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Blockchain Based Decentralized Grading System

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Abstract -. This paper proposes a decentralized student grading system using blockchain technology, aiming to enhance the security, transparency, and accessibility of academic grading. By using smart contracts and cryptographic algorithms, the system ensures tamper-proof, real-time access to student results for authorized stakeholders. It eliminates the need for centralized data handling, minimizes human error, and strengthens trust in academic evaluations. This project demonstrates how blockchain can transform educational administration by providing immutable, transparent, and auditable academic records.

***Key Words*:** Blockchain, Student Grading, Decentralized Application, Smart Contract, Ethereum, MetaMask, Web3.js

1. INTRODUCTION

Traditional grading systems often involve multiple manual steps, prone to error, manipulation, and delays. These centralized systems also suffer from lack of transparency and limited access to results by stakeholders. To overcome these issues, blockchain technology offers a promising alternative.

Blockchain is a distributed and immutable digital ledger that records transactions across a peer-to-peer network. With its decentralized nature and cryptographic integrity, it provides a secure and transparent platform for data management. This project utilizes Ethereum blockchain to build a decentralized application (DApp) that enables secure grade entry and access for students, faculty, and administrators.

The primary goal is to automate and secure the process of publishing student results by leveraging smart contracts, which execute predefined functions automatically when triggered.

2. LITERATURE SURVEY

Several research efforts have explored blockchain's integration with educational systems. Most have focused on issuing certificates, managing academic identities, or maintaining student records.

In 2018, MIT introduced a blockchain-based diploma system that allowed students to share verifiable certificates digitally. Similarly, the University of Nicosia uses blockchain for academic credential verification.

A few prototypes have attempted to store exam results and manage student evaluations using smart contracts. However, they often lack a user-friendly front-end or full integration with Ethereum tools like MetaMask.

Our system builds on these foundations by offering an end-to-end solution with secure access, result immutability, and decentralized control using a combination of Ethereum, Solidity, and Web3.js.

2.1. EXISTING SYSTEMS

2.1.1. Moodle (Used by University of Cambridge, Open University, etc.)

Moodle is an open-source Learning Management System (LMS) that has gained widespread adoption in educational institutions across the globe, including the University of Cambridge and Open University. It supports the complete academic process—from course content delivery to assessments and grading—within a centralized digital framework. Instructors can assign coursework, conduct quizzes, collect submissions, and assign grades using built-in grading tools. These grades are stored in a centralized institutional server and accessed through role-based logins by students and administrators.Despite its flexibility and customizable features, Moodle faces significant limitations when evaluated in terms of data integrity and decentralization. Since the grading data is stored centrally, it can be modified by administrators or staff with elevated privileges. Even though Moodle maintains change logs for transparency, these logs are not cryptographically verifiable. Therefore, it is difficult to guarantee that grades have not been tampered with. Moreover, access is dependent on institutional authentication systems, and there is no provision for independent verification of grades by third parties. These limitations reduce trust among stakeholders and make the system vulnerable to internal manipulation or system failure.Additionally,

Moodle requires dedicated IT resources for server management, backup scheduling, and software updates. In developing regions or resource-constrained institutions, maintaining a secure and reliable Moodle infrastructure can be challenging. The lack of decentralization and immutable records underscores the need for a more secure and transparent approach.

2.1.2. Oracle PeopleSoft Campus Solutions

PeopleSoft Campus Solutions by Oracle is a robust and enterprise-level ERP system used by premier educational institutions like Stanford University, the University of Michigan, and the University of California system. It is designed to manage a wide array of academic processes, including course registration, student financials, and grading. Faculty members use the system to upload or update grades for their respective courses, while students log into a centralized student portal to access their academic records.

PeopleSoft excels in handling complex workflows and integrating with institutional databases, but it also inherits the traditional drawbacks of centralized systems. All data, including grades, are maintained within the university's internal servers, meaning any tampering or data corruption—intentional or accidental—must be addressed internally. While audit trails and role-based access controls are in place, they rely heavily on the institution's security policies. The absence of cryptographic validation or distributed ledger technology makes it impossible to independently verify the authenticity of grades once published.

The system also comes with high setup and maintenance costs, requiring skilled personnel for configuration, customization, and data management. Furthermore, its proprietary nature limits interoperability with external systems, which can be a barrier in scenarios like student transfers, cross-institution collaboration, or government audits. In contrast to decentralized blockchain-based solutions, PeopleSoft remains a closed system with limited transparency and high operational overhead.

