

Blockchain in Education: A Comprehensive Approach for Managing Academic Credit Transfer Systems

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ABSTRACT

Purpose: Primarily this study is to explore the potential application of the blockchain as technology for managing the Academic Bank of Credit (ABC) system. It aims to identify the pros and cons involved with the implementation of blockchain technology to ensure secure, transparent, and efficient storage and transfer of academic records across multiple educational institutions.

Design/Methodology/Approach: This research employs a qualitative review of existing literature and technological frameworks related to blockchain in education. It analyses various blockchain models, consensus mechanisms, and regulatory approaches to assess their suitability for ABC systems. The study synthesizes prior scholarly work, technological standards, and regulatory considerations to formulate comprehensive insights.

Findings: The study finds that blockchain possesses significant potential to transform the ABC systems, by providing immutable security, fostering trust, and streamlining credit transfer processes. However, several barriers remain, notably issues related to scalability, consumption of high energy in public blockchains, privacy concerns with sensitive data, governance complexities, and lack of interoperability across institutions. Implementing permissioned blockchains, adopting energy-efficient consensus mechanisms, and establishing standard regulatory frameworks are identified as crucial steps to mitigate these challenges.

Originality: This research offers an integrated analysis of blockchain's capabilities and limitations specifically tailored for educational credit management systems. It contributes novel insights into combining technological advancements with regulatory frameworks to cater the distinguished challenges of using blockchain in education. The comprehensive overview serves as a strategic guide for policymakers, educational institutions, and technology developers aiming to leverage blockchain for secure, efficient academic record management.

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KEYWORDS: Blockchain | Academic Bank of Credit (ABC) | Education | Data Privacy | Interoperability | Scalability | Security

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Introduction

With the advent of digital technologies in education, the management of academic records has evolved significantly. The concept of the Academic Bank of Credit (ABC) is gaining traction as a part of educational reforms in many countries, aimed at creating a unified platform for storing, sharing, and transferring academic credits among institutions (University Grants Commission, 2021). ABCs allow students to accumulate academic credits from multiple institutions and later transfer or redeem them for academic degrees. But to ensure the safety and correctness of the records, it is important to set up a strong system that promotes trust and openness.

The potential of distributed and unchangeable behaviour of Blockchain technology makes it a possible way to handle ABC systems. However, while blockchain presents significant advantages in terms of transparency and security, it also introduces a set of unique challenges, especially in the context of managing sensitive academic data. This study examines the difficulties associated with employing blockchain technology for the management of Academic Bank of Credit (ABC) systems and explores potential novel solutions to minimise these obstacles.

Blockchain for Academic Bank of Credit

Primarily the contribution of using blockchain in any ABC system is to introduce a system where the records (students' academic credits) are safe and secure from any tempering. By recording these transactions on a blockchain, any Teaching-Learning institution can assure that the credits are immutable, verifiable, and securely stored (Steiu, 2020). The decentralized nature of the Blockchain reduces the risks of fraud and manipulation of records, which is mandatory for maintaining trust in the academic credentialing system.

Advantages of Blockchain in ABC

The advantages of using blockchain in the Academic Bank of Credit (ABC) system include enhanced security, transparency, and reduced costs. Blockchain's inherent security features ensure that academic records cannot be tampered with or altered by unauthorized parties, thereby safeguarding students' credentials. Its transparent nature means that all transactions, such as credit transfers, are publicly available to authorized users, promoting trust and accountability across institutions. Additionally, blockchain technology can significantly lower administrative costs by eliminating the need for intermediaries in verification processes, streamlining operations, and reducing manual efforts. Overall, these benefits contribute to a more reliable, efficient, and trustworthy system for managing academic credits. The key advantages are as follows :

- **Security:** Blockchain provides a highly secure environment, ensuring that academic records cannot be tampered with or altered by unauthorized parties (Alnafrah & Mouselli, 2021)
- **Transparency:** With blockchain, all transactions (i.e., credit transfers) are publicly available to authorized users, promoting transparency (Agrawal et al., 2022)
- **Reduced Costs:** Blockchain eliminates the need for intermediaries in the verification process, reducing administrative costs for institutions (Raimundo & Rosário, 2021)

