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Blockchain Technology Applications in Education

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Abstract - The invention of new technology and availability of high speed connection is playing a vital role in every aspect of our daily lives. This advancement also brings a number of challenges, especially security related challenges. The Blockchain technology, one of the most influential inventions in the last decade attracts attention for its potential to provide security from supply chain management to shipping and other areas. The education sector also needs to utilize the benefits that blockchain technology provides. Educational institutions especially tertiary institutions are now eyeing to employ this application to improve teaching and learning activities and promote collaboration among the stakeholders such as students, teachers and parents. It will also be used in e- transcripts, digital degrees and certification, cloud storage, identity management. This on progress study discusses the blockchain technology applications that can be maximized by the education sector.

Keywords - *Blockchain, Blockchain applications, e- transcript, digital degree*

1. Introduction

Blockchain technology, which is also known as distributed secure ledger technology was introduced in 2008 and first used as a peer-to-peer electronics cash system transactions for bitcoin cryptocurrency. Blockchain technology is a time-series data block that is interconnected to form a chain structure embedded with cryptography and the distributed ledgers [26].

The blockchain technology had gained attention for its widespread cyber security capabilities that can be utilized in a number of businesses such as worldwide finance, commerce administrations and healthcare. The potential services for the blockchain expand its current applications and it seems it is making a huge contribution in academe. The academe may be a segment that is fair as vital as healthcare and finance, and there are ranges inside this segment that may well be moved forward by utilizing this innovation.

Educational institutions have long controlled the function of learning, whereas researchers, instructors and individual learners have almost no independence for the learning process and outputs. With the quick rising advancement of the cloud computing and globalization of the learning environment, the conventional school centered classroom learning in traditional educational institution is gradually changing and correspondingly, long lasting learning, online learning, versatile learning and conveyed learning based on practical issue is getting to be increasingly common [1].

The blockchain might improve the capacity of educational institutions to provide support for instructors, information for guardians and community individuals to participate, to empower modern learning structures, and to extend and provide learning opportunities for more students.

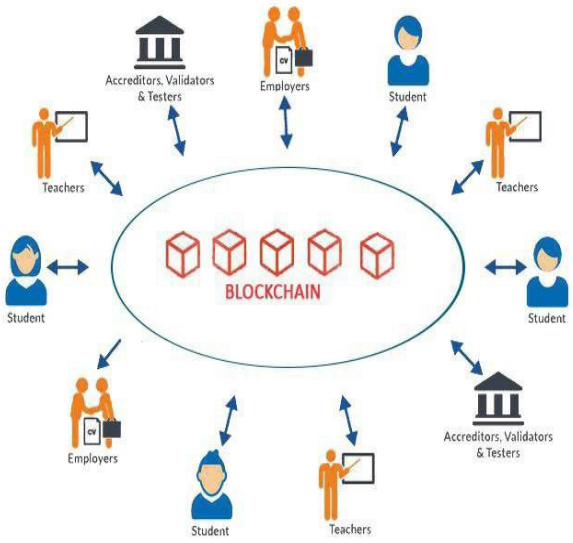

Fig. 1 Blockchain Application in Education

Figure 1 illustrates the blockchain applications in education. It is a steadily growing concept which can offer many different advantages to many educational stakeholders. Blockchain as a ledger it records transactions, and other required activities performed in educational institutions.

As shown in figure 1, there are many different applications of the blockchain technology in the education sector. Education sector is starting to implement this technology in different possible areas. The strengths of the different applications of blockchain in education will mainly provide greater transparency and also enhances the security. Moreover, it improves traceability, increased efficiency, reduced costs and improves processing speed.

Characteristics of blockchain

Blockchain has the following key characteristics [2]:

1. *Decentralization*. It can be classified into three forms architectural, political and logical decentralization.

2. *Persistency*. All records in the whole network cannot be tampered and any falsification can be detected easily.

3. *Anonymity*. A user could generate many addresses to avoid identity exposure. It preserves the privacy on the transactions.

4. *Auditability*. It improves the traceability and the transparency of the data stored in the blockchain.

2. Related Works

According to Bartolomé et. al. [3] blockchain technology will be an open source to different fields although it will be troublesome after its completion for digital currency. Its advantage is in the ability to move from a centralized data logging to a distributed system that will make sure no alteration of the information and the maintenance of privacy.

