Blockchain technology to support smart learning and inclusion: Pre-service teachers and software developers viewpoints

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Tecnología Blockchain para apoyar el aprendizaje inteligente y la inclusión: puntos de vista de los maestros en formación y desarrolladores de software

Resumen:

En apoyo de un ecosistema abierto para el aprendizaje inteligente y de larga duración, este estudio evalúa la percepción de las partes interesadas como los maestros en formación y los desarrolladores de blockchain, sobre la viabilidad de la tecnología blockchain para abordar las numerosas brechas en la implementación del entorno de aprendizaje inteligente. Esta investigación fue diseñada dentro del proyecto internacional Ecosistema Inteligente para el Aprendizaje y la Inclusión (SELI). Un total de 491 maestros en formación y 3 desarrolladores de blockchain de varios países participaron en el estudio. Los datos del estudio se obtuvieron de un cuestionario y una entrevista. Se realizó un trabajo de estadística descriptiva y análisis de contenido en los datos recopilados. Los resultados de este estudio indican que la tecnología Blockchain en el campo educativo rara vez se conoce, y la frecuencia de uso es bastante baja. Los maestros en formación encuestados, en su mayor parte, desconocen el grado de efectividad de la tecnología blockchain en educación. Los desarrolladores de Blockchain opinan que Blockchain todavía es nuevo para muchas personas y que los recursos para la aplicación basada en la educación son muy raros, incluso si están allí, aunque no muchos son de código abierto.

Blockchain technology to support smart learning and inclusion: Pre-service teachers and software developers viewpoints

Solomon Sunday Oyelere[1] Umar Bin Qushem[2] Vladimir Costas Jauregui[3] Özgür Yaşar Akyar[4] Łukasz Tomczyk[5] Gloria Sanchez[6] Darwin Munoz[7] and Regina Motz[8]

[1,2] University of Eastern Finland, Joensuu, Finland [3] Universidad Mayor de San Simón [4] Hacettepe University, Turkey [5] Pedagogical University of Cracow, Poland [6,7] Universidad Federico Henríquez y Carvajal, Dominican Republic [8]Universidad de la República, Uruguay
{solomon.oyelere, umarbin}@uef.fi, vladimircostas.j@fcyt.umss.edu.bo, akyar.ozgur@gmail.com, tomczyk_lukasz@prokonto.pl, gsanchez@ufhec.edu.do, dmunoz@ufhec.edu.do, reginamotz@gmail.com

Abstract. In support of an open ecosystem for lifelong and smart learning, this study evaluates the perception of educational stakeholders such as pre-service teachers and blockchain developers about the feasibility of the blockchain technology in addressing the numerous gaps in the implementation of smart learning environment. This research was designed within the international project, Smart Ecosystem for Learning and Inclusion (SELI). A total of 491 pre-service teachers and 3 blockchain developers from these countries participated in the study. The study data was collected from a questionnaire and interview. Descriptive statistics and content analysis was performed on the collected data. Results from this study indicates that Blockchain technology in the educational field is rarely known, and the frequency of use is quite low. The pre-service teachers surveyed, for the most part, are unaware of the degree of effectiveness of blockchain technology in education. Blockchain developers are of the opinion that Blockchain is still new to many people and resources for education based application are very rare, even if it is there, yet not many are open-source.

Keywords: Smart learning environment, Open learning ecosystem, Inclusion.

1 Introduction

The application of blockchain technology in education is gaining popularity recently. Many institutions across the globe have started initiatives to develop blockchain-based solutions that will address pedagogical gaps [29]. Most contemporary blockchain solutions in education have focused on transcripts, badges, and records of achievement. For example, Arenas & Fernandez [28] present a decentralized verification of academic credentials based on blockchain. The blockchain stores compact data proofs of digital educational credentials for easy verification. Similarly, Ocheja, Flanagan, & Ogata, [29] studied a blockchain based approach for connecting learning data across several learning platforms, institutions and organizations. In fact the advancement of technology and current capabilities of digital devices have impelled another possibility to the traditional educational records and transcripts, which comprise of additional security and comprehensive information. However, some important solution of blockchain are

still unimplemented, such as the description of the skills attained, competencies, soft skillsets, level of skill mastery, managing access rights, extra-curricular activities that support learner's development [15][25][29]. Furthermore, students do not have direct access to their educational history and transcripts, but have to rely on the institutions, which may not be the optimal solution for sharing the record. In support of an open ecosystem for lifelong learning, and smart learning, this study evaluates the perception of educational stakeholders such as teachers, pre-service teachers and blockchain developers about the feasibility of the blockchain system in addressing the numerous gaps in the implementation of smart learning technology. The overall aim of this research is to present the preliminary findings about the application of Blockchain technology in the educational settings from the point of view of preservice teachers and technical developers.