2.2. LIMITATION EXISTING SYSTEM OR RESEARCH GRAPH

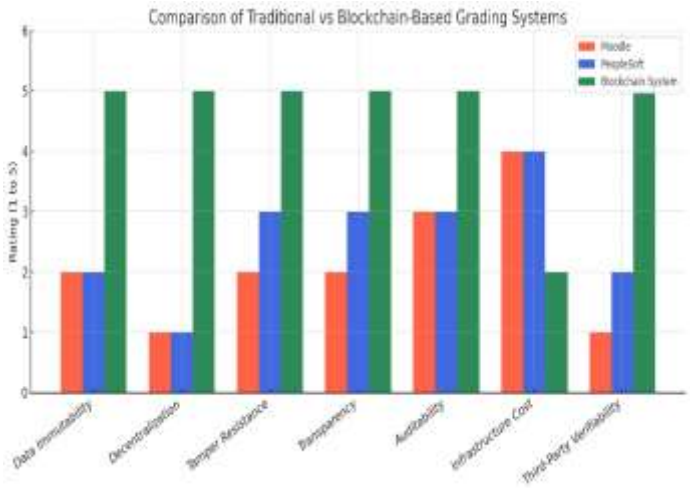
Despite the widespread adoption of centralized systems like Moodle and PeopleSoft Campus Solutions, several critical limitations hinder their effectiveness in maintaining secure, transparent, and verifiable academic records.

Centralized grading systems are prone to internal manipulation, accidental data loss, and limited auditability. Since all data is stored and managed by the institution, any error or malicious intent by internal administrators may compromise the integrity of academic records. Furthermore, there is a lack of cryptographic verification, making it difficult for external parties—such as employers, accreditation bodies, or transferring institutions—to independently validate student results.

These systems also suffer from infrastructure-related challenges. Regular backups, system updates, and server maintenance are essential to prevent data corruption or loss. In resource-constrained environments, such technical requirements may not be consistently met. Moreover, centralized platforms lack real-time transparency and trust, often resulting in disputes, delays, or a lack of confidence among stakeholders.

In contrast, blockchain-based grading systems offer decentralized control, immutability, and enhanced transparency—addressing most of these limitations.

Table -1: Comparison of existing systems



3. OBJECTIVES

The main objective of this project is to design and implement a decentralized grading system utilizing blockchain technology to ensure the accuracy, transparency, and immutability of academic records. The system aims to overcome the challenges faced by traditional centralized systems, such as data tampering, limited access control, and lack of auditability. By using smart contracts on the Ethereum blockchain, the platform will provide a secure and automated mechanism for grade entry, storage, and verification. A critical objective is to establish a transparent framework where grades, once

recorded, cannot be altered by any party, thereby ensuring trust among students, faculty, and academic institutions. Additionally, the project seeks to develop an intuitive user interface that integrates seamlessly with blockchain through Web3.js and MetaMask, allowing different stakeholders to interact with the system efficiently. It also intends to reduce administrative overhead, simplify record verification for external bodies like employers or accrediting agencies, and promote digital literacy by familiarizing users with emerging technologies. By achieving these goals, the system is expected to demonstrate the practical application of blockchain in academic environments and encourage further research and adoption of decentralized technologies in the education sector.

5. PROPOSED SYSTEM

The proposed system introduces a decentralized application (Dapp) that utilizes the Ethereum blockchain to manage and store student grades in a secure, transparent, and tamper-proof manner. In this system, traditional centralized databases are replaced by distributed ledger technology, allowing academic institutions to automate the grade submission and retrieval process without relying on a single point of control. The architecture is designed around smart-contract-executing pieces of code written in Solidity—that define the logic for recording grades, verifying user permissions, and ensuring that data, once entered, cannot be altered or deleted.

To provide a user-friendly interface, the frontend is developed using standard web technologies such as HTML, CSS, and JavaScript. Web3.js is used to establish a connection between the frontend and the blockchain network, enabling users to interact with smart contracts through a browser. MetaMask, a browser-based Ethereum wallet, is integrated for secure login and transaction approval, ensuring that only authenticated users such as faculty or authorized administrators can enter or update grades.

