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Exploring Integration in Education through Blockchain Technology

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Abstract

New technological advances and the availability of high-speed connections have brought about significant changes in our daily lives. However, behind all these conveniences, we are also faced with complex security challenges. One of the innovations that has really attracted attention is Blockchain technology, which has become the most influential invention in the last decade. Blockchain promises extraordinary security in supply chain management, including in the shipping industry and other fields. In addition, the education sector also sees tremendous potential in utilizing this technology. Universities and other educational institutions are working on using blockchain technology to enhance teaching and learning processes and strengthen collaboration between students, teachers and parents. Blockchain applications are also expected to be used in the creation of electronic transcripts, digital certification, cloud storage and identity management. Ongoing studies have revealed the maximum potential of blockchain technology in education and how it can be utilized effectively.

Keywords: *Blockchain Applications, Blockchain, Digital Degree, Electronic Transcript.*

1. Introduction

The peer-to-peer transaction system for the bitcoin cryptocurrency was the first application of blockchain technology, sometimes referred to as distributed and secure ledger technology, which was initially announced in 2008 [1]. Each block in a blockchain is encrypted using cryptographic methods, and the entire system is made up of chronologically related blocks. Blockchain also functions as a distributed ledger, where each user of the network has an exact duplicate of the ledger [2].

Blockchain technology has gained popularity because of its capacity to offer a wide range of cybersecurity levels [3]. This technology may be applied in a number of commercial sectors, including international banking, trade administration, and healthcare. Blockchain technology appears to have a big impact on academia and has a huge service potential.There are other sectors within academia that could potentially adopt this innovation in the future. Academia is a sector as significant as health and finance [4].

Researchers, teachers, and individual students have not had much liberty to govern and steer their own learning processes and outcomes up until this point. Educational institutions have dominated the management of the learning process [5]. The learning paradigm in traditional educational institutions, which is focused on the classroom, is, however, increasingly shifting as a result of the rapid improvements in cloud computing and

the global learning environment. Additionally, learning that is long-term, online, problem-based, and versatile is becoming more widespread [6].

By implementing blockchain technology, educational institutions may be better equipped to support teachers, inform parents and the community, strengthen contemporary learning structures, and expand and offer more students learning opportunities [7]. Blockchain technology enables greater stakeholder collaboration, data transparency and validity in the evaluation and acknowledgment of academic achievements, and optimization of administrative and managerial processes in educational institutions [8]. Furthermore, blockchain may make it simple to create and validate verifiable digital certificates, giving students access to a greater range of academic and employment options [9].

An example of a blockchain use in a learning environment is shown in Figure 1. This idea is still evolving and offers different advantages to diverse stakeholders in the education industry. In educational institutions, transactions and other activity are recorded using blockchain as a ledger [10]. Educational institutions can enhance data security, authenticity, and transparency as well as enable more efficient communication between students, professors, parents, and other associated parties by utilizing blockchain technology [11].

Blockchain technology can be used in a variety of ways in the education sector, as shown in Figure 1 [12]. This technology is now being used in a number of prospective domains in the education sector. Increased transparency and security are the primary benefits of blockchain use in education [13]. The traceability, effectiveness, cost-effectiveness, and data processing speed can all be improved by this technology. As a result, implementing blockchain technology in education has the potential to fundamentally alter how learning is carried out, bring about important advantages, and boost the industry as a whole [14].

Blockchain has several key characteristics that stand out, including:

Decentralization: Blockchain operates in a decentralized form, which can be classified into three forms, namely architectural, political, and logical decentralization. This means that no single entity controls or has full authority over the blockchain network [15].

Persistence: The reliability and robustness of the blockchain lies in its indestructibility. All records stored across the network cannot be manipulated without the knowledge or consent of the majority of participants. Thus, any attempts at counterfeiting can be easily detected [16].

Anonymity: Blockchain provides a level of anonymity to users. A user can generate multiple addresses to perform transactions, thus avoiding exposing their personal identity. This helps maintain user privacy in transactions made [17].

Auditability: The existence of the blockchain also increases the level of traceability and transparency of data. Every transaction recorded in the blockchain can be accessed and verified by all network participants. This helps increase the integrity and trust in the data stored on the blockchain [18].

2. Research Method

According to Bartolome et al., blockchain technology has potential as an open source that can be applied in various fields, although it was originally known primarily for digital currencies [19]. One of the main advantages of blockchain technology is its ability to transform a centralized data system into a distributed system. This can ensure the security and integrity of information, as well as maintain data privacy. The use of blockchain technology provides high trust and traceability in transactions and data exchange, with the potential to increase efficiency and reduce dependence on third parties [20].