2 Literature Review

Nowadays, some universities and institutes have applied blockchain technology into education, and most of them use it to support academic degree management and summative evaluation for learning outcomes [1]. There are many application and development occurring in technical industry with the integration of blockchain technology which aims to strengthen the effort of open ecosystem for learning by securing collaborative learning environment, protecting learning objects, identifying the necessary technologies and tools, enhancing the students interactions with educational activities and provides a pedagogical support for lifelong learning [2]. This chain block is thus a transaction log or ledger (ledger) public, shared by all nodes in the network [25].

2.1 Technologies to Support Open Education - Existing Blockchain Solution in Education

To begin with a full-scale system, it certainly addressed the MIT Media lab's blockchain education credentialing system 'Blockcerts' which is the only fully functional blockchain based system that supported open education. The inception of the blockcerts started from an incubator project at MIT Media Lab in 2015 which operated its functions with collaboration with Learning Machine, a Cambridge based Software Company. The blockcerts is capable of delivering digital certificates of achievement and served as a middleware in between issuance and retrieving certificates online which eliminates the risk of falsified certifications available on the market by so many unlicensed issuers [3]. In the aim of integration of blockcerts, MIT used blockchain wallet which solves the problem of public and private keys in securing bitcoin blockchain transactions though bitcoin network is getting bigger raising the question mark to a new additional fee to the stakeholders. Based on the success of the blockcerts, the university of Nicosia was the first higher education institute that adapted the distribution of academic certificate through bitcoin blockchain [4][5] alongside the Malta, as the first European Country to follow the lead [6].

In the wave of new technological needs to the education system, decentralized Autonomous credit system is an ideal approach to digitize the sector [7]. EduCTX, a blockchain based higher education credit platform was invented to fill the gap, especially in Europe where the European Credit Transfer and Accumulation System (ECTS) is used as a common academic credibility [7]. Turkanovic, Holbl, Kosic, Hericko and Kamislac's proposed global blockchain-based higher education credit platform took the advantage of ARK [8], open-source blockchain platform in building a unified, simplified and globally ubiquitous higher education credit and grading system which supports various stakeholders including HEIs in their activities related to students and organizations and provides a gateway of fraud detection and early prevention. It also enables future employees' possibilities to track the students' academic achievements in a transparent way through a peer-to-peer network and proof of work [9][10].

Building digital trust in cyberspace is a risk judgement among stakeholders. Blockchain came along to prove a safe environment for many financial institutions, it is now ready to bring the trust in the education sector as well such as validating processes to documents including certificates, course assessment and evaluation of student competencies. Bandara, Loras and Arraiza [11] argued quite nicely in their work and proposed a blockchain-secured Digital Syllabus. This infrastructure reduces the interdependency and allows Digital Syllabus to store on a public database (blockchain network) through hash function before validating and producing a validated Syllabus [11]. The overall process encourages more openness to our education and set a great example to have an impact on our society.

3 Research Design and Context

This research was designed within the international project, Smart Ecosystem for Learning and Inclusion (SELI) [24]. The main objective of this study was to investigate the conditions related to the integration of Blockchain technology in ICT-supported learning, teaching and educational inclusion. These goals are primarily diagnostic but they will also enable comparative analyses of the selected European and Latin American countries. While conducting the research among pre-service teachers, we answer the following questions:

How often are blockchain used in the school environment and among the pre-service teachers?

What is their subjective evaluation of the blockchain used to support learning, teaching and digital inclusion?

What is the level of interest in new online trainings focused on the development of blockchain in learning, teaching, development support and digital inclusion?

The research data was collected using the questionnaire and interview. The technique used was the diagnostic survey and the tool was an online or printed questionnaire. The research was conducted among pre-service teachers in the period May - September 2019. The research covered the countries: Uruguay, Poland, Bolivia, Turkey. A total of 491 pre-service teachers and 3 blockchain developers from these countries participated in the research.

