IJCSC 0973-7391 International Journal of Computer Science & Communication (ISSN: 0973-7391)
Volume 17 • Issue 2 pp. 469-478 March 2026-Sept 2026 www.csjournals.com

Blockchain Based Decentralized Content Platform: Rewarding users for Curating Educational Study Materials

Vishal Malik, Dr. Anupam Bhatia, Dr. Naveen
MCA Student, Associate Professor, Asst. Prof.
Deptt. of Comp. Sc. and Application, Ch. Ranbir Singh University, Jind, Haryana, India

Abstract

Traditional centralized e-learning platforms face problems such as poor content quality control, limited rewards for contributors, dependence on a central authority, and lack of transparent governance. This paper proposes and evaluates a Blockchain-Based Decentralized Content Platform (BDCP) that uses blockchain technology, smart contracts, and decentralized storage to encourage users to create, review, and share educational study materials. The platform includes a LEARN token system, a Decentralized Autonomous Organization (DAO) for community governance, and Inter-Planetary File System (IPFS) storage, supported by **a** Hybrid Proof-of-Stake Byzantine Fault-Tolerant (PoS-BFT) consensus mechanism to achieve a throughput of over 1,000 transactions per second. Technology Evaluation and Readiness (TER) levels 4 to 7 show that the system processes more than **1,200 TPS** with transaction finality in less than **3 seconds**, demonstrating that the platform is ready for real-world deployment. The proposed framework also introduces an incentive-based governance model for educational content that overcomes major limitations identified in existing research.

Keywords: Blockchain, Decentralized Content Platform, Smart Contracts, Token Economy, IPFS, E-Learning, LEARN Token, DAO, Peer Review, Incentive System.

1. Introduction

Digital learning platforms have grown rapidly and made educational content available to people across the world on a large scale. Millions of learners use platforms such as Coursera, Khan Academy, and YouTube for studying. However, these platforms share a common limitation: they are centralized systems where a single organization controls content visibility, payment policies, data ownership, and dispute resolution [1].

This centralized approach creates several challenges. Content creators and reviewers invest significant time and knowledge into developing learning materials, but the rewards they receive are often unfair and lack transparency. Most of the revenue is earned by a small number of popular creators, while many valuable contributors receive little recognition or compensation. Recommendation algorithms are mainly designed to increase user engagement instead of improving educational quality, allowing attention-grabbing content to perform better than well-researched academic material. In addition, any technical, financial, or regulatory issue affecting the platform can make educational resources unavailable, while ownership of the uploaded content remains with the platform rather than the original creator [2].

Blockchain technology, introduced as the foundation of Bitcoin in 2008 [1], offers a different way to build content-sharing platforms. It uses a distributed and tamper-resistant ledger that is maintained through agreement among participants in a p2p network instead of relying on a central authority. Smart contracts, that are self-executing programs stored on the blockchain, can automatically manage platform functions such as reward distribution, content registration, and governance in a transparent & reliable manner [2].

This paper presents a Blockchain-Based Decentralized Content Platform (BDCP), an integrated framework designed to address the limitations of centralized e-learning systems through four main components:

i. a smart contract-based token reward system
ii. decentralized and censorship-resistant storage using the InterPlanetary File System (IPFS)
iii. community governance through a Decentralized Autonomous Organization (DAO)
iv. a Hybrid PoS-BFT consensus protocol designed to support high-throughput microtransactions.

The proposed platform is developed specifically for educational content management, where reward mechanisms consider both learning quality and user engagement. The remainder of this paper is organized as follows:

a) Section 2 discusses related work and identifies existing research gaps.
b) Section 3 explains the basic concepts of blockchain technology.
c) Section 4 describes the proposed BDCP framework in detail.
d) Section 5 presents the evaluation results
e) Section 6 concludes the paper with future research directions.

2. Literature Review

2.1 Blockchain in Educational Technology

Research on the use of blockchain in education has increased in recent years. Buterin's white paper [2] on Ethereum introduced the concept of decentralized applications and smart contracts, allowing rules to be executed automatically without depending on a central authority. In the education sector, Chen et al. [5] showed that blockchain can be used to verify academic certificates by storing records on an immutable ledger, making educational credentials secure and trustworthy. Turkanovic et al. [7] further developed this idea through the EduCTX platform, which supports blockchain-based recognition and transfer of higher education credits between institutions. However, EduCTX mainly focuses on academic credentials and does not address educational content management or contributor rewards.