Alammary et al. [4] in their study explained that blockchain technology is novel in the field of education. In line with this they conducted several research analyses and reviewed different scientific literatures and proposed a framework for three major themes: applications, benefits, and challenges about this topic. The result yield that the blockchain technology is mostly used to: issue and verify academic certificates, share students' competencies and learning achievements, and evaluate their professional ability. Additionally, it provides important benefits to education including providing a secure platform to share students' data, lowering cost, and enhancing trust and transparency.

Yumna et. al. on their paper[5] explored and examined all the features of blockchain and provide appropriate solutions that will help the problems encountered in education in an accurate manner.

In the study of Chen et. al.[6] they discussed that Blockchain uses cryptograph techniques and distributed consensus algorithms to create features for instance decentralization, traceability, immutability, and currency properties. The blockchain technology can help students to nurture learning motivation. Moreover, it store a complete, trustworthy set of record of educational activities including the processes and results in a formal as well as an informal learning environments. Furthermore, it will also help to record teachers' teaching behaviors and performance thus providing a reference for teaching evaluation. As a summary, for both learners and teachers, blockchain has great potential applications in instructional design, behaviors recording, and analysis as well as formative evaluation.

The explanation of medical records and library check-outs that could be tied to a blockchain ledger containing verifiable time-stamped records of creation and ownership has been the main concern of Hoy et al. [7]. The system could be used to transfer value between users, detect changes in documents, or prevent data tampering. Likewise, the paper of Casino et. al.[8] gives a comprehensive survey of blockchain-based applications over different spaces. Blockchain-enabled applications over assorted divisions such as supply chain, commerce, healthcare, Internet of Things, security, and information administration, and other key topics, patterns and developing areas. This study also mentioned the deficiencies distinguished especially impediments the blockchain innovation presents and how these confinements may affect over diverse segments and businesses. As blockchains utilized and more developed, their applications are anticipated to enter more industries/domains. Additionally, there are numerous attempt to propose blockchains as a solution to databases. Moreover, there are numerous scenarios where conventional databases ought to be utilized instep.

The study of Mikroyannidis et. al.[9] investigated the applications of Smart Blockchain Badges on information science instruction. In specific, they explored how Smart Blockchain Badges can bolster learners that need to

progress their careers in information science, by advertising them based on their learning accomplishments. As a result, the work contributes towards closing the data science aptitudes crevice by connecting data science instruction to the industry. Smart Blockchain Badges are utilized to provide feedback to learners in supporting them to accomplish their career objectives. Furthermore, the sending of Smart Blockchain Badges to genuine learners be utilized properly and it will also assess their convenience for long lasting learning.

The research work of Muhamed et al.[10] uncovered that blockchain innovation empowers the implementation of a decentralized application where the need of third party to control the sharing of information is not required. Any exchange ever completed is automatically recorded in an open record in a verifiable and changeless way. In line with this, they proposed a global course crediting platform for higher educational institutions, named EduCTX. The platform is based on the concept of the /European Credit Transfer and Accumulation System (ECTS). It constitutes a universally trusted, decentralized higher institution credit and reviewing framework that can offer a universally unified perspective for understudies and higher educational institutions, as well as for other potential partners such as private, government and other institutions. As a confirmation of concept, it displays a model usage of the platform, based on the open-source.ArkBlockchain Platform, which is a universally conveyed peer-to peer network. EduCTX prepare, oversee and control ECTX tokens, which speak to credits that understudies pick up for completed courses such as ECTS.

The study of Funk et al.[11] which is about health profession teachers that encountered numerous challenges to adjust instructive strategies to modern advancement. The major evaluation of these novel methods is the need of the capacity to find out the beginning, legitimacy, and responsibility of the information that's made, shared, and procured. Health profession education based on the blockchain will possibly permit to made strides following of substance and the people who make it, evaluate instructive effect on numerous levels of learners, and construct a relative esteem of instructive mediations. There's potential for blockchain to significantly alter long haul of health profession instruction and profoundly change how patients, experts, teachers, and learners associated around secure and substantial data. Health profession education (HPE) is in consistent in dynamism and must adjust to address propels in biomedical sciences, changes in learning hypothesis, modern administrative arrangement, mechanical development, and endeavors to have healthcare experts perform at the most noteworthy level of competency.

Another research about blockchain as the center innovation utilized to make the cryptocurrencies, like bitcoin conducted by Chen [12]. As portion of the fourth mechanical insurgency since the innovation of steam motor, power, and data innovation, blockchain innovation has been connected in numerous regions such as fund, legal, and commerce. The paper centered on its potential instructive applications and investigated how blockchain innovation can be utilized to fathom a few instruction issues. This article presented the highlights and focal points of blockchain innovation taking after by investigating a few of the current blockchain applications for instruction.