4 Results

4.1 Perception of Pre-service Teachers to Blockchain in Education

The percentage of pre-service teachers who have never been used blockchain technology exceeds 75% in Uruguay, Poland, and Bolivia. Turkey is an exception, in which about half of the respondents used this technology. The frequent and widespread use of this technology is 11.3% for Turkey, meanwhile for Uruguay is 4.31% and, for Poland is 4%. Occasional use of this technology for respondents in Turkey is 38%, 20.67% in Poland and, 17% in Uruguay. Bolivia is a country with frequent use of less than 1% and occasional use that barely reaches 7.8% (see Figure 1). Blockchain technology in the educational field is very little used, and the frequency of use is quite low. Except for Turkey, that reaches 38% of occasional use, the other countries have occasional use less than 20.67%, being Bolivia the country with fewer respondents using blockchain.

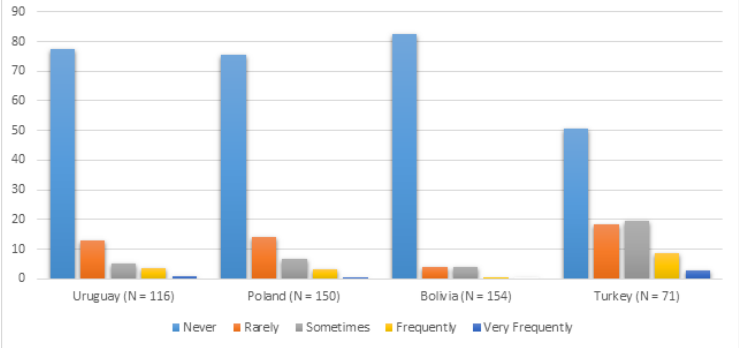

Fig. 1. Usage of the blockchain technology

The pre-service teachers surveyed, for the most part, are unaware of the degree of effectiveness of blockchain technology in education. In Uruguay and Bolivia, lack of knowledge of the degree of effectiveness is high; 75.86% in Uruguay and 77.92% in Bolivia. In Poland, 40.67% of respondents and 45.1% of them in Turkey state that they do not know the degree of effectiveness of this technology (see Figure 2).

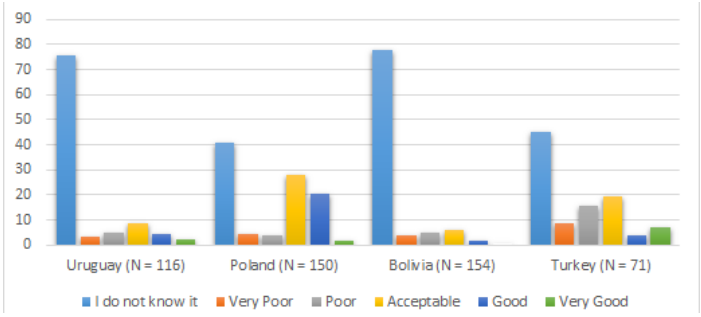

Fig. 2. Perception of how effective the blockchain solutions are in education

Considering only the pre-service teachers who have a perception of the degree of effectiveness of blockchain in education, there is a tendency to evaluate it as acceptable by approximately one-third of the respondents, meanwhile, Poland reaching almost half of those respondents (47.19%) with acceptable approval of this technology. The high percentage of respondents who consider it low effective are in Bolivia and Turkey; The case of Turkey has a high percentage of respondents who used this technology (reaches 54.9%) and has a high percentage of disenchanted with the experience in its use. Poland is a compelling case, since the group that has experience of use with this technology, only 14.61% consider it ineffective (see Figure 3).

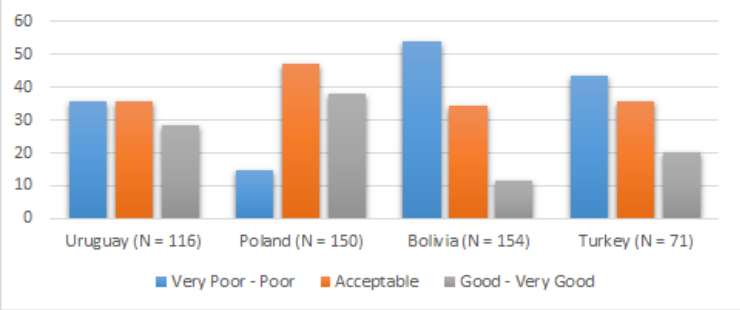

Fig. 3. Pre-service teachers with perception about blockchain solutions in education

In general, one-third of the pre-service teachers surveyed do not know about blockchain technology. Turkey is the country in which they know most about this technology. In Bolivia, half of the respondents (51.3%) have an interest in learning about blockchain for education, followed by Uruguay (44.02%), Poland (37.33%) and Turkey (36.7%) (see Figure 4). In the case of Uruguay and Turkey, neutrals (which are presumed not to have an interest but could have one) are approximately one-fifth of the respondents. 17.24% in the Uruguayan case and 22.5% in the Turkish case. Bolivia and Poland have the lowest neutral rates.