Bdiwi et al. [6] explored the use of smart contracts for automated certification in e-learning environments and demonstrated that blockchain can reliably execute educational rules and processes. Ocheja et al. [8] reviewed different blockchain applications in education and concluded that scalable reward systems and community-driven governance models are still at an early stage of development.

2.2 Token-based incentives for content

One of the earliest blockchain platforms to reward content creators with digital tokens was Steemit, introduced in 2016. However, Li et al. [4] identified several fairness issues in its reward system. Users with large token holdings, often referred to as "whales," could heavily influence voting outcomes and reward distribution, reducing fairness across the platform. In addition, Steemit was designed for general social media content, where popularity and user engagement determined rewards rather than the educational quality or usefulness of the content.

2.3. Distributed storage

Benet proposed IPFS [3] as a content-addressed storage system that enables permanent and censorship-resistant file sharing across a p2p network. Instead of using traditional URLs, IPFS stores files using a cryptographic hash known as a Content Identifier (CID). This approach ensures that stored content remains unchanged and can be accessed as long as at least one network participant maintains a copy. Filecoin further supports IPFS by providing financial incentives for storage providers and improving long-term data availability.

2.4 Decentralized Autonomous Organizations (DAO)

Hsieh et al. [9] studied the development of Decentralized Autonomous Organizations (DAOs) as a governance model in which platform rules are implemented through smart contracts and policy decisions are made by token-holder voting. DAOs reduce dependence on centralized management by allowing community members to update platform rules, resolve disputes, and choose representatives through a transparent decision-making process.

2.5 Research Gaps

The literature review highlights three major research gaps that this work aims to address:

- No existing educational platform combines IPFS-based storage, blockchain token rewards, and DAO governance within a single integrated architecture.
- Current token reward systems, such as Steemit, mainly reward popularity and user engagement instead of educational quality. They also do not provide dedicated incentives for educational content curation and peer review.
- Existing blockchain-based educational platforms mainly reward content creators and provide little or no incentive for users who review, verify, and validate educational content.

3. Blockchain Technology Introduction

3.1 Blockchain Architecture

A blockchain is a sequence of cryptographically secured blocks maintained by a peer-to-peer network. Each block contains a header that stores the hash of the previous block, a Merkle root representing all transactions in the block, a timestamp, and the validator's digital signature. The block also includes a list of verified transactions. This design ensures immutability, meaning that if any block is modified, all following blocks become invalid, allowing the network to quickly detect any unauthorized changes [1].

3.2 Cryptographic Primitives

BDCP uses SHA-256 to generate block hashes and Keccak-256 to hash smart contracts. Every user activity, including content uploads, peer review submissions, and governance voting, is digitally signed using the Elliptic Curve Digital Signature Algorithm (ECDSA) with the user's private key. This provides authentication, prevents impersonation, and ensures that users cannot deny their actions. Content ownership is securely linked to the creator's blockchain address, while users are identified through their public key addresses. For privacy-sensitive operations, such as proving that a reviewer has expertise in a specific subject without revealing personal information, the platform uses Zero-Knowledge Proofs (ZKPs).

3.3 Hybrid PoS-BFT Consensus

The consensus mechanism plays an important role in ensuring both the performance and security of the platform. Bitcoin's Proof of Work (PoW) consumes significant energy and cannot efficiently handle the large number of micro-transactions required by a content reward platform. Ethereum 2.0 uses the Proof of Stake (PoS) model, which is more energy-efficient and encourages honest validator behavior through stake-based incentives. BDCP combines PoS with Byzantine Fault Tolerance (BFT) to form a Hybrid PoS-BFT consensus mechanism. Validators are selected using a Verifiable Random

Function (VRF), followed by BFT-based voting to achieve deterministic transaction finality. This approach supports fast, low-cost microtransactions while maintaining reliable operation even if up to one-third of the validators become malicious or unavailable.

3.4 Intelligent Contracts

Smart contracts are programs stored on a blockchain that automatically execute predefined rules when required conditions are met. BDCP implements its smart contracts using Solidity and extends the audited OpenZeppelin contract library [10] to automate three major platform functions: content registration, reward distribution, and governance execution. Once deployed, these contracts remain immutable unless they are designed with approved upgrade mechanisms. As a result, reward policies and governance rules cannot be changed by a single participant without receiving approval from the community.

4. Proposed System Framework

4.1 System Overview and Architecture

The BDCP follows a three-layer architecture:

i. the storage layer uses IPFS to store educational content
ii. the blockchain layer manages ownership records, token transactions, and governance
iii. the application layer provides the user interface and off-chain services.

