

Blockchain Technology for Higher Education Sytem: A Mirror Review

Shallu Sharma
Research Scholar
School of Computer and Application
Lovely Profession University
Phagwara, Punjab(India).
shallujoshii@gmail.com

Ranbir Singh Batth
School of Computer Science and Engineering
Lovely Profession University
Phagwara, Punjab(India).
ranbir.21123@lpu.co.in

Abstract—The higher education system in developing countries has remained quiet unchanged for long time. Even with new and better technologies in this field has emerged tremendously; their adoption is marked extremely narrow. The connection between student and faculties is unchanged and the records are still stored and validated centrally. Block chain has introduced a fresh and novel path to decentralize the records and their exchange for gaining knowledge and skills. This paper is an attempt to understand block chain technology and its application on education. It discusses the use of block chain and the few of the many models designed to support educational bodies. The mere attempt to discuss the problem and challenges faced by block chain for successful support to education is presented in this article.

Keywords—Block chain technology, education, digital libraries, data archives, Learning Records, Learning Pools, Higher education,e-learning.

I. INTRODUCTION

In today world, education is considered as basic necessity of life. Several countries are innovating various methods to promote and enhance their education systems. Education technologies have participated remarkably in this mission for several decades. Out of these all, libraries have always been a trusted source of learning resources providing agency. It is a hub for all kind of learning data for all students in various subjects. But, the higher education system in developing countries has remained quiet unchanged for long time. Even with new and better technologies in this field has emerged tremendously; their adoption is marked extremely narrow. The connection between student and faculties is unchanged and the records are still stored and validated centrally. A broad category of data sharing challenges comes as data format, legal issues, security, problems with unintended results of data sharing. This problem holds its significance as it may cause social, ethical, financial and regulatory troubles along with the technical ones. As different institutions have different and isolated learning data from each other, it is not easy to access learner's history of all learning activities from other systems. Therefore, a blockchain powered approach is required to connect learning data across various Learning Management Systems (LMS), Learning Record Pools (LRP), institutions and organizations. With the unique properties of blockchain technology, such sharing framework will confirm as solution for learning data reliability, availability and immutability with security, privacy and access control. Besides of the various potential implementations of blockchain for education systems, resource sharing is still in its infancy. Every institution around the world has his significant mound of learning

resources in a form of their library to support their students education. Books, e-books, audio and video lectures are available in different libraries. Not to mention that their size varies as per the budgets of their governing body. Besides, public libraries are provided by their government to ensure ample learning materials for book lovers and these services are availed by the students time by time. The main drawback of libraries is that they are centralized. They are controlled by their respective institutes and access to their study materials is only limited to their registered students. This is the main reason of poor or extremely less use of many of these resources causing a waste.

Suppose a scenario where these resources can be pooled along and accessed by every registered user even if it doesn't belong to that specific governing body. Blockchain can be the answer. With access control and identity management techniques, blockchain provides a decentralized mechanism to share these gems amongst different students of various institutes to avail study materials at zero or less cost. Here, it is to be noted that external learner is provided with a unique ID (a global icard) to avail access from any library in the pool.

Blockchain is a distributed arrangement that permits to creation a digital distributed record of transactions and sharing it among various nodes on the network in place of storing it at a central server. Basically blockchain frameworks have three types:

- public or low permissioned block chain
- private or permissioned blockchain
- associational or grouped blockchain

TABLE 1: COMPARISON OF BLOCKCHAIN TECHNOLOGY

Property	Public BCT	Consortium BCT	Private BCT
Consensus determination	All miners	Selected Set Of nodes	All organizations
Real permission	public	Public or restricted	Public or restricted
Immutability	Nearly Tamper proof	Could be tamper	Could be tamper
Efficiency	Low	High	High
Consensus process	permissioned	Permission less	Permission less

Satoshi Nakamoto introduced blockchain in 2008 in his publication "Bitcoin: A Peer-to-Peer Electronic Cash System". The cryptographic based proposed system enabled any two parties to trade without third person intervention. Thus, the problem of double expending was solved as first blockchain application.