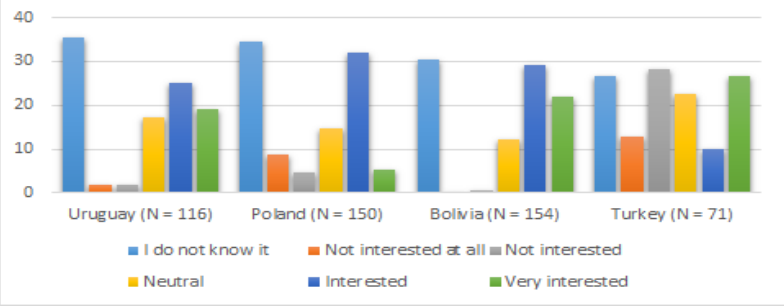

Fig. 4. Interest in learning more about the blockchain

It is striking that the most considerable interest in learning about blockchain technology is in Bolivia, being the country with the highest percentage of respondents who never used it and also with the highest percentage of disenchantment with it. It is likely that the novelty as applied technology in education has caught his attention and aroused an interest in knowing about it.

4.2 Perception of Blockchain Developers - Findings from Interview with the Developers

As part of this study, interviews with the developers was one of the key learning features. Technical development and backend information of any system is something considered hidden in many of our current time's project. However, as the project of SELI is adding a new platform for smart learning, sharing the development experience from our core developers in order to amplify the real concerns and opportunities might be useful for people and who would like to get in this route especially Blockchain based technology in the near future. As a result, our developers namely Andres Heredia and Mateo Mejia from Ecuador, as well as Alvaro Yapu Cossio from Bolivia shared the view with us.

Throughout the interview, a total of 12 questions has been asked to each developers in regards to Blockchain technology and its relevance for Education. The discussion was open-ended and expressive. One of the highlighted points is that most of the developers agreed that Blockchain is still new to many people and their resources for education based application are very rare, even if it is there yet not many are open-sources. However they all arguably expressed that it is getting popularity in many sectors including education. Developer Andres pinpointed the fact in the field of secured certificates is not very developed and few universities and educational institutes tried to implement it using blockchain. In the questions what blockchain can bring to the education sector, they iterated the privacy and security concern. In using such technology, it allows in-depth verification without having to be dependent on third-parties and the data structure in a blockchain technology is append-only. Thus, data cannot be altered or deleted so easily. In addition, it establishes a token of education, creates a coin that has no value, instead an educational value that can be used to subscribe to new courses or to receive job offers.

In order to observe their experiences so far in developing blockchain for SELI project, we wanted to ask developers the understanding and the needs of this Project Model to them. Developers describe it as challenging but day by day it becomes clear and structure was formed. Moreover, it is an undeniable fact that each developer has different approaches to the development environment regardless of the project and process, hence Mateo used SCRUM, while Andres went for a framework called 'NextJS' to deploy the client part in blockchain and go-Ethereum to implement the network through RPC and Web3 (Library of NextJS). Furthermore, developers expressed that a few key things to keep in mind if one wants to be a blockchain developer which are knowledge of how blockchain works, programing languages that allow to deploy a blockchain network like go-Ethereum or solidarity for contracts and some advance knowledge on nodes, security, the logic of smart contracts. Not to mention, developers shared mixed

experiences such as Mateo whom it was simple as he focused on connectivity of the platform with web services like REST. On the other hand, Alvaro highlighted some challenges especially communication and unstructured methodology of building the application with available technologies which needs experimentation before execution. In overall, developers said working in the SELI project provides a new experience and skills which can be used to build more educational application in the future. Moreover, the SELI system brought us a very good alternative to other platforms like Moodle since it involves the use of blockchain for the issuance of certificates which was not available on any other platform by the date.