3. Blockchain Application in Education

There are many areas of blockchain application in education among them the following are considered in this study, which is the first phase of the main research. These are:

A. *Online Education* - Sometimes referred as distance instruction or electronics learning, uses data and the internet innovation for content delivery and quick learning. It is known as a web-based educating strategy. With the blockchain innovation an ideal solution will be provided to the issues of online instruction, which are validity and security. The blockchain can also generate non-modifiable learning records for online instruction, without the required third-party involvement for monitoring it, and ensure the reasonable recognition of course credits. The implementation of blockchain innovation can be within the following areas of internet-based education. [13]

1. *Students' learning progress record*- The blockchain can stores data in a database located in different areas and it records data blocks in sequence and also record the timestamps. The new data blocks cannot be alter or deleted.
2. *Authenticated certification of learning results* – Nowadays, the certification for online education has a problem because of the inefficient third-party agencies. The

solution to the problem is that blockchain technology provides a simple, efficient certification of learning results, like academic certification. The students' certificates can be verified easily even if they are lost. The blockchain uses an asymmetric encryption algorithm in cryptography to ensure the security and credibility of the data.

3. *Decentralized sharing of contents and other resources*- The blockchain application also provides execution automatically and does not require third-party verification. In this regard the implementation of this system will simplify the transaction process, realize smart, automated and decentralized transactions and improve the overall security of the transaction [14].

B. *Student data privacy and consent* – Mostly students' guardians are required by educational institution to sign different types of forms to permit schools on the usage of student data, but they may not efficiently differentiate between the forms they signed for consent and also they may not have information where and when this forms will be used. To overcome this, Gilda, Shlok & Mehrotra, Maanav[15] proposed a framework by using hyperldeger fabric and composer that implemented blockchain innovation. This framework is used as a digital agreement to be executed without the requirement of relying on a third party legal document. The proposed framework is blocks of repeated authorization which will allow the educational institution to grant access of data for any legal purpose after securing the consent for data access privilege from the guardian of the student through smart contract.

1. Hyperledger Fabric is a project developed by IBM. It is a segmental architecture that delivers high degrees of flexibility, resiliency, confidentiality, in design and implementation. The flexibility in design helps to attain privacy, scalability, and other required attributes. The fabric is designed to maintain pluggable implementations of a different function, it also allows to use various programming language to apply chaincodes, but mostly it use the Go language and run within Docker containers[16].
2. *Hyperledger Composer* Hyperleger Composer is an open source framework that helps to create blockchain application with minimal cost by saving the time of developing the application. Composer provides the facility and abstraction needed by the blockchain application to run smart contracts on the hyperleger fabric [17].

C. *Learning outcomes and meta-diploma* - blockchain based technology for learning outcomes, which is based on graduation requirement index of university, with professional certification can use automated evaluation software as a tool. The course-learning outcomes achievement values, which is based on the quantitative and qualitative combination of grades, process and evidence, the course name, learning outcomes name (graduation requirement indicator) and the weight of the course, etc. can be included in the block. The conversion from evaluation of students' achievement to the post-job competence evaluation results can also be done, and student competency evaluation will be sent to the curriculum, which realize the continuous quality improvement of the program students are attending. In the chain of educational block, graduated students have not only diploma, but reached information which has constituted index capacity of graduate requirement during the learning process. Compared with the rough approval only decided by diploma before, it could approve the constitution of learning process, verify gold content of the diploma and make a categorization of different students who get the diploma. The learning outcomes are basic of mutual recognition and credit transfer of higher education internationally and the footstone of internationalization of higher education and talent flow. Learning outcomes could come from different educational institutions, working practice experience, on-line study and other learning processes. On account of the educational idea of outcomes-oriented, when the index points of graduate requirements set by the institution are achieved, the institution could award diploma to learners. [18]

D. *Operational Skill Competition* - By letting understudies mimic operations and diversions on an advanced instruction operation framework, schools can be able to examine learning accomplishment and quality of

education. In digital education zone, it utilizes blockchain innovation to make strides competition mode. It's supportive to streamline handle, progress proficiency and maintain a strategic distance from the issue of misty and distortion messages. Other than, it can give unchangeable computerized certification of scholastic accomplishment. Based on existing investigate foundation, against highlights on related clients and administrations, particularly the standard and trustful issue in competitions and assessment mode these days, it examined competition mode based on blockchain innovation, outlined blockchain's application mode and outline, analyzed assessment criteria and calculation, outlined an operational expertise assessment show, created an operational aptitude competition assessment framework based on e- business sandbox and tested it [19].