In their research, Alammary et al. explained that blockchain technology is innovative in the educational context [21]. They conducted an analysis and review of the scientific literature and proposed a framework for three main themes: applications, benefits, and challenges associated with using blockchain technology in education [22]. Their research results show that blockchain technology is widely used in issuing and verifying academic certificates, sharing student competencies and learning achievements, and evaluating professional abilities [23]. In addition, these technologies provide important benefits in education, including providing a secure platform for sharing student data, reducing costs, and increasing trust and transparency. Thus, the use of blockchain technology can bring a significant positive impact on the education system [24].

Yumna et al. explore and examine all the features of blockchain technology, as well as provide relevant solutions that can assist in properly addressing the problems encountered in the educational context [25]. Through their research, they have analyzed various aspects of blockchain technology and identified how their implementation can provide accurate solutions to challenges faced within the education sector. With this approach, they seek to provide a better understanding of the potential and benefits of blockchain technology in overcoming educational problems and make a significant contribution to improving the education system as a whole.

In a study by Chen et al., they discuss how blockchain technology uses cryptographic techniques and distributed consensus algorithms to create features such as decentralization, traceability, immutability, and currency properties. Blockchain technology has the potential to assist students in cultivating their learning motivation. In addition, this technology can keep a complete record of all educational activities that can be trusted, including the learning process and its results, both formal and informal, in the learning environment. In addition, blockchain technology can also assist in recording teacher behavior and performance, which can then be used as a reference for teaching evaluation. Overall, for students and teachers, blockchain has great potential applications in instructional design, behavior recording, analysis, and formative evaluation.

Research conducted by Hoy et al. highlighting the importance of recording medical information and lending library books that can be tied to a blockchain ledger. This ledger contains creation and ownership records with verifiable timestamps. Blockchain systems can be used to transfer value between users, detect changes in documents, or prevent data corruption.

On the other hand, the paper written by Casino et al. presents a comprehensive survey of blockchain-based applications in various sectors. Blockchain applications support various divisions such as supply chain, commerce, health, Internet of Things (IoT), security, information administration, and other emerging topics. This research also identifies the main weaknesses in blockchain innovation and how these barriers may affect various business segments. Along with the use and development of blockchain, it is expected that its applications will increasingly expand to various industries and domains.

In addition, a lot of effort is being put into proposing the use of blockchain as a solution for databases. Even so, there are also scenarios where conventional databases are still needed.

In research conducted by Mikroyannidis et al., they investigated the application of Blockchain Smart Badges in the context of science instruction. Their particular focus was to explore the extent to which Smart Blockchain Badges can support students who wish to advance their careers in information science by promoting them based on their learning achievements. This research aims to fill gaps in data science skills by linking data science instruction to industry needs. Smart Blockchain Badges are used to provide feedback to learners and support them in achieving their career goals. Delivery of Smart Blockchain

Badges to students who are actually well managed, while evaluating their comfort in long-term learning is also carried out.

Research conducted by Muhamed et al. revealed that blockchain innovation empowers the implementation of decentralized applications where a third party is not required to control the sharing of information. Every exchange that occurs is automatically recorded in a verifiable and irreversible logbook. In line with this, they proposed a global course credit platform for higher education institutions called EduCTX. This platform is based on the concepts of the European Credit Transfer and Accumulation System (ECTS) which is a universally recognized framework. EduCTX provides a universal and decentralized perspective on credit and review of higher education institutions, and can engage other potential partners such as the private sector, government and other institutions. As a verified concept, this platform uses a peer-to-peer model called ArkBlockchain Platform, which is a universal network that can be delivered peer-to-peer. EduCTX is responsible for managing, monitoring and controlling the ECTX tokens, which represent the credits taken by students for completing courses as in the ECTS system.

In a study conducted by Funk et al., examined the challenges faced by the educational health profession (HPE) in adapting instructional strategies to modern advances. The main evaluation of this new method is the need for capacity to know the beginning, legitimacy, and responsibility for the information that is generated, shared, and obtained. Blockchain could permit HPE to take the next steps in managing the substance and people involved, evaluating instructional impact at different levels of learners, and building mutually respectful relationships in instructional mediation. The potential for blockchain to significantly transform HPE and transform the way patients, experts, teachers and students relate to secure and substantial data is immense. The educational health profession (HPE) continues to be in high dynamics and must adapt to challenges in the biomedical sciences, changing learning hypotheses, modern administration, developments in mechanisms, and efforts to ensure that health professionals possess an appropriately recognized level of competence.