5 Discussion

Although there is an increasing amount of study exist about blockchain use in education, there is a lack of empirical study which gathers data from actual target users regarding use of blockchain. In this study we collect data and investigate findings from target users as well as developers in order to reveal end user perceptions about blockchain technology. The very first research question aimed to explore how often is blockchain used in the school environment and among the students of teaching degrees. According to obtained results although pre-service teachers in Turkey is an exception, in which about half of the respondents used this technology, pre-service teachers who have never been used blockchain technology exceeds 75% in Uruguay, Poland, and Bolivia. This shows that although many institutions across the globe have started initiatives to develop blockchain-based solutions that will address pedagogical gaps Grech & Camilleri [27] very few percentage of potential users have actually used blockchain in educational settings.

The second research question aimed to explore pre-service teachers' subjective evaluation of the blockchain used to support learning, teaching and digital inclusion. Findings show that the pre-service teachers surveyed, for the most part, are unaware of the degree of effectiveness of blockchain technology in education. In Uruguay and Bolivia, lack of knowledge of the degree of effectiveness is high; 75.86% in Uruguay and 77.92% in Bolivia. In Poland, 40.67% of respondents and, 45.1% of them in Turkey state that they do not know the degree of effectiveness of this technology. Considering research project carried out by researchers from the University of New England where one of the key identified problems in education was lack of pedagogical responses to the needs of the students [12] it is important to investigate pre-service teachers understanding about the technology in relation to pedagogy. Because today's pre-service teachers are the first generation who can actually use it in their future classes as the technology is mostly limited with university use cases. Unfortunately study reveals only a few preservice teachers perceive blockchain as useful despite many application and development occurred in technical industry with the integration of blockchain technology which aims to strengthen the effort of open ecosystem for learning by securing collaborative learning environment, protecting learning objects, identifying the necessary technologies and tools, enhancing the students interactions with educational activ-

ities and provides a pedagogical support for lifelong learning [2]. Perhaps when blockchain use cases such as the case of the blockcerts from the university of Nicosia which was the first higher education institute that adapted the distribution of academic certificate through bitcoin blockchain [4, 5] and Malta, as the first European Country to follow the lead [6] are increased in universities, pre-service teacher' awareness about the use of blockchain in education may increase. Their awareness can be even enlarged with a blockchain based higher education credit platform such as the European Credit Transfer and Accumulation System (ECTS) is used as a common academic credibility [8] or similarly, blockchain based approach for connecting learning data across several learning platforms, institutions and organizations as studied by [30]. In this way blockchain may have inevitable influence in teacher's carrier as it enables future employees' possibilities to track the students' academic achievements in a transparent way through a peer-to-peer network and proof of work [10].

The third research question aimed to explore interest in new online trainings focused on the development of blockchain in learning, teaching, development support and digital inclusion. According to the results, half of the respondents (51.3%) in Bolivia showed interest in learning about blockchain for education, followed by Uruguay (44.02%), Poland (37.33%) and Turkey (36.7%). Blockchain Technology considered as a potential technology to support pedagogy of professional education like nursing and health care through this decentralized academic degree management and secured evaluation tools for learning outcomes [1, 16]. However we can say that still the users are not ready to accept technology. Although some universities and institutes have applied blockchain technology into education, and most of them use it to support academic degree management and summative evaluation for learning outcomes [1] our findings reveals that there is a relatively low level of blockchain technology.

6 Conclusion and Guidelines for the Stakeholders

The blockchain technology has created a new paradigm in the information society. More and more applications are made every day, including the education sector. The use of blockchain in education presents a great opportunity to increase the agility and transparency in the academic process. However, the use of this technology for education is on an incipient stage, especially in Latin American countries. This situation is an excellent opportunity to revolutionize the way of how education services are conceived, in terms of academic information system, recording academic achievements, security of information, collaborative learning environment, learning management system and contributing to the reliability of online education. Analysis of blockchain use, in preservice teachers in three of the four studied countries, shows that the use of blockchain is very low. Findings suggest that they are not aware of the effectiveness of the technology, nevertheless, more of the third part of the respondents of all the countries represented are interested in acquiring competencies in the new technology. This information brings the chance to state as a starting point the following recommendations:
(i). Promote the inclusion of blockchain technology in the different aspect of education sector. (ii). Develop a capacity building plan for the teachers to use the available technology, as a SELI Platform, to improve the education experiences. (iii). Promote and

establish synergies between the regulation institutions and private institutions that provide education services to promote the implementation of blockchain technology. (iv). Create a showcase environment of the possible uses of blockchain technology in education. (v). Promote a legal framework for support and enable the use of blockchain technology in the academic process.

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