Challenges in Using Blockchain for Managing ABC

This section covers the potential challenges associated with the usage of blockchain to manage the Academic Bank of Credit (ABC) system. Primarily the concerns is scalability; as the participating institutions and students increases, public blockchains such as Ethereum or Bitcoin face significant limitations in transaction throughput, potentially leading to delays and inefficiencies. Energy consumption is also a matter of concern, especially for blockchains utilizing Proof-of-Work (PoW) consensus mechanisms, which require substantial computational power and energy resources, making large-scale implementations resource-intensive and less sustainable. Data privacy and protection present additional concerns, as storing sensitive academic and personal information on transparent blockchains could expose students' data to unauthorized access, raising compliance related issues with regulations for data protection like GDPR. Interoperability also poses a significant hurdle, since different educational institutions often use varied software and the management of data-oriented systems with various software is not easily compatible with blockchain platforms. This factor can obstruct credit transfer mechanism and can hinder the data sharing across institutions, emphasizing the requirement for standardized protocols to ensure smooth integration and interoperability within the ABC ecosystem.

Scalability

Blockchain, particularly public blockchains, is often criticized for scalability issues, and due to the increase in the number of institutions the number of students also increases, thus the level of performed and recorded transactions on the blockchain would also grow substantially. Public blockchains, say Ethereum or Bitcoin, also face challenges in handling a high number of transactions due their limitation for their respective transaction throughput (Sanka & Cheung, 2021). In the case of ABC systems, which may involve multiple universities and millions of students, blockchain networks would need to scale efficiently to ensure that transactions can be processed without delays.



Energy Consumption

The energy usage of blockchain systems, especially those utilizing Proof-of-Work (PoW) consensus mechanisms, represents an additional obstacle. PoW mechanisms, which are used in many public blockchains, require substantial computational power to validate transactions, which leads to higher consumption of energy (Sedlmeir et al., 2020), and as per ABC this becomes a matter of concern, because Academic / Teaching-Learning institutions are generally not equipped to handle the resource demands associated with large-scale blockchain implementations. Energy-efficient consensus mechanisms, such as Proof-of-Stake (PoS), could moderate this problem, but their adoption is still in progress (Al Ghamdi, 2022)

Data Privacy and Protection

Academic records are highly sensitive, containing personal and academic information about students. Blockchain's transparency feature, while beneficial in promoting trust, could be a double-edged sword when it comes to privacy. Storing such sensitive information on a public blockchain could expose students' personal data to unauthorized access, raising concerns regarding data protection and privacy compliance in accordance with frameworks like the General Data Protection Regulation (GDPR) (Gilda & Mehrotra, 2018). Solutions such as encryption and using permissioned blockchains could address these concerns but present additional complexities.

Interoperability

The fundamental challenge of applying blockchain in an ABC system is the lack of interoperability between different educational institutions' systems. Academic institutions often use different software and database systems for managing records, which may not be easily integrated with blockchain platforms (Ramasamy & Khan, 2024). This could result in fragmented ABC systems, where blockchain solutions might only work within specific institutional boundaries, thus hindering the transfer of credits across institutions. Interoperability standards and protocols are required to be developed to get assured that the blockchain-based ABC systems can be smoothly incorporated into current institutional infrastructures (Anthony Jnr, 2024).

Governance and Regulation

The governance challenges are raised due to the distributed nature of blockchain, particularly when the management of the academic records is required to be done. In general, the Traditional centralized systems in educational institutions are typically managed by a governing body or authority that oversees the policies and procedures for record-keeping. In a blockchain-based system, however, governance becomes

more complex, as the responsibility for handling the ledger is divided among various parties (Rikken et al., 2019). There is a requirement of clear regulations and frameworks to define the duties, functions and accountabilities of stakeholders, to guarantee adherence to data protection regulations, and manage disputes effectively.