The platform uses a hybrid blockchain model where the public blockchain stores transparent ownership and reward records, while sensitive institutional data is maintained on permissioned sub-chains. The platform supports four main user roles:

- Learner (browses, downloads, and rates study material)
- Contributor (uploads educational content)
- Curator (reviews submitted content)
- Governance Participant (proposes and votes on platform policies).

4.2 Tokenomics of LEARN Token

- LEARN is an ERC-20 utility token that serves as the platform's native reward currency. Tokens are distributed through three main reward channels:
- Contributor Rewards: Given to contributors whose uploaded study material successfully passes peer review and receives downloads and positive ratings.
- Curator Rewards: Awarded to reviewers who provide accurate, high-quality, and timely peer reviews.
- Learner Participation Incentives: Small token rewards are provided to learners for regular platform activity to encourage long-term participation.
- The reward calculations for creators and curators are defined as:
- $\text{CreatorReward} = \text{BaseReward} \times \text{QualityScore} \times \log(\text{Downloads} + 1)$
- $\text{CuratorReward} = \text{ReviewReward} \times \text{ReviewQuality} \times \text{TimelinessBonus}$

• The QualityScore is calculated as the weighted average of peer ratings on a scale of 1 to 5. TimelinessBonus encourages reviewers to complete evaluations within the expected review period. ReviewQuality measures how closely a review matches the overall agreement among reviewers, encouraging detailed and honest evaluations instead of careless reviews. As educational content receives more downloads and better ratings, creators earn higher rewards, while reviewers receive greater incentives for accurate and timely assessments.

4.3. IPFS Distributed Storage

IPFS is used to store study material files, while the ContentRegistry smart contract stores only the Content Identifier (CID), metadata, creator address, subject category, and upload timestamp on the blockchain. This approach reduces blockchain storage costs while maintaining data authenticity, immutability, and resistance to censorship. Any modification to a file generates a new CID, making every change permanently visible.

4.4 Architecture of the smart contract

The platform uses three smart contracts:

• ContentRegistry: Stores the CID, creator address, upload time, subject tags, and metadata of every uploaded study material, creating a permanent and verifiable ownership record.
• RewardDistributor: Collects peer review scores after the required number of reviews is completed, calculates LEARN token rewards using the reward formulas, and automatically distributes tokens to eligible contributors and curators.
• GovernanceDAO: Accepts governance proposals from token holders, defines the voting period, and automatically implements proposals that achieve the required quorum. These proposals may update reward parameters, subject categories, or moderator assignments without requiring manual intervention.

4.5. Peer review process

Content submitted by contributors is placed in a peer review queue. Curators are selected based on their declared subject expertise and non-transferable reputation scores. Reward distribution begins only after at least three independent reviews have been completed. Every review is recorded as a blockchain transaction, creating a transparent and verifiable review history. Reviews that differ significantly from the overall reviewer consensus receive a lower ReviewQuality score, discouraging biased or low-quality evaluations.

4.6 Governance of the DAO

The GovernanceDAO contract allows token holders to submit proposals and vote on platform decisions, including reward policies, minimum review requirements, subject categories, and dispute resolution procedures. A proposal is automatically approved and executed if it receives support from at least 51% of the participating token holders during the voting period. All proposals, votes, and execution records are permanently stored on the blockchain, creating a transparent and auditable governance history that cannot be controlled by a single authority.

4.7 Blockchain life cycle: Content for Submission to a Prize

The complete content upload and reward process consists of seven steps:

a. Content Upload: The contributor uploads the study material to IPFS, where a unique Content Identifier (CID) is generated.
b. Transaction Creation: The user's Web3 wallet signs a transaction containing the CID, metadata, and subject tags before broadcasting it to the validator network.
c. Validation: Validator nodes verify the digital signature, check the CID, and enforce upload rate limits to prevent spam.
d. Block Inclusion: The validated transaction is added to a newly created candidate block.
e. Consensus and Finality: Using the Hybrid PoS-BFT protocol, the block reaches deterministic finality after receiving Commit messages from 2f + 1 validators (where f represents the maximum number of faulty validators), typically within 2–3 seconds.
f. Peer Review Queue: After confirmation, the uploaded content enters the peer review queue, where assigned curators submit their evaluations through blockchain transactions.
g. Reward Distribution: Once the required number of peer reviews has been completed, the RewardDistributor contract automatically calculates and distributes LEARN tokens to eligible contributors and curators.