E. *University Grades* - A blockchain framework based on Ethereum was developed to utilize by a college for recording understudy grades and to provide a crypto currency. Based upon an exploratory, subjective assessment, the authors identified few concerns between the concept of a college as an association, and the concept of distributed autonomous organizations (DAOs) in Ethereum [27]. These incorporated concerns are mechanism of trust, boundaries of openness, and values in methods. The authors also includes layout implementation and the assessment process.

F. *Education-Industry Cooperative System* - Based on [21], within the current Education-Industry participation, substantive data asymmetry exists between the educational institutions and utilizing companies. Understudy credit frameworks and the historical data of the student required a mechanism to sustain it for future use. The authors utilize the straightforwardness and non-tampering highlights of the blockchain framework to actualize an Education-Industry cooperative framework based on the blockchain Hyperledger framework. Utilizing the Certificate Authority benefit and exchanges within the Hyperledger system, the framework defined the role of universities and companies within the framework accordingly, and empowers colleges and undertakings to share data straightforwardly, which accomplishes data symmetry among understudy expertise and information data, requests of undertaking enlistment, and availability of job openings. The Hyperledger Fabric has been used in Education-Industry agreeable model framework.

G. *Educational Record, Reputation and Reward* - The blockchain itself is a disseminated record of advanced occasions, the dispersed agreement strategy to concur whether an unused square is authentic, robotized keen contracts, and the information structure related with each piece or not. A lasting disseminated record of mental exertion and related reputational compensate, based on the blockchain that instantiates and democratizes instructive notoriety past the scholarly community. The trials of a private blockchain or putting away instructive records, drawing too on our past inquire about into notoriety administration for instructive frameworks. The first benefit is in giving a single secure record of instructive achievement, open and disseminated over numerous institutions [22].

H. *Educational Certificate* – Since most of the available instructive certificate administration cannot ensure information security and reliability of the student information. Utilizing blockchain may overcome the trust issues but blockchain by itself has limitations that restrict its full implementation. In blockchain limited throughput and access time is observed. To overcome the mentioned limitation and to answer certificate inquiry with exact information efficiently educational certificate blockchain (ECBC) was proposed. ECBC builds a tree structure (MPT-Chain) which provides an efficient answer for inquiry. Moreover, it supports back chronicled exchanges inquiry of an account. [23].

I. *Student Capability Evaluation System* – Using blockchain technology, students' academic performance and academic achievements in school, training, competitions, practice and other activities outside school can be analyzed to evaluate

the students' capability, which helps the students and companies who will open employment opportunity for them. Paper [24] presents a design scheme of the student professional ability evaluation system based on blockchain technology, which can analyze student ability analysis method based on clustering algorithm. The presented system may also provide possibilities for creating an ecosystem of student ability evaluation.

J. *Online Quiz Scheme Based on Double-layer* - The students' online quiz is one of the advantages that the technology offers to educational institution. In the traditional system the scoring system may be not be as transparent as expected. To provide a solution for the transparency issue a web test based on Double-layer Consortium Blockchain was proposed. The proposed solution provides open confirmation of students' answers and the reply records that cannot be altered by any party [25].

4. Challenge of Blockchain Application in Education

The blockchain application although brings many advantages, it also presents various challenges; among these: it requires wide-ranging process alteration in the organization such as developing guidelines for the implementation of blockchain in instruction, e-certifcates, grading and other potential areas that the institution is looking to use the blockchain technology. Since each institution has its own way to store and oversee understudyinformation they need to adopt and accept to store the data using principles of blockchain technology. As blockchain selection increments, modern guidelines are being characterized each day, with the potential that may require investment.

Blockchains are intensely repetitive which makes them bloated and slow; as a result it may contribute for the inefficient forms of information capacity in terms of throughput.

With the implementation of blockchain the modern records will be accessible based on its technology then the question is what will happen to the existing information.

5. Conclusion

Blockchain application provides a secure distributed ledger technology. Though the study it shows that blockchain can be used in many areas of education for instance, online education, student data privacy and consent learning outcome and meta-diploma, operational skill competition, university grades, education-industry cooperative system, educational record, reputation and reward, Educational Certificate, Student Capability Evaluation System, Online Quiz Scheme Based on Double- layer. The study can be further improved by including several other application involving blockchain applications in education.

This study will allow educational institutions to assess and decide what blockchain application in education will be beneficial to them based on their respective organizations. This research on progress focuses on the application of blockchain with the confidential documents for instance e-transcript and few others.

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