The system is designed to handle input and retrieval of grades based on unique Ethereum wallet addresses associated with each student. When a grade is entered, a transaction is triggered on the blockchain, and a unique transaction hash is generated, ensuring transparency and traceability. Students can later use their wallet addresses to check their grades without needing login credentials or relying on a third party. The immutable nature of blockchain guarantees that once a grade is stored, it cannot be modified, thus eliminating concerns of data tampering or manipulation.

This proposed system not only enhances the trust and security in academic evaluation but also reduces administrative overhead, supports independent verification of grades by external bodies, and aligns with the growing demand for decentralized and digital educational infrastructures. It serves as a scalable, transparent, and future-ready model for academic resultmanagement.

5.1. ANALYSIS/FRAMEWORK/ALGORITHM

5.1.1. ALGORITHM

The algorithm for the decentralized grading system begins with the initialization of the blockchain environment using the Ethereum testnet. The system connects the frontend interface to the blockchain through the Web3.js library, which enables communication with the deployed smart contract. The first step involves the authentication of users through MetaMask. When a faculty member or admin logs in using their Ethereum wallet, the system verifies their credentials before granting access to grade submission features. Once authenticated, the authorized user inputs the student's Ethereum wallet address along with the corresponding grade. The frontend invokes the addGrade() function of the smart contract, which validates the input and triggers a blockchain transaction. This transaction records the grade on the Ethereum blockchain, ensuring that the data is immutable, and time stamped. The transaction hash is returned and stored for reference. For grade retrieval, students connect their MetaMask wallet and invoke the getGrade() function by entering their wallet address. The smart contract fetches the grade associated with the address and displays it on the frontend without revealing any centralized data source. Throughout the process, the blockchain ensures secure, transparent, and verifiable data exchange without intermediaries. The algorithm is event-driven and reactive, executing actions only when triggered by user interaction through the frontend interface.

5.1.2. SYSTEM ARCHITECTURE

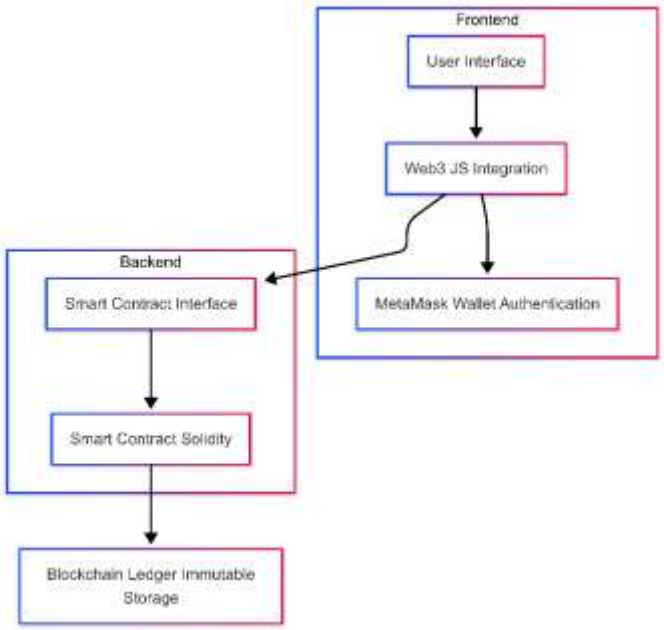


Fig -1: Architecture

5.2. SYSTEM DESIGN

The system is designed as a decentralized application (DApp) that operates on the Ethereum blockchain, integrating both frontend and backend components through smart contract technology. The architecture is modular, consisting of three main layers: the user interface layer, the blockchain interaction layer, and the smart contract layer. Each component is designed to ensure seamless data flow, high security, and a transparent grading mechanism.At the user interface level, the system employs HTML, CSS, and JavaScript to create a responsive and accessible web application. This interface allows different users—students, faculty, and administrators—to interact with the system according to their permissions. MetaMask is used for user authentication and transaction approval, ensuring secure communication between the frontend and the Ethereum network.The blockchain interaction layer uses Web3.js, a JavaScript library that connects the frontend to the deployed smart contracts on Ethereum. This layer handles all blockchain-related operations, such as sending transactions to add grades or fetching data based on wallet addresses. Web3.js ensures that the frontend communicates accurately with the smart contracts while also allowing for real-time updates.The smart contract layