



A Blockchain-Based Higher Education Credit Platform

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Abstract: Blockchain technology allows the creation of a suburbanized atmosphere wherever transactions and information are not below the management of any third-party organization. Any dealing ever completed is recorded in an exceedingly public ledger in an exceedingly verifiable and permanent method. Based on blockchain technology, we propose a global higher education credit platform. It is a decentralized higher education credit and grading system that can offer a unified viewpoint for students and higher education institutions (HEIs), as well as for other potential stakeholders such as companies, institutions, and organizations. The platform may be a 3a opening move towards an additional clear and technologically advanced type of teaching system.

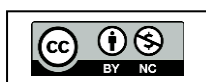
Keywords: IoT, Blockchain with IoT, Security, etc.

I. INTRODUCTION

Blockchain technology, initially conceived to regulate Bitcoin [1], has undergone a transformative evolution, positioning itself as a foundational technology for decentralized applications across various sectors [2]. Its versatile applications, particularly within higher education, healthcare, supply chain management, and the Internet of Things (IoT) [3], make it a pivotal tool in addressing the intricate challenges faced by both Higher Education Institutions (HEIs) and students within the higher education system [4].

This research delves into the multifaceted role of blockchain in higher education, with a specific focus on its influence on IT infrastructure and computing solutions for monitoring university systems. The overarching objective is to contribute to the enhancement, maintenance, or restoration of the educational system [5]. Privacy and security breaches, notably in the realm of academic diplomas and degrees, are on the upswing within higher education. Blockchain technology emerges as a robust solution to ensure the authenticity of academic records and uphold the accuracy of information [6]. The growing digitization of higher education intensifies concerns regarding secure data storage. Blockchain's distinctive features, including decentralized open data, fraud prevention, secure information storage, and the reduction of transaction expenses related to academic data control, are positioned as potent remedies to these challenges [7]. Blockchain is not merely a technological solution but is conceptualized as a transformative force, proposing a student-centric approach to record-keeping, and addressing critical issues within higher education [8].

While previous systematic literature reviews (SLRs) have significantly contributed to understanding the applications of blockchain in higher education [5,9], their emphasis has often been on specific areas of utilization. In contrast, this study adopts a Systematic Bibliometric Literature Review (LRSB)





[5] to synthesize existing knowledge, identify gaps, and outline future research directions. Beyond categorizing prior studies based on their application areas, this study endeavours to pinpoint themes demanding more attention, highlight major challenges and propose potential research paths to advance the existing knowledge base.

Firstly, to provide a comprehensive exploration of the current state of blockchain technology in higher education, and secondly, to analyze existing challenges while outlining potential research directions in this ever-revolving domain [15]. The following sections of the article are organized in the following manner: Section 2 provides a comprehensive overview of blockchain technology, Section 3 outlines the methodology utilized for the LRSB, Section 4 unveils the research findings, followed by an in-depth discussion. Lastly, Section 5 encapsulates concluding remarks, acknowledges limitations, and proposes directions for future research to enrich our understanding of the complex interplay between blockchain technology and higher education.

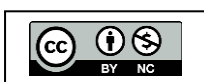
The aim of the proposed blockchain-based higher education credit platform is to transform the management and transfer of academic credits within the higher education sector. Through the utilization of blockchain technology, our objective is to establish a secure, decentralized, and immutable platform facilitating the seamless recording, verification, and transfer of academic credits across institutions worldwide [16]. This initiative targets the streamlining of existing processes, such as the often complex and time-consuming credit transfer procedures, while promoting trust, transparency, and inclusivity for students, educators, and institutions. Ultimately, our vision is to empower learners to navigate their educational paths with increased flexibility, while fostering collaboration and innovation within the global higher education community.

II. LITERATURE REVIEW

Upon examining prevalent themes in the literature, it is evident that innovation, decentralization, and digital innovation stand out as primary concepts. Categorizing these concepts further, technological features, innovation, decentralization, and ecosystems emerge as key themes in blockchain technology literature. Notably, some concepts span multiple categories, laying the groundwork for deeper analysis.

Numerous researchers have investigated the application of blockchain for the secure storage of university grades, specifically in the form of transcripts. A team from the University of Glasgow successfully developed a functional prototype for recording student grades on the Ethereum public blockchain [17]. This exploratory project encountered challenges, particularly in utilizing smart contracts to algorithmically calculate grades.

Another project, outlined in [3], presented a prototype utilizing a private BigChainDB blockchain for storing student transcripts, although it focused on transcripts rather than individual course grades. The initial outcomes of this project were encouraging. Yokubo [9] detailed a prototype implementation of a university transcript system using a private Ethereum blockchain and ERC-20 tokens. This setup allowed students to access their grades, while professors and administrative staff could input and manage the grading information.





In his 2018 work, Stefan K. Johansen meticulously documented the technological and literary landscape of blockchain within Information Systems research. He outlined the prerequisites for blockchain to function as an innovation enabler, emphasizing the need for certain factors for success. Johansen acknowledges that blockchain technology is still evolving and has a way to go before achieving mainstream adoption.

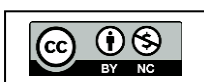
According to a source referenced as [10], blockchain technology was anticipated to revolutionize transactions, impacting various application areas. Focused on peer-to-peer networks, this source used service systems as a unit of analysis to explore blockchain's potential contributions. It identified characteristics facilitating trust and decentralization, essential for forming and coordinating service systems.

Karamitsos [11] delved into the application of blockchain and smart contracts in real estate, presenting a detailed smart contract design for renting residential and business buildings. Leonardo [12] developed an ontology to elucidate concepts and structures related to blockchain, creating a continuum of architectural solutions ranging from centralized to fully distributed systems.

A. Motivation

Employees within the education sector occasionally encounter challenges related to the misplacement of crucial documents, a predicament that extends to students who may lose their diplomas at inconvenient times. Moreover, individuals from conflict-ridden regions seek to continue their education elsewhere, and there are instances where a school's server malfunctions or experiences a complete data wipeout for various reasons. The pressing nature of these issues underscores the need for a comprehensive and qualitative exploration. The central research questions driving this study are pivotal in shaping the qualitative investigation:

1. How to sustain a trustworthy repository of academic records in a decentralized fashion? This question delves into the exploration of solutions that ensure the secure and decentralized storage of academic records. By doing so, the study aims to address the challenges associated with the misplacement or loss of essential documents, providing a robust system that mitigates these issues.
2. In what way can recruiters efficiently authenticate certificates from educational institutions without delays? This question targets the efficiency of the verification process for academic certificates, focusing on creating streamlined mechanisms that enable swift and reliable verification. Such a solution is crucial for recruiters to make informed decisions promptly.
3. Which technology is optimal for individuals seeking ongoing skill enhancement for both professional and personal development in the modern world? This question explores the technology landscape, aiming to identify and recommend the most effective tools and platforms that learners can utilize to continuously enhance their skills. The focus here is on aligning with the dynamic demands of the modern world for both professional and personal development.





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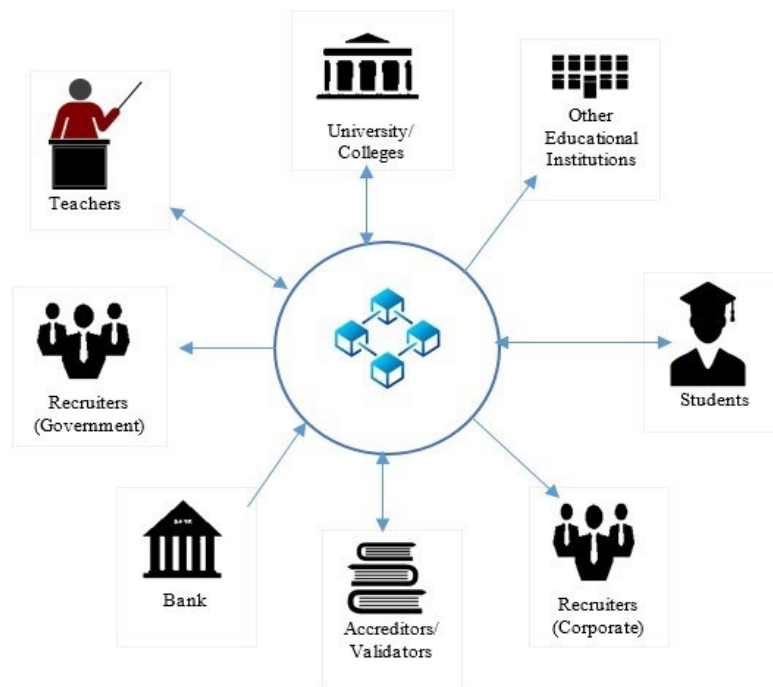
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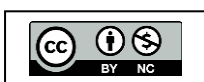
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The multifaceted nature of these research questions acknowledges the complex challenges within the education sector and seeks to propose practical, technology-driven solutions. Through a qualitative study, the research aims to contribute valuable insights that can revolutionize the way academic records are stored, certificates are verified, and learners engage in skill development for sustained personal and professional growth. Individuals encountering difficulties in obtaining copies of their academic records can discover resolutions through blockchain-secured credentials. Functioning with sensitive information like courses, assignments, solutions, payments, grades, and certificates, the platform is crafted to elevate both security and accessibility.

A visual depiction of this motivating example is presented in Figure 1.



The integration of blockchain technology in the education sector [14] holds significant potential for enhancing the efficiency of schools, colleges, and universities. By leveraging a shared database, educational institutions can streamline processes for verifying candidate details. This includes expediting the certificate issuance process through smart contracts upon course completion, empowering students to assert control over their degrees and diplomas. Furthermore, the utilization of blockchain extends benefits to students and examination cells alike. The technology facilitates the secure storage and easy accessibility of educational data, while concurrently reducing costs and time expenditures. Blockchain, through the implementation of advanced smart contracts, facilitates the transfer of academic records to the blockchain. This not only ensures the safety of educational data but also addresses challenges related to degree printing, verification, and storage.





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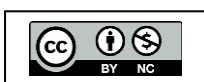
One notable advantage of blockchain in the education sector is its ability to streamline the examination process. Key benefits include the elimination of biases, the removal of intermediaries, and a significant reduction in both costs and paperwork. Blockchain's transparent and decentralized nature contributes to a more efficient and trustworthy educational ecosystem, benefiting students, institutions, and other stakeholders involved in the education sector.

B. Blockchain Technology

Blockchain technology, heralded for its transformative impact, extends its influence across a myriad of sectors [17]. At its core, blockchain enables the development of decentralized applications, meticulously programmed to operate on a network, thereby recording sets of data securely without the necessity for intermediaries [20]. The intricate mechanisms of blockchain applications, particularly the storage of data through encrypted group signatures, along with shared algorithms, address concerns related to anonymous abuse [21]. In the context of higher education, the significance of these features becomes paramount, considering the extensive exchange of data, particularly diplomas and degree certificates, among institutions [22,23].

Within the higher education sector, blockchain emerges as a promising technology, especially in the realm of smart contracts [25]. Its capabilities facilitate stakeholders in validating learning records and managing identities, offering a transformative potential for institutions [24]. By allowing institutions to selectively share data with other Higher Education Institutions (HEIs), blockchain mitigates the risks associated with the counterfeiting or falsification of trustworthy qualifications, such as diplomas or certificates [26]. The decentralized ledger, coupled with the elimination of the need for a trusted third party, enhances smart contract-based protocols, automating contract enforcement across multiple administrative levels—a significant boon for higher education [19]. Additionally, the streamlined processes introduced by blockchain contribute to operational efficiency while reducing the likelihood of errors [27].

Despite the promising prospects, there exists a discernible resistance to the widespread adoption of blockchain technology. Skepticism persists, fueled by doubts about its ability to surmount administrative barriers and bring transparency to higher education systems [28]. Questions also linger about its potential to revolutionize student experiences and reshape faculty roles within higher education institutions [29]. From an employer's perspective, trust issues arise due to inaccuracies in how students articulate their skills and qualifications on resumes [18]. To overcome these challenges, a comprehensive understanding of blockchain and its intricate nuances is imperative, shedding light on its key advantages for both students and Higher Education Institutions (HEIs). Often, institutions find themselves lacking the requisite education and coordination systems necessary to adequately prepare professional staff, relying on traditional learning and education methods with limited integration of technology for data management [20].





III. ISSUES IN THE CURRENT EDUCATION SYSTEM

The existing education system grapples with significant challenges, particularly in the traditional examination procedures, which have become notably sluggish [13]. The inherent sluggishness in these processes contributes to irregular delays in grading and result declaration timelines. Relying on manual methods for tasks such as dispatching examination copies and finalizing results not only incurs substantial costs and consumes a considerable amount of time but also introduces the potential for discrepancies in results—a matter that severely compromises fairness in the assessment process. These challenges are particularly pronounced in areas where manual paperwork persists, amplifying the complexities and inefficiencies inherent in the current education system.