Various applications on blockchain[20][21] are based on its versatile features as smart contracts, decentralization,

transaction speed, etc. In education, blockchain technology provides remarkable assistance to institutions and students in certification and credentials, easy record access, verification and authentication of records, records maintenance and in recruiting processes. Besides above, blockchain technologies have opened the scope for universities and institutions to manage finances and accounts.

1.1 FEATURES OF BLOCKCHAIN

Some of the commonly known features of blockchain are:

- a) *Decentralized*: The data stored on ledger is decentralized which is shared publicly through the nodes connected in a mesh network. [1, 3, 6].
 - b) *Traceability*: Since the information is stored in secured blocks, Blockchain promotes traceability of an event on the network. The data is secured by simplex cryptographic hash function [4] and whole chain of blocks is managed by mining pools. [3].
 - c) *Smart contract*: It is a computer protocol proposed to digitally support, validate, or impose the performance of a contract. It allows the transaction to be performed without third party. Moreover, these transactions are traceable and permanent. These self-executing program runs on distributed network. [7].
 - d) *Immutability*: In block chain, data is stored in ledger form and with each modification by external nodes; the value of associated cryptographic hash key changes with adjacent blocks and data tampering will be interrupted. [7, 8].
 - e) *Currency*: Cryptocurrency is a block chain technology of using digital or virtual currency, which confirms a throughout protected and trustworthy transaction. Since, different mining algorithms are used to form this currency; it can be used in dealings as finance and accounting [2].
 - f) *Consensus mechanism*: It is a mechanism of mutual consent amongst all nodes associated in the network. [5]. Thus, mediators are not required anymore. Some techniques of this mechanism are Proof-of-work (POW), proof-of-stake (POS), delegated-proof-of-stake (DPOS) [3].
- The following figure summarizes the key properties of blockchain technology:

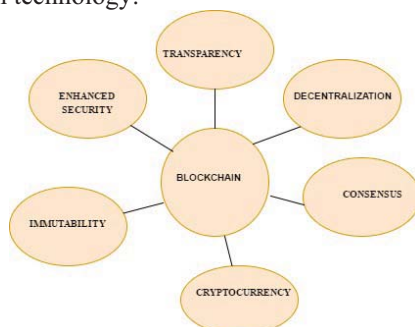


Fig 1: features of blockchain technology

II. USING BLOCKCHAIN FOR LEARNING[22]

It is not easy to find novel technologies like blockchain to join education system smoothly. The distinct benefits of blockchain can be seen as data storage, formative evaluation, data security, universal database, smart contracts and much more. Several inventiveness actions have been taken to store data for students and faculties by educational

institutions. Following describes how block chain can be used in education:

a. Single institution

In San Fransisco, Holburton School is a software school which provides project-based education as an option from college courses. It has used blockchain to store and distribute its issued certificates to stop fake certification. To create, login and store the certificates in the database, encryption and two-factor authentication is implemented.

b. Groups of institutions

As group of educational institutions, the requirement for shared archives of documents and achievement records become genuine. For instance, EPFL, Boston, Delft, ANU and UBC are the group of universities that created a codeshare-like concord on certification. It can be used to form global association amongst different clusters of educational groups to share resources at cheaper rates.

c. blockchain database

A national level approach to share database at all levels as schools, colleges, institute, universities, examination boards, employers, associations and others is greatly needed. An overall controlling body is required to sit on all and control everything for them to smoothly run the database in system. Block chain technology can be the solution.

d. Global assessment

The current assessment system is a cumbersome procedure of approvals and authentication of certificates and achievements. The main trouble is involvement of different bodies and centralization of data. Block chain technology is decentralized method of storing credentials and achievements which platforms to assessment scores recording and sharing globally. All it needs is that education bodies to use it. It will offer global service.

e. Blockchain and badges

Open badges provide tamper proof system to store and share credentials and deal with authentic accreditations on mass data. Thus, genuine data can be available anytime and anywhere at cheaper cost.

f. Corporate learning

The current learning and talent management technologies are become incompetent to store huge amount of data to train their employees and record their performances. A more open and secured system is required to hold records internally and externally as well.

g. Apprenticeships

With expansion of vocational education at both public and private institution, it is getting difficult to manage the training and certification. The management and delivery of resources has become a complex business. Block chain services can be availed for neat distribution of database for verification and distribution of resources and certification.

h. Bodies of knowledge

John Helmer provides the idea of authentication of identity of the resource provider from the libraries. Recent systems are not competent regarding verification due to use of centralized ledgers[19]. But block chain can provide a model to gather and distribute the resources from different learning and research bodies from various sources. Also easy payment method like micropayments excludes third party charges as block chain supports free transactions..

