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Educred : A Blockchain based learning Credibility System

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A B S T R A C T:

EduCred is a blockchain-powered educational credit system designed to overcome the limitations of traditional centralized academic platforms, which often face issues of manipulation, lack of transparency, and restricted scalability. The system introduces LearnCredit, a custom ERC-20 token that students earn by completing courses, quizzes, assignments, and other learning milestones, serving as verifiable proof of academic achievement stored securely in their personal blockchain wallets. By replacing centralized databases with decentralized smart contracts, EduCred ensures tamper-proof, transparent, and automated reward distribution. Students can redeem their LearnCredits for meaningful benefits such as internal or sessional mark improvements, attendance relaxation, premium learning content, and gamified incentives. With a scalable decentralized architecture, EduCred also supports future integration with other educational systems and institutions, enabling blockchain-verified NFT certificates, cross-institution academic credentials, and portable achievement records. This approach highlights the transformative potential of blockchain technology in creating a fair, secure, and future-ready education ecosystem.

Keywords: Blockchain, Decentralized, Education Tokenized, Credit System, ERC-20 Token, LearnCredits, Smart Contract, Academic Rewards, Educational Blockchain Wallet, Tamper-proof, Records, Transparency, Decentralized Architecture, NFT Certificates, Cross-Institution Credentials, Gamified Learning EdTech, Immutable Academic Records

1. Introduction

Academic evaluation and reward systems in most institutions are still governed by centralized databases and manual verification procedures. This model creates multiple weaknesses, such as a higher chance of data tampering, low transparency in record handling, weak system interoperability, and limited motivation for learners to engage in consistent skill development. Although modern e-learning platforms provide access to educational content and online assessments, they do not offer a secure or permanently verifiable method for validating student accomplishments. In many cases, reward structures remain restricted to individual organizations and cannot be authenticated or transferred outside their original platforms, reducing their long-term academic and professional value.The growing interest in credit-based learning systems highlights the importance of reliable recognition mechanisms. However, without decentralization, such credits remain vulnerable to bias, unauthorized alterations, and authenticity concerns. Additionally, centralized storage of records prevents learners from using their verified achievements across multiple educational institutions or digital platforms. These shortcomings create the need for a transparent, trustless, and incentive-driven educational environment that is independent of a single controlling authority.To overcome these challenges, **EduCred** introduces a blockchain-enabled, token-based academic credit system that securely records and verifies learner accomplishments. The platform uses a custom ERC-20 token known as **LearnCredit** to represent verified academic efforts.

Key features include:

• Students earn LearnCredits by completing quizzes, assignments, courses, and significant learning milestones.
 • All earned credits are stored securely in the learner's personal blockchain wallet, ensuring immutability and lifetime ownership.
• Smart contracts handle automated token issuance, removing the risk of bias, manipulation, or unauthorized changes.
• LearnCredits may be redeemed for benefits such as:
   1) Minor improvements in internal or session assessments
   2) Relaxation in attendance requirements
   3) Access to premium learning resources, gamified challenges, and advanced educational modules

2. Literature Review

2.1 Blockchain-Enabled Learning Ecosystems

In recent years, there has been significant growth in learning systems that utilize blockchain technology to strengthen data authenticity, traceability, and learner identity protection. Blockchain improves not only the delivery of educational content but also the way learning outcomes are verified. By replacing centralized storage with a distributed ledger, institutions can securely monitor learner progress, skills development, and academic achievements with greater transparency and reliability. As a result, many modern digital learning environments are beginning to adopt blockchain as a foundational mechanism for trustworthy evaluation.

2.2 Blockchain in Certificate and Credential Verification

The most widely recognized application of blockchain in education is its use in validating academic credentials. Well-known institutions such as MIT, Harvard, and the University of Nicosia have explored blockchain-based certification methods. These certificates contain encrypted hash values recorded on the blockchain, allowing employers and institutions to instantly verify their authenticity.This mechanism ensures:

- Permanence of records
- Protection from unauthorized modification
- Elimination of forged certificates
- Faster verification compared to manual processes

As a result, it improves the credibility of learners and provides reliable proof of competence in professional environments.

