Risk Engineering: Challenges in Future ICT Systems is a book chapter which provides an initial overview of the fundamental mechanisms we need to build to support the risk engineering view: risk ontology, modeling, and composition of risk and language of risk.

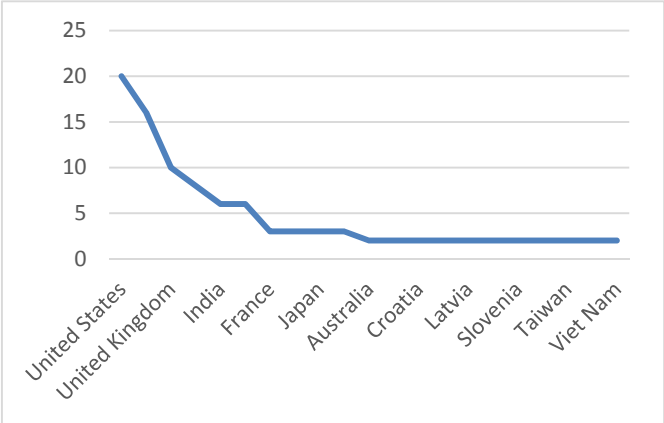
It can be noticed that already at the beginning of the publications on the subject there was an alternation in the publications, being that began with only three publications in 2016, is that in 2017 there were 17 publications and in 2018 there was significant growth with 63 works. That is, the research in the area points to evidence of the relevance of the theme and in general of the discussions that are related to blockchain and education and the topics of data security technology in the educational scenario.

3.1.2. Time distribution of studies

Of the 120 papers, a varied list of authors, institutions, and countries that stand out in the research on blockchain and education.

When analyzing the country that has the most published in the area, one can see that the United States stands out with an average of 17% of the total publications, a total of 20 works. In the second place, China stands out with 13% of the publications, that is, 16 works. Chart 2 shows the top countries with up to two publications in the area.

Graph 2. Distribution by country of work



Source: Authors (2019)

Another analysis carried out is related to the identification of prominent authors in the area where it was observed that 14 authors could be referred to as a reference in the theme blockchain and education, considering author reference that has two publications indexed in the area. In order to organize this data, Table 2 was elaborated, with authors of outstanding in the area, their respective numbers of published articles, institution in which they are affiliated and country.

Table 2. Relation authors with the highest number of publications with their affiliations and country

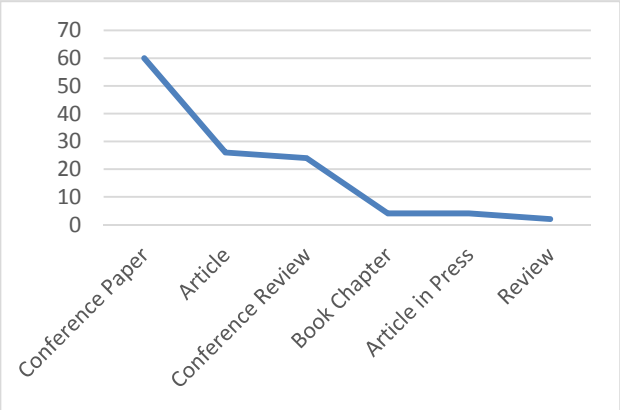
Authors	Number of publications	Affiliation	Country
Domingue, J.	2	Open University	United Kingdom
Duan, B.	2	Xiangtan University	China
Hara, S.	2	Middlesex University	United Kingdom
Hori, M.	2	NPO CCC-TIES	Japan
Kita, T.	2	Kumamoto University	Japan
Mitchell, I.	2	Middlesex University	United Kingdom
Miyahara, H.	2	University of Yamanashi	Japan
Miyashita, K.	2	Kyoto Women's University	Japan
Ono, S.	2	NPO CCC-TIES	Japan
Pröll, B.	2	Johannes Kepler Universitat Linz	Austria
Retschitzegger, W.	2	Johannes Kepler Universitat Linz	Austria
Schwinger, W.	2	Johannes Kepler Universitat Linz	Austria
Schönböck, J.	2	University of Applied Sciences Upper Austria, School of Informatics	Austria
Tsai, W.T.	2	Beihang University	China

Source: Authors (2019)