5. System Requirements and Implementation

5.1 Tools and Technologies

Table 1: Tools and Technologies Used in BDCP

Tool / Technology	Category	Purpose in BDCP
Ethereum / Solidity	Blockchain Platform	Smart contract development for rewards and governance
IPFS + Filecoin	Decentralized Storage	Persistent, censorship-resistant study material storage
Node.js + Express	Backend Runtime	API gateway and off-chain service coordination
React.js + ethers.js	Frontend Framework	Web interface for learners and contributors
MetaMask / WalletConnect	Wallet Integration	User authentication and transaction signing
Hardhat + Truffle	Dev Framework	Smart contract compilation, testing, and deployment
Ganache	Testing Tool	Local blockchain simulation for unit testing
The Graph Protocol	Indexing Layer	Efficient querying of on-chain content and reward data
OpenZeppelin	Contract Library	Audited ERC-20 and DAO contract templates
Docker + Kubernetes	Containerization	Deployment, environment management, and horizontal scaling

5.2 Functional Requirements:

- Wallet-based user registration and authentication using MetaMask or any compatible Web3 wallet.
- Upload study materials to IPFS and register the corresponding content on the blockchain through the ContentRegistry smart contract.
- Record every content submission on the blockchain and automatically assign it for peer review.
- Enable the RewardDistributor contract to calculate and distribute LEARN token rewards based on the defined reward mechanism.
- Use the GovernanceDAO contract to create proposals, conduct voting, and automatically execute approved governance decisions.
- Provide a search and discovery interface that allows users to filter content by subject, quality rating, and upload date.
- Offer a user dashboard displaying token balance, reputation score, contribution history, and total earnings.
- Support DAO-elected moderators to flag inappropriate content and manage the dispute resolution process.

5.3 Non-functional requirements

- Performance: Support a minimum throughput of 1,000 transactions per second (TPS) to handle large numbers of simultaneous microtransactions.
- Scalability: Support Layer-2 rollups during periods of heavy network activity and allow horizontal scaling of platform services.
- Security: Protect the platform against Sybil attacks, front-running, smart contract reentrancy attacks, and IPFS content spoofing.
- Availability: Maintain at least 99.9% system uptime while tolerating failures or malicious behavior from up to one-third of validator nodes.
- Usability: Simplify transaction signing to provide a Web2-like user experience while preserving Web3-level security.
- Interoperability: Implement the LEARN token according to the ERC-20 standard, allowing compatibility with other blockchain platforms and cryptocurrency exchanges.

6. Evaluation: TER Level Achievement (4–7)

The BDCP framework was tested using Technology Evaluation and Readiness (TER) Levels 4 to 7. The testing started with individual components in a laboratory and ended with testing the complete system in a real-world-like environment.

6.1 Laboratory Confirmation – Level IV TER

The three smart contracts, ContentRegistry, RewardDistributor, and GovernanceDAO, were developed in Solidity using the OpenZeppelin library. They were tested on Ganache, which is a local blockchain testing environment. The tests checked CID registration, reward calculation for different QualityScore values and download counts, governance proposal creation and execution, and special cases such as empty review lists and zero-download content. All smart contracts passed the tests and produced the expected results.

6.2 TER Level

The smart contracts were deployed on the Ethereum Sepolia public test network. This allowed testing under real blockchain conditions, including changing gas fees and network delays. IPFS was tested by uploading actual study materials such as PDF documents and video files to a multi-node IPFS network. The generated CIDs were successfully stored on the blockchain, and the uploaded files were retrieved correctly from IPFS. Peer review submission and on-chain record creation were also tested using simulated reviewer accounts.

6.3 TER level 6

A prototype web application was built using React.js and ethers.js. It demonstrated the complete user workflow. Users connected their MetaMask wallet, uploaded files to IPFS, received a CID, registered content through the ContentRegistry contract, submitted peer reviews, received LEARN token rewards through the RewardDistributor contract, and created and voted on proposals using the GovernanceDAO contract. The prototype also supported multiple simulated users performing all four platform roles at the same time.

6.4 TER Level 7: System Prototype Demonstration in Operational Environment

The prototype was tested under heavy load to simulate real-world use. The main results are:

- Throughput: The platform achieved about 1,200 transactions per second (TPS), which is higher than the required 1,000 TPS.
- Finality: The Hybrid PoS-BFT consensus mechanism completed transaction confirmation in less than 3 seconds.
- Reward Correctness: All test cases showed that LEARN token rewards were calculated and distributed correctly.
- Fault Tolerance: The system continued to work correctly even when up to one-third of the validator nodes were unavailable. This confirmed the fault tolerance of the BFT consensus mechanism.
- Governance Execution: Governance proposals that received enough votes were executed automatically without any manual action.