2.3 Blockchain for Lifelong Academic Records

Today, individuals acquire knowledge from diverse sources such as online courses, training programs, internships, and workshops. In traditional systems, these achievements remain scattered across multiple platforms. Blockchain enables the creation of a permanent, unified learning record that brings all accomplishments into a single secure digital profile. These records cannot be altered, can be shared with different institutions, remain accessible throughout life, and encourage continuous learning development

2.4 Blockchain-Based Incentive and Reward System

Research indicates the increasing use of blockchain-based reward systems to encourage student participation. In such models, learners receive digital tokens upon achieving specific educational milestones. These tokens may represent achievements, credibility levels, or learning points. Automated smart contracts distribute rewards only when predefined conditions are satisfied, thus ensuring fairness and encouraging consistent engagement. EduCred builds this concept by incorporating a credibility-based reward structure.

2.5 Research Gaps and Contribution of Educred

Most existing blockchain-based education systems mainly concentrate on the issuance of digital certificates. However, research indicates that there is still a lack of comprehensive solutions that understand learning as an ongoing process rather than a one-time outcome. The following major gaps have been identified in current systems:

- Absence of integrated learning credibility frameworks
- Lack of continuous, verified activity tracking beyond final certificates
- No standardized scoring mechanism to measure genuine learner engagement
- Limited use of hybrid models that combine blockchain with scalable databases
- Inadequate support for mentor-student validation and guidance

EduCred has been designed specifically to bridge these gaps. The proposed system introduces:

- Secure, blockchain-based validation of learning achievements
- Off-chain storage for detailed learning data using a scalable database model
- A credibility scoring system that reflects real effort and participation
- A mentor-assisted verification process to improve authenticity
- Transparent and verifiable academic records that can be shared across platforms

Through these features, EduCred presents a more complete, reliable, and future-ready approach to academic credibility and skill recognition

3. Methodology
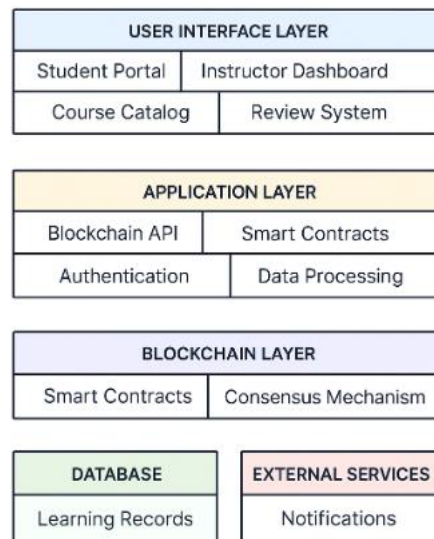
Fig. 1 – System Architecture

3.1 Requirement Analysis

The project begins with identifying the limitations of existing centralized educational systems, focusing on issues such as lack of transparency, potential data tampering, and unreliable reward mechanisms. Functional requirements—including student authentication, credit earning, wallet integration, and smart contract interaction—are gathered. Non-functional requirements such as security, scalability, and transparency are also documented to align the system with real-world institutional needs.

3.2 System Design and Architecture Planning

A layered architecture is designed to integrate the frontend, backend, blockchain network, and database. The system follows a modular approach where React.js handles user interactions, Node.js processes API logic, MongoDB stores metadata, and the Polygon Mumbai Testnet records token transactions. Smart contract workflows are mapped out to ensure seamless issuance and redemption of LearnCredit tokens. ER diagrams, workflow diagrams, and architectural charts are created during this phase.

3.3 Smart Contract Development (ERC-20 LearnCredit Token)

A custom ERC-20 token named LearnCredit is developed to represent academic achievements. The smart contract defines token creation, credit issuance rules, transaction logging, and redemption mechanisms. Solidity is used to code the contract, which is tested locally using Hardhat before being deployed on the Polygon Mumbai Testnet. The contract ensures that all credit-related operations are tamper-proof, automated, and fully transparent.

3.4 Backend Development Using Node.js and Express

The backend implements RESTful APIs for authentication, credit processing, wallet verification, and activity management. JWT is used for secure authentication, while Ethers.js enables interaction with the deployed smart contract. The backend validates student actions, triggers credit issuance through blockchain transactions, and logs metadata in MongoDB. Proper middleware is added for security, error handling, and request validation.