Potential Solutions

The performed work identified several potential solutions to handle the challenges of using blockchain for managing the Academic Bank of Credit (ABC) system. To tackle privacy concerns, it suggests utilizing permissioned blockchains, which restrict access to authorized participants and can incorporate encryption to safeguard sensitive student data. To reduce energy consumption, alternative consensus mechanisms such as Proof-of-Stake (PoS) or Practical Byzantine Fault Tolerance (PBFT) are recommended, as they demand significantly less computational power compared to traditional Proof-of-Work (PoW) systems. The paper emphasizes the importance of developing standardization and interoperability frameworks, which would establish common protocols for seamless integration and communication between different institutional systems, thereby mitigating fragmentation. Additionally, establishing clear regulatory frameworks is vital; governments and regulatory bodies should create guidelines that ensure strict adherence with privacy laws, address storage of data and consent, and also promote transparency in transactions. Collectively, these solutions aim to make blockchain-based ABC systems more secure, energy-efficient, interoperable, and compliant with legal standards, facilitating wider adoption and effective implementation.

Permissioned Blockchain

To address data privacy concerns, a permissioned blockchain could be utilized for managing ABC systems. Only authorized participants are permitted to access and update the Permissioned blockchains, offering a more controlled environment compared to public blockchains (Abad-Segura et al., 2021). Such systems can be configured to encrypt sensitive student information, thereby protecting privacy.

Energy-Efficient Consensus Mechanisms

The Consensus mechanisms like Proof-of-Stake (PoS) or Practical Byzantine Fault Tolerance (PBFT) could be employed to tackle the issue of energy consumption. These mechanisms require significantly less computational power compared to Proof-of-Work (PoW) (Wadhwa et al., 2022). These alternative mechanisms offers much reliable way to validate transactions while preserving the security of the blockchain.

Standardization and Frameworks

Establishing uniform protocols to enable interoperability among educational institutions is essential for the effective implementation of blockchain-based ABC systems. Industry-wide frameworks that define how blockchain solutions can interact with existing institutional systems would facilitate the adoption and integration of blockchain across multiple institutions (Silaghi & Popescu, 2025)

Regulatory Frameworks for Blockchain in Education

To ensure that blockchain implementations in ABC systems are compliant with privacy regulations, governments and the guidelines/regulations framed by the regulatory bodies should be clear. These regulations should address the storage of student data, consent mechanisms, and transparency in transactions, providing a legal framework that ensures the privacy and security of academic / educational records (De Filippi & Mannan, 2025)

Conclusion

This paper explores the application of blockchain technology for managing the Academic Bank of Credit (ABC) systems, emphasizing its potential benefits and the various challenges involved. The discussion highlights advantages such as enhanced security, transparency, and reduced administrative costs due to blockchain's immutable and decentralized nature. However, it also addresses significant challenges, including issues of scalability, consumption of high energy, concerns related to the privacy of data, and difficulties in the data interoperability among different educational institutions. To mitigate these problems, the paper discusses potential solutions like adopting permissioned blockchain networks, employing energy-efficient consensus mechanisms such as Proof-of-Stake, and developing standardized protocols and regulatory frameworks for interoperability and data protection. The conclusion emphasizes that while blockchain holds considerable promise for revolutionizing credit management systems and facilitating seamless academic mobility, overcoming these technical and regulatory challenges is crucial. With appropriate strategies and innovations, blockchain can significantly contribute to creating more secure, transparent, and efficient academic record-keeping systems in the future.

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Annexure 16.4.2

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Reviewers Memorandum



Reviewer’s Comment 1: The topic of using blockchain for academic credit management is timely and relevant. The paper does a commendable job of clearly outlining both the benefits and challenges. To further enhance its impact, the methodology section could include a bit more detail, perhaps by briefly explaining how the literature sources were chosen and analyzed. This small addition would add even more depth to an already strong foundation.

Reviewer’s Comment 2: The paper offers a comprehensive and insightful view of how blockchain can enhance the Academic Bank of Credit system, particularly by improving transparency and security. The clear explanation of both the advantages and challenges is especially commendable. To make the discussion even more relatable, including a real-world example or case study from the education sector could further strengthen the practical relevance of the arguments.

Reviewer’s Comment 3: This is a well-structured and informative paper, with the authors effectively highlighting the key technical and regulatory challenges of implementing blockchain in education. The content is rich and thoughtfully presented. A brief explanation or simplification of a few technical terms could make the paper even more accessible, especially for readers from non-technical backgrounds, and further enhance clarity and reader engagement.



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