Other research conducted by Chen discusses the use of blockchain innovation in creating cryptocurrencies such as Bitcoin. As part of the fourth mechanical revolution after the innovation of the steam engine, electricity and information technology, blockchain innovation has created an impact in areas such as finance, law and commerce. This study focuses on potential instructional applications and investigates how blockchain innovations can be used to solve several problems in education. This article provides an overview and main focus of blockchain innovation, followed by a walkthrough of some relevant blockchain applications with instructions.

3. Findings

In this study, which is the first stage of the major research, we are considering the following topics of blockchain application in education. Which are:

3.1 Blockchain Application in Education

- Online education, also known as distance teaching or e-learning, leverages data and internet innovations to deliver learning content quickly. This is a web-based educational strategy. In facing the challenges of online instruction regarding validity and security, blockchain innovation emerged as the ideal solution. With blockchain technology, unmodified learning records can be generated without involving a third party for monitoring, as well as ensuring fair recognition of course credits. The implementation of this blockchain innovation has great potential in various fields of internet-based education.
    a. Records of students' learning progress show that Blockchain technology provides an effective solution for storing data in databases spread over various areas. By using this technology, each data block can be recorded

sequentially and equipped with an accurate timestamp. Even more interesting, each new block of data added cannot be modified or deleted, providing high data security and integrity. Thus, Blockchain becomes a very useful tool in recording and tracking student progress in a transparent and secure manner.

b. certification of authenticated learning outcomes in online education faces challenges due to reliance on inefficient third-party institutions. To solve this problem, blockchain technology provides a simple and efficient solution in certification of learning outcomes, including academic certification. The certificates of the disciples could easily be verified even if they were lost. Blockchain uses an asymmetric encryption algorithm in cryptography to ensure data security and reliability. As such, blockchain becomes a reliable tool for providing valid and trustworthy certifications in the world of online education.
c. The application of blockchain technology in the sharing of content and other resources provides the benefit of automatic execution without the need for third party verification. This simplifies transaction processing, results in smart, automated, and decentralized transactions, and improves overall transaction security. By using blockchain applications, users can carry out transactions with high efficiency and reliability, without the need to rely on third parties for verification. In this context, blockchain technology provides innovative solutions and empowers users to participate in resource sharing in a more effective and secure way.

- Issues of student data privacy and consent are often a challenge in educational institutions, where guardians of students are often asked to sign various types of consent forms regarding the use of student data. However, it is often difficult for them to tell which form they signed to provide consent, and they may not have clear information about how and when the data will be used. To solve this problem, Gilda, Shlok, and Mehrotra, Maanav have proposed a framework that uses Hyperledger Fabric and Composer to implement blockchain innovation. This framework aims to be a digital agreement that can be enforced without relying on legal documents from third parties. Within this proposed framework, there is a recurring authorization block that allows educational institutions to provide data access for legal purposes after obtaining data access rights approval from the student's guardian through a smart contract. With this framework, it is hoped that student data privacy can be better maintained and the approval process can be carried out transparently and safely in the context of data use in educational institutions.
- The application of blockchain-based technology in learning learning outcomes allows the use of need-based university graduation indexes, with professional certifications able to use automatic evaluation software as a tool. Information about course learning outcomes, such as achievement scores based on a combination of quantitative and qualitative scores, process and evidence, course names, indicators of passing requirements, and course weights, can be included in blocks. Conversion from student achievement evaluations to post-employment competencies can also be carried out, and student competency evaluations will be sent to a curriculum that embodies the quality improvement of the student programs attended. In the educational block chain, graduating students not only receive diplomas, but also receive information that has become an index of the capacity needs of graduates during the learning process. Compared to approval based solely on previous diplomas, this allows approval of the learning process, verification of the essential content of the diploma, and the establishment of different categories of students who earn diplomas. Learning

outcomes form the basis of mutual recognition and credit transfer in international higher education, as well as the basis for the internationalization of higher education and talent flows. Learning outcomes can come from various educational institutions, practical work experiences, online studies, and other learning processes. Due to the results-focused educational approach, when the index shows that the graduate requirements set by the institution are met, the institution can award diplomas to students.