These results show that the BDCP framework meets the requirements of TER Level 7. They also show that the platform is ready for pilot deployment and future testing with real users.

7. Comparative Analysis with Existing Platforms

Table 2: BDCP vs. Existing Platforms

Platform	Token Rewards	Curator Incentive	Decentralized Storage	DAO Governance	Education-Focused	Open Access
Coursera / edX	No	No	No	No	Yes	Partial
Khan Academy	No	No	No	No	Yes	Yes
Steemit / Hive	Yes	Partial	No	Partial	No	Yes
Wikipedia	No	No	No	Partial	Partial	Yes
EduCTX [7]	No	No	No	No	Yes	No
BDCP (Proposed)	**Yes**	**Yes**	**Yes (IPFS)**	**Yes (DAO)**	**Yes**	**Yes**

BDCP is the only evaluated platform that offers token-based rewards, dedicated curator incentives, decentralized IPFS storage, DAO governance and a focus on educational content quality at the same time. This combination directly tackles the research gaps identified in Section 2.

8. Discussion

8.1 Incentive Alignment

One of the main strengths of BDCP is that it connects user rewards with the quality of educational content. Unlike Steemit, which mainly rewards popular content, BDCP calculates rewards using both QualityScore and the number of downloads. This helps high-quality educational content receive better rewards instead of low-effort viral content. The reward for curators also depends on ReviewQuality. Reviews that are very different from the final group opinion receive lower scores. This encourages reviewers to give honest and careful feedback instead of random or biased ratings.

8.2 Decentralization and Governance

Many existing educational platforms are controlled by a single organization that can change rules at any time. BDCP reduces this problem by using a DAO governance model. Platform rules are stored in smart contracts, and any policy change must be approved by a majority of token holders before it is applied. This means that no single person, including the platform developers, can change reward rules or remove content on their own. All governance activities are recorded on the blockchain, making the process open and transparent.

8.3 Limitation

The proposed platform has some limitations. First, the evaluation was based on simulations, and it has not yet been tested with real learners, contributors, and curators. Second, the value of the LEARN token may change over time because of market conditions, which can affect the reward system. Third, content moderation in a decentralized platform can take more time than in a centralized system, even though the DAO moderator model provides a fair process. Finally, the current platform is mainly designed for STEM subjects. Different methods may be needed to evaluate educational content in areas such as humanities and the arts.

9. Conclusion

This paper presented the design, analysis, and evaluation of the Blockchain-Based Decentralized Content Platform (BDCP). The proposed platform addresses the major limitations of centralized e-learning systems by combining blockchain-based rewards, decentralized IPFS storage, smart contracts, and DAO-based governance into a single framework.

The LEARN token reward system encourages contributors and curators to focus on educational quality by rewarding useful content, higher ratings, more downloads, and careful peer reviews. The DAO governance model allows the community to make important platform decisions instead of depending on a central authority. The evaluation at TER Levels 4 to 7 showed that the platform achieved more than 1,200 transactions per second, transaction finality in less than 3 seconds, and reliable operation even when some validator nodes failed.

BDCP brings together blockchain rewards, curator incentives, IPFS storage, and DAO governance in one educational platform. The evaluation results show that the framework is ready for pilot deployment. Future work will include testing the platform with real users and extending support to multiple blockchain networks.

10. References

[1] Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. https://bitcoin.org/bitcoin.pdf

[2] Buterin, V. (2014). Ethereum: A Next-Generation Smart Contract and Decentralized Application Platform. Ethereum White Paper.

[3] Benet, J. (2014). IPFS – Content Addressed, Versioned, P2P File System. arXiv:1407.3561.

[4] Bdiwi, R., de Runz, C., Faiz, S., & Cherif, A. A. (2019). Towards a New Ubiquitous Learning Environment Based on Blockchain Technology. Proc

[5] Protocol Labs. (2024). IPFS Documentation. https://docs.ipfs.tech

[6] Turkanovic, M., Holbl, M., Kosic, K., Hericko, M., & Kamisalic, A. (2018). EduCTX: A

[7] Ocheja, P., Flanagan, B., Ueda, H., & Ogata, H. (2019). Managing Lifelong Learning Records Through Blockchain. Research and Practice in Technology Enhanced Learning, 14(1).