3.5 Frontend Development Using React.js

The frontend provides an intuitive student interface with modules for login, dashboard, credit history, wallet connection, and learning activities. React components are designed to be modular and reusable, while Tailwind CSS ensures a clean, responsive light-theme layout. Through Ethers.js, the frontend integrates MetaMask to enable wallet connectivity and allow students to view on-chain credit balances in real time.

3.6 Database Integration Using MongoDB Atlas

MongoDB is used to store non-blockchain data such as student profiles, activity logs, quiz metadata, timestamps, and smart contract transaction references. The database complements blockchain storage by maintaining fast, structured access to frequently used information. A schema-based design is followed using Mongoose ORM to ensure consistency and data integrity throughout the system.

3.7. Testing and Validation

Multiple levels of testing—unit testing, integration testing, and system testing—are conducted to ensure reliability. Backend APIs are tested using Postman and Jest, while blockchain interactions are validated through testnet transactions. Integration tests verify the communication flow between frontend, backend, and blockchain. Validation checks confirm that LearnCredit tokens are issued correctly, transactions are immutable, and system outputs match expected behaviors.

3.8. Deployment and Performance Evaluation

The frontend is deployed on Vercel, the backend on Render, and the smart contract remains deployed on Polygon Mumbai Testnet for live credit transactions. Performance metrics—including transaction time, API latency, and wallet synchronization—are evaluated. The system is tested under multiple usage scenarios to ensure scalability, reliability, and seamless user experience across devices.

3.9. Future Enhancements and Scalability Planning

The final phase involves planning extensions such as NFT-based certificates, multi-institution integration, AI-driven learning insights, and cross-platform credit interoperability. The decentralized architecture of EduCred enables long-term scalability, allowing the system to evolve into a full-fledged blockchain-based academic credential ecosystem.

3.10. Technology Stack

Components	Technology Used
Frontend	React.js
Backend	Node.js with Express.js
Blockchain	Ethereum
Smart Contract Language	Solidity
Database	MongoDB
Authentication	JWT (Json Web Tokens)
Libraries	Ethers.js
Analytics	Chart.js

4. Discussion

The proposed EduCred system demonstrates how blockchain can significantly improve the academic credentialing and validation workflow. Unlike traditional centralized systems where student records are stored and controlled entirely by educational institutions, EduCred distributes certificate ownership directly to the students via a blockchain wallet. This enhances data transparency, immutability, and tamper-proof storage.

During implementation, we observed that key features such as certificate hashing, student identity verification via MetaMask, and smart contract execution contribute toward a secure and decentralized framework. The approach ensures that once certificate data (hash) is uploaded, it cannot be altered or deleted — mitigating issues like certificate duplication, forgery, and unauthorized modifications.

The integration of credit allocation, smart contracts, and real-time verification allows educational institutes and employers to instantly validate the authenticity of credentials without relying on physical documents or manual verification. This improves operational efficiency and reduces institutional workload.

However, current scalability constraints and the dependency on internet connectivity for blockchain operations may limit adoption in certain environments. Additionally, transaction fees and network congestion in public blockchain networks can influence performance. A transition from a local developer network to a testnet, and finally a cost-efficient mainnet like Polygon, will be essential to achieve industry-level deployment.

Overall, the study reveals that blockchain-driven credential management systems like EduCred offer a future-ready, secure, auditable, and student-empowering alternative to conventional systems. With upcoming enhancements in backend integration, employer verification dashboards, and automated validation mechanisms, the platform can evolve into a fully decentralized academic ecosystem beneficial to students, institutes, and recruiters worldwide.

5. Conclusion and Future Scope

EduCred demonstrates the potential of blockchain technology to transform academic reward systems by making student achievements secure, verifiable, and decentralized. By tokenizing credits as ERC-20 LearnCredit tokens, the system ensures complete ownership, transparency, and incentive-driven engagement in learning environments. Smart contract–based automation eliminates human intervention and bias, fostering fairness and trust within academic evaluation.

In the future, EduCred can be expanded to support **NFT-based certificates**, **AI-driven analytics**, **cross-institution credit transfers**, and **multi-platform integration**. A mobile app version can further enhance accessibility and usability. As educational institutions continue shifting toward digital transformation, EduCred provides a scalable and future-ready foundation for decentralized academic credentialing.

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