III. RELATED WORK

The following table shows the research regarding implementation of block chain in the field of education:

TABLE 2: LITERATURE SUMMARY

YEAR	AUTHOR	PAPER TITLE	DESCRIPTION AND FINDINGS
2018	Guang Chen [3]	Exploring blockchain Technology and its Potential applications for education	Focused on block chain Technology and its features and its potential applications in education. BChain is implemented for degree managements, student performance evaluation and smart contract based learning at several universities and institutes.
2018	MOIZ UDDIN AHMED [10]	A model of adaptive E-learning In an odl environment	Proposed a learner model for adaptable e-learning model to <ul style="list-style-type: none"> investigate the profiles and preferences of the local learners. evaluate learning ability of set group of students with content model and learner model
2018	Carmen Holotescu [11]	Understanding blockchain opportunities And challenges	Purposed a public blockchain called OpenEduChain as an archive for Open Learning Resources. It is proposed to create a datastore about the open educational tems created by teachers and students.
2017	Antonio Bartolomé [12]	Blockchain in education: introduction and Critical Review Of The state of the art	Established that BC can be used as a tool for resume preparation without central storage and distributing it on the network; explains the risks and factors to consider on implementing BC in education. References and links to related papers are provided for better knowledge about this new technology and is a contribution to the vital debate on terms to implement it in education system.
2017	Diane J Skiba [13]	The potential of blockchain In Education and health care	.Explained BC as a tool for academic degree management and evaluation of learning results.The paper is proposing a view of adapting block chain in healthcare and nursing education and its future potential in the medical field.
2017	Aithal And Shubhra-jyotsna [14]	An innovative education Model To realize Ideal education system.	Proposed an evaluation system named Ideal Education System model in which <ul style="list-style-type: none"> participants can evaluate their skills anytime and anywhere the results will be declared immediately help in quick self evaluation by the participants.
2017	Kennedy Hadullo [15]	A model for evaluating E-learning systems quality In higher education in developing countries.	Presented a model for assessing LMS assisted e-learning. The model is proposed to appraise the quality of e learning systems in Kenya private and public universities and avoid system failures.
2017	Hoy[5]	An introduction to the Blockchain And its implications for Libraries and medicine	Describes briefly the potential future uses of BC technology to librarians and medical practitioners and related problems. A theoretical study and broad overview of usefulness of this new technology in library and records management is laid down and future aspects have been hinted.
2016	Sharples and Domingue [16]	The blockchain and kudos: a distributed system for educational record, reputation and reward.	Proposed a perpetual distributed record of academic effort. A detailed discussion on block chain as reputation and reward management is put in the paper. The criteria of using block chain as distributed record system, proof of intellectual work and intellectual currency as explained briefly with critical overviews.

IV. FIVE BLOCKCHAIN EDUCATION MODELS

Block chain technology has built educational models with significant challenges in programming their block chains. The main purpose is to overcome scalability problem and achieve powerful performance and proficient productivity. For this, learning models have used various types of decentralized distributed networks to relieve the congestion from their platforms to achieve the required quality of communication. Some of the platforms are explained as follow:

a) EdgeCoin

Educational documents like degrees and certificates have been stored by EdgeCoin. It directly cut the cost of validation for students and institutions by confirming their authenticity from the third party to their block. This eliminates bureaucracy and paperwork. Moreover, it helps the education system by validating the credentials with one click and save time and cost with its decentralized management system.The technology used by EdgeCoin is Proof of Scale (PoS) instead of Proof of Work (PoW). Unlike PoW, PoS selects few node on the network to run the site and it increases the speed of work. Therefore, not all nodes have to process every transaction and this reduces the processing time.

b) TeachMePlease

TeachMePlease (TMP) provides online and offline database of learning bodies to different learning groups of kids as well as individual learners with instructors. These different educational programs need large amount of space and power to process such huge data and TeachMePlease made such platform available to them.