Based on this table 2 concerning figure 2, it is noticed that the prominent countries of publication are not necessarily where one finds the authors with the highest number of publications. For example, the United States that stands out as the country with the most publications in the area does not appear when analyzing countries, considering the prominent authors. Already the United Kingdom, country that appears in third place in the general rank only brings two authors. Thus, it is noticed that considering the authors of highlights the countries that stand out in the first instances are: Japan with 5 authors and Austria with 4 authors, by country. However, in Chart 2, these countries appear as four and fifth countries, respectively. Also, in second place is China with 2 authors, however, to look at the general graphic, this stood out as the second place of representative of publications in the theme. This allows us to infer that where there is a higher concentration of publications, these cannot be considered as reference authors in the area. The publication is concentrated in large numbers from a variety of authors.

From the general survey, it was possible to further analyze the type of document the researches in the area of blockchain and education. It is noticed that the publications focus on a conference paper with 50% of the total article number with 22% of the publications. In total, there are six categories of marked indexations and a group called undefined aggregates the other and possible indexations, as shown in graph 3.

Graph 3. Distribution of publications by type of newspaper



Source: Authors (2019)

Among the six types of documents, there are 60 conference paper, 26 publications journal-articles, 24 conference review, 4 book chapter, 4 articles in the press, and 2 reviews.

From the bibliometric analysis, based on the retrieved workgroup, in the Scopus database, it was possible to identify a total of 170 different keywords. Being that of these the highlight is for the word "Blockchain" with 74 occurrences. Following the highlight was "Engineering Education" and "Internet of things" in a total of 25 and 13 occurrences respectively. In the fourth position stands out the word Education with 12 occurrences. There is also technological development with Learning Systems and Smart Contracts highlighting in fifth place. For analysis of these 170 different words used in the 120 articles, the cloud of tags was elaborated, with the keywords that appear with up to 7 occurrences, demonstrated in Figure 1, from the recovered works, highlighting the keywords.

Figure 1.Tag cloud

The interface of blockchain and education discussion converges with the theme science, education, learning, technology, national economy, and security in data transmission.

4 Discussion: Blockchain Technology Applications to Education Policy

Blockchain is a distributed database, spread across many computers with no central control that could transform governance, the economy, businesses, and the functioning of organisations [9]. Also, by the way, it is already here, not only in Bitcoin [10], but in many other services and commodities – badges, credits, and qualifications.

All things are distributed, public, synchronized and encrypted, and the transactions are logged with a time, date, and other details. This configures a more efficient, secure, and transparent way of handling transactions. The application of Blockchain to Education [11]; can be implemented both on national and international educational bodies. It will be me the most secure system to store badges, credits, and qualifications.

The blockchain provides allows you to measure progress and learning outcomes. [12]. Students can even receive real-time rewards.

According to Bakri Awaji and Ellis Solaiman, some educational units, notably higher education institutions, use the blockchain experimentally, though the records are much more specific, authentic and revealed anti-theft.

Applying the blockchain to education requires assessment to be formative, constant monitoring of students' educational development, and the actual use of learning delivery.

The blockchain technology used as a shared and permanent record of completion of work and certificates, thus eliminating the need for a formal record of dates and authors.

Just as bitcoin has currency characteristics, so blockchain for education link to a reputational currency [13].

At this time, some Universities already use this system to manage student certificates received via digital platforms.

Moreover, education is becoming more diversified, decentralized and disintermediated, and blockchain will help to maintain reputation, trust in certification, and proof of learning.

Some of the processes that can improve from this technology are certificates, helping to stop fake certification, with encryption and two-factor authentication process. For a group of universities that need to co-operate and share repositories of certification, blockchain introduces integrity and

transparency in the process. In a global system and with the increasing mobility of the students, a blockchain database of credentials is the answer, whether the students are moving to another educational institution, a new job, or a new country

One of the biggest obstacles to blockchain's widespread use is a reluctance to a new technology which people have some difficulties in understanding [14]. Despite its distinct advantages, in the Educational System, the process tends to be slow.

Based on the literature review, some recommendations for Higher Education public policy arise:

− Creation of a public blockchain to store the digital signatures associated with the digital certifications and the verification of the authenticity of a certificate only requires comparison with the digital signature stored on the blockchain.

− Definition of measures to facilitate the transfer of credits to award learning (such as Higher Education Institutions using ECTS).