The prolonged duration of these processes has extensive implications, impacting not only the efficiency of educational institutions but also the overall student experience. Timely and precise assessment holds immense importance for students, directly influencing their progression through educational levels and subsequent career paths. Therefore, addressing these challenges becomes imperative for the improvement of the education system, ensuring fairness, efficiency, and alignment with the constantly evolving technological landscape.

IV. BENEFITS OF BLOCKCHAIN-BASED HIGHER EDUCATION CREDIT PLATFORM

1. Enhanced Data Security:

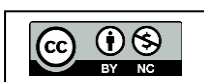
- Blockchain utilizes advanced cryptographic techniques to secure data.
- Student records are stored in a tamper-resistant and transparent manner, reducing the risk of data breaches or unauthorized alterations.
- Improved data security safeguards sensitive academic information.

2. Transparent and Trustworthy Records:

- All transactions on the blockchain are transparent and traceable.
- Immutability ensures that once grades or credits are recorded, they cannot be altered, fostering trust in the authenticity of academic records.
- Stakeholders, including employers and other educational institutions, can verify records with confidence.

3. Streamlined Administrative Processes:

- Smart contracts automate various administrative processes, such as credit issuance, validation, and transfer.
- Reduced reliance on manual efforts and paperwork leads to increased efficiency and lower administrative costs for educational institutions.
- Automation ensures faster and more accurate handling of academic transactions.





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4. Global Accessibility and Recognition:

- Blockchain facilitates easy and secure access to academic records for students, institutions, and employers.
- Interoperability allows for the seamless exchange of records between different educational systems and institutions.
- The standardized format enhances the global recognition of academic credentials, benefiting students seeking opportunities internationally.

5. Empowered Students with Data Ownership:

- Students have greater control and ownership of their academic records.
- They can selectively share their credentials, maintaining privacy and controlling access to their educational information.
- Blockchain empowers students to securely manage and share their academic achievements as needed.

V. RESULTS

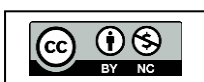
As of my last update in January 2022, no widely recognized instances of a blockchain-based higher education credit platform had emerged. However, the idea has generated considerable interest in academic and technological circles as a potential solution to several challenges in higher education. Implementing such a platform would require extensive collaboration among educational institutions, regulatory bodies, and technology developers. The primary goals would include streamlining credit transfer processes, enhancing data security, and promoting transparency within higher education systems globally.

Developing a functional platform would involve addressing various technical, logistical, and regulatory hurdles. This includes ensuring interoperability among different institutions' systems, maintaining the integrity and privacy of student data, and navigating legal frameworks governing educational records and privacy. While there may be ongoing research, pilot projects, or initiatives exploring this concept, significant progress and adoption within the education sector would be necessary to realize its full potential. Ultimately, the success of a blockchain-based higher education credit platform would depend on its ability to meet the diverse needs of students, educators, and institutions while navigating the complexities of the modern educational landscape.

VI. CONCLUSION AND FUTURE ENHANCEMENT

Blockchain, functioning as a decentralized ledger technology, employs cryptography and distributed consensus algorithms to embody properties like decentralization, traceability, immutability, and currency features. Its potential has been demonstrated across various industries, including academia. The currency properties of blockchain present opportunities for innovative applications in education, offering a secure and comprehensive record of educational activities in both formal and informal learning settings.

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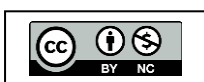


To validate this concept, a proposed blockchain architecture for learning solutions, known as the PETs architecture, has been introduced. This global, blockchain-based architecture aims to enhance higher education learning systems by providing a unified perspective for learners and educational institutions worldwide. This framework extends notable advantages to potential employers by simplifying the direct verification of student information and enhancing the efficiency of the hiring process. Simultaneously, learners benefit from a comprehensive and transparent overview of their completed courses, fostering a more informed approach to their academic journey. Educational institutions, on the other hand, can seamlessly access real-time data, offering a holistic view of students' academic progress regardless of their educational history.

The proposed solution operates within a decentralized peer-to-peer network system, emphasizing its adaptability, security, and resilience. This design ensures that information is not only easily accessible but is also safeguarded in a tamper-resistant manner. As we extend this framework, considerations should include its scalability to accommodate a growing user base, adaptability to evolving technological landscapes, and potential contributions to fostering a more interconnected and accessible global education ecosystem.

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