TMP blockchain architecture is divided into two parts: private and public. Its private portion collected and stores the academic and personal data of the user like documents, copyrights, CV's and certificates. The public part provides these archives for public access for verification by invited parties.

By doing this, TMP relieved the congestion from its platform by directing traffic directly to the main ledger along with keeping the public access closed in block chain network.

c) SuccessLife

SuccessLife is the blockchain company created by Success Resources which provide books, coaching, classes and study materials available at lower expenses and reducing downs the cost of overpriced workshops. SuccessLife have also shared events like coaching, webinars, videos and workshop assignments on its platform.

The SuccessLife token (SLTs) supports the transaction between the token holders and through multi chain payment system, give them high transaction speed. The multi chain architecture allow blockchain model to support time-stamping, data sharing and encrypted database for better content management and easy integration by third party.

d) Sony Global Education

The Sony Corporation and Sony Global Education (SGE) have created a blockchain-based platform to record student educational data. Students' educational data from numerous

schools is managed and merged by the school administrators, and is mapped out as an analytics system on the bases of experiences and transcripts. Furthermore, the learners can not only store their own formal or informal experiences, but also can share them with selective audiences for quick verification. The documents and credits can be transferred from one institution to other through stored ledger for validating the credentials across education systems, and secure with a number of student services in a solitary storehouse of information.

Sony's blockchain achieves its fast flow as their system is mechanized by Hyperledger Fabric 1.0. The Sony hyperledger has solved their problem of scalability by separating the standard PoW transaction processing which include three phases: constructing the blocks, aligning the blocks, and validating each of these blocks. Since the workload of the nodes is reduced, the flow of data increases. This optimized the scalability and performance as only read/write set and digital signatures are sent around the network.

e) Tutellus

With the peer to peer connectivity, Tutellus has shared more than 120,000 video courses on almost every subject on its platform for the users learning. It requires a super fast platform to adjust this amount of traffic and the communication streams amongst the faculties and their students. Tutellus has used a four-layer architecture which includes:



Fig: 2 Four layer architecture

Tutellus has used a tactic known as “sharding,” in which the responsibilities are distributed between the nodes and this makes the communication faster and more proficient. The large database is parted into smaller but faster and much easily managed parts known as data shards. The whole block chain is managed as distinct number of nodes enabled to solve different tasks. Each node shared their data with the Directory Service (DS) Committee which integrates the whole data into a final block. This final block is diverted back to all groups. This allows the company to maximize its capabilities for each task.

The models discussed above are summarized in following figure:

TABLE 3 : Models using block chain technology

S no.	Model	Works	Benefits	Technology used
1	Edge coin	Educational documents	Low cost and less processing time	Proof of scale(pos)
2	Teachme Please	Online and offline learning database	Hige processing power and space	Decongesting the network
3	Success life	Resources to study	Coaching, webinars,etc.	Multi chain architecture
4	Sony global Education	Student records	Student data credentials management	Hyperledger 1.0

5	Tutelles	Peer to peer	video courses on all subjects	Sharding
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V. CHALLENGES FOR ADOPTING BLOCKCHAIN

Even when block chain technology have been accepted by many fields of business, fnances, healthcare, etc; several challenges are faced in education. Some of them are discussed as below:

1. *Security*: Even when security is the basic feature of blockchain technology, the risk of mischievous attacks cannot be ignored. As data is authorized online and credentials are shared on a network, transactional privacy on each node cannot be ensured every time. Due to frequent updates in the information, data leakage may occur and this may put the database in danger.[8][17].

2. *Speed*: The blockchain scalability is a major problem. The slow speed of transaction can be faced by education system while implementing blockchain. With more blocks joining the chain, the size of data become huge, and speed of the transaction slows. Also, every transaction required verification which is a time consuming issue with increased size of blockchain.