− Definition of a system to track the reuse of open educational resources and also the use and reuse of intellectual property created by an institution.

− Definition of a system based on blockchain technology learners would for students to store their evidence of learning received from any source – whether formal, non-formal or informal – and when shared, a blockchain would be used for instant verification of the authenticity of these documents.

− Implementation of a system where students would provide payments for studies via blockchain-based cryptocurrencies.

− Definition of a system with students data-keeping that data safe, and ensuring that the devices that access to the data are also secure.

5. Conclusions

This article identified the primary scientific production related to blockchain technology for education, and beside of the number of articles have been increasing the implementation process still are in the initial stage.

The main current activities of the Education institutions using blockchain are awarding certificates and accepting blockchain-based cryptocurrency payments. The trust in blockchain technology need to migrate from finance to education, and a change in the mindset of the Educational leaders and policymakers need to happen in order them to understand the benefits and opportunities for the Education sector, being influential in future studies to analyze the impacts of blockchain technology on Education.

References:

[1] Yifu, J. Title of the article. Blockchain + Education *Demand Analysis and Technical Framework, China Educational Technology,* **2017**, 368, 62-69.

[2] Xianmin, Y.; Xin, L.; Huanqing; W.; Keyun, Z. Application Model and Realistic Challenge of Blockchain Technology in Education, Modern distance education research, 2017; Volume 2, pp. 34–45.

[3] Sharples, M.; Domingue, J. The Blockchain and Kudos: A Distributed System for Educational Record, Reputation and Reward. Open Research Online, 2016; pp. 40-46.

[4] Lakatos, E. M; Marconi, M. Fundamentos de metodologia científica. São Paulo: Atlas,2010.

[5] Santos, R. N. M.; Kobashi, N. Y. Bibliometria, cientometria, infometria: conceitos e aplicações. Tendências da Pesquisa Brasileira em Ciência da Informação, Brasília, v.2, n. 1, p. 155-172, 2009.: <http://inseer.ibict.br/ancib/index.php/tpbci/article/viewArticle/21>. Accessed on: 16 out. 2019

[6] Neilson, D.; Hara, S.; Mitchell, I. Bitcoin Forensics: A Tutorial. Global Security, Safety And Sustainability - The Security Challenges Of The Connected World, [s.l.], p.12-26. 2016.: Springer International Publishing. http://dx.doi.org/10.1007/978-3-319-51064-4_2.

[7] Sharples, M.; Domingue, J. The Blockchain and Kudos: A Distributed System for Educational Record, Reputation and Reward. Adaptive And Adaptable Learning, [s.l.], p.490-496. 2016. Springer International Publishing. http://dx.doi.org/10.1007/978-3-319-45153-4_48.

[8] Huth, M.; Vishik, C.; Masucci, R. From Risk Management to Risk Engineering. Handbook Of System Safety And Security, [s.l.], p.131-174, 2017. Elsevier. http://dx.doi.org/10.1016/b978-0-12-803773-7.00008-5.

[9] Yuan, Y. and Fei-Yue, W.. Blockchain: The State of the Art and Future Trends, Acta Automatica Sinica, 42(4): 481-494. 2016.

[10] Kosba, A., Miller, A., Shi, E., Wen, Z., Papamanthou, C.Hawk: The Blockchain Model of Cryptography and Privacy-Preserving Smart Contracts. Security & Privacy, 839-858. 2016.

[11] Xianmin, Y., Xin L., Huanqing, W., Keyun, Z., Application Model, and Realistic Challenge of Blockchain Technology in Education, Modern distance education research (2): 34-45. 2017.
[12] Awaji, B. and Solaiman, E.. Online Education using Blockchain and Smart Contracts. Dccsedu 2019
[13] Sharples, M., De Roock, R., Ferguson, R., Gaved, M., Herodotou, C., Koh, E., Kukulska-Hulme, A., Looi, C.-K., Mcandrew, P., Rienties, B., Weller, M. and Wong, L. H. (2016) Innovating Pedagogy 2016 Exploring new forms of teaching, learning and assessment, to guide educators and policy makers
[14] Yuan, Y. and Fei-Yue, W. Blockchain: The State of the Art and Future Trends, Acta Automatica Sinica, 42(4): 481-494. 2016.