- In the context of operational skills competition, schools can use frameworks that allow students to imitate operations and transfer to further operational instructions. By leveraging blockchain innovation in the digital education zone, competitive mode measures can be created. This helps simplify management, develop skills, and maintain a strategic distance from ambiguous issues and message distortions. In addition, it can also provide irreversible computerized certification for scholastic learning achievement. Based on the existing research, taking into account the concerns of the relevant clients and the administration, especially in terms of standards and trust in the current competition and scoring mode, a blockchain-based competition mode was tested. In this test, the application of the blockchain in competition mode and the outline, scoring criteria and calculations are analyzed, as well as the operationalization of the skill assessment event. Through this process, an operational skills competition assessment framework is formed based on testing and experimentation using the e-business sandbox.
- increasing the value of universities, an Ethereum-based blockchain framework was developed that can be used by universities to record student grades and provide cryptocurrency. In this study, through exploration and subjective assessment, the authors identify some of the concerns that arise between the concept of college as an association and the concept of distributed autonomous organization (DAO) in Ethereum. Identified concerns included trust mechanisms, open boundaries, and the values involved in the method. The author also covers the implementation layout and assessment process as part of this framework.
- In the current Education-Industry System, there is industrial participation which causes substantial data asymmetry between educational institutions and the companies that make use of them. A mechanism is needed to maintain credit frameworks and student historical data for future use. In this research, the authors use the transparency and unobtrusive advantages of the blockchain framework to realize Education Industry cooperation based on the Hyperledger blockchain framework. By leveraging the benefits of Certificate Authorities and exchanges in the Hyperledger system, this framework defines the roles of universities and companies in a compliant framework, and empowers universities and companies to share data directly. This overcomes the data symmetry between skills learned and data information, application requests, and job availability. The Hyperledger framework has been used in the approved Education-Industry model framework.
- In the context of Records of Education, Reputation and Honors, blockchain has the ability to propagate a continuous record of events. It includes deal strategies to verify the authenticity of unused entities, sharp automated contracts, as well as the information structure associated with each piece. These records are perpetual and widespread in nature, including mental labor and reputational compensation associated with education. Through the application of blockchain, the democratization of an instructive reputation can be achieved through scientific examples and principles. Experiments with blockchain in instructional record keeping have changed the paradigm regarding the importance of administration within instruction frameworks. Its main benefit is that it provides a single security for instructive

achievement records that is open and can be distributed across institutions.

- Educational certificates are necessary because the majority of educational certificate administrations available today cannot guarantee the security and reliability of student information. While blockchain can be used to address this trust issue, blockchain itself has limitations that limit its full implementation. There are limitations in terms of throughput and access time on the blockchain. To overcome these limitations and efficiently address the need for educational certificates, the use of the educational certificate blockchain (ECBC) is proposed. ECBC makes use of a tree structure (MPT-Chain) which provides efficient answers to these questions. In addition, ECBC also supports recording of exchanges that can be accounted for from related accounts.
- Student ability evaluation system can be done effectively. Through blockchain, students' academic and non-academic achievements at school, training, competitions, exercises, and activities outside of school can be analyzed and evaluated. This helps students to gain a better understanding of their abilities, as well as opens up job opportunities for them in the future. In addition, companies can also use this evaluation data to identify potential candidates that match their needs. Thus, a blockchain-based student ability evaluation system provides benefits for students and companies in creating job opportunities according to student abilities.
- Student online quizzes are one of the advantages offered by technology in educational institutions. In traditional scoring systems, there is often a lack of transparency that is expected. To overcome this problem, a solution has been proposed which is a Dual Layer Blockchain Consortium based web test. This solution provides open confirmation of student answers and maintains an immutable record by any party. By using blockchain technology, the integrity and authenticity of student answers can be guaranteed, while transparency in the assessment process can be increased. This gives students, teachers and other stakeholders greater confidence in a fair and accurate evaluation system.

4. Conclusion

Blockchain applications provide secure distributed ledger technology. Research has shown that blockchain can be used in various fields of education, such as online education, student data privacy, verification of results and meta-diplomas, operational skills competitions, university grading systems, education-industry cooperation, educational records, reputation and awards, educational certificates, student ability evaluation system, as well as a multi-layer based online quiz scheme. This study can be enhanced by considering other blockchain applications involved in education. By harnessing the potential of blockchain, the education sector can optimize the use of this technology to increase efficiency, security and collaboration in various aspects of learning and education administration.

This study will provide an opportunity for educational institutions to evaluate and decide how the application of blockchain in education can benefit them according to their respective needs and organizations. This research will focus on the application of blockchain in sensitive documents such as e-transcripts and various other things. By analyzing these advances, educational institutions can understand the potential use of blockchain in enhancing the security, integrity and efficiency of administrative processes as well as providing broader benefits for students and stakeholders in the educational environment.

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