3. *Cost*: The cost of implementing and adopting block chain is very high. With increased size of blockchain, the cost of maintenance also increases. Without managing the operational cost, it is expensive to implement block chain in legacy system. [3,4].

4. *Data Sharing*: Institutional and managerial accept is required to share their private data on a network. Till now, their data is centrally organized and stored. The lack of calarity in defining the boundaries stops these legal and educational bodies to share their data on blockchain.

5. *Extent*: In tradition scenario of education, it is difficult to answer about the boundaries setting, the usability of the products and lack of clarity and maturity of the technology to the institutions. May be, an easy user interface, more security checks, good designs and easy terminology can convince them to accept this technology, but it's a long road to go. [19]

Blockchain is one of the supreme innovations of recent times. It seems that it will take a considerable time before the technology is accepted broadly.

VI. SCOPE IN LIBRARIES

Out of various available sources of information retrieval, library has acted as a reliable, easy and trustworthy source. To store and distribute the learning resources, libraries are the easiest to approach. Libraries have always supported people to acquire information and develop their opinions. It has played a noticeable role in social enlightens and intellectual developments.[29]

During the industrial revolution in 20th Century, new technologies have emerged. Better and faster computers were introduced with enormous m storage power. The storage problem of libraries was solved during this period. Technologies as Machine Readable cataloging[26] gets more advance. It changed local offline batching to online with computer networking. New standards combined

computers with library catalogs and resources records. Professional and user access gets easier. Inert-library and online database access comes into the picture. With industrial automation, libraries become de-centralized. Resources are shared at inter-organizational level to save funds and spaces. By 1990, libraries became more vivacious by integrating federal and de-centralized databases.

With the passage of time, new technologies have emerged. But unfortunately, libraries are slower to adopt new technologies. Most of the time, the book transactions like borrowing and returning remained same and manual. Even before, re-issuing, the book must be returned to the library first. With little or no co-operation amongst the libraries, patrons need to register themselves separately in each library to access their isolated resources. The reason behind this void is that the libraries has always remained isolated and self-administrated. This burdened not only their pockets but it is cumbersome to access the geographically distant locations. The centralized nature of institutes and their libraries is the main reason of poor or extremely less use of their resources. On the other hand, several patrons are not able to enjoy good literature and knowledge banks due to this isolation. Blockchain is the novel answer to this problem. With access control and identity management features, non- members of governing bodies can be given access to these knowledge hubs at zero or low cost. With blockchain, participant does not need central authority for a trusting transaction. With unique global identity, patrons can avail the resources shared amongst the member institutions. It can remove the obstacles for both patrons and providers.[30]

Some of the existing soft wares in library automation systems are listed as below:

TABLE 4: LIBRARY AUTOMATION SOFTWARES[28]

Software	Platforms	Network	Access	Manag ement	Data base Search
Codeachi	Stand by	Private	Single	Central	Local
Librarysoft	Web based	Private	Multi	Central	Local
Glibrary	Integrated	Private	Single	Central	Local
Libero	Web based	Private	Single	Central	Global
Soutron	Web based	Collaborat ive	Multi	Central	Local
Accessit	Web based	Private	Multi	Distri buted	Local
Eloquent	Web based	Private	Mobile	Central	Global
Pmb	Open source	Private	Single	Central	Local
Liberty	Cloud based	Collaborat ive	Mobile	Distri buted	Global
Insignia	Fully integrated	Public	Single	Distri buted	Global

Aproposely, it is clear that listed softwares are not blockchain supported. Therefore, security and access will remain an issue.

VII. CONCLUSION AND FUTURE SCOPE

This paper is an attempt to explain the role which the blockchain technology can play in education sector. A main area where blockchain benefit is the collaboration of

different institutions in sharing their data on the network, including students' records and credential, but also the skills and qualifications. Utilizing such technology will increase students' flexibility as it grants them access to the complete academic programming at every other institution. Educational institutions can reduce operating costs by sharing infrastructure, academic programs and services. Job-driven education is another scope for block chain technology implementation.

Recruiting agencies could examine and evaluate student's skills and recommend certain learning programs. Another important area for future research can be quality enhancement in online education using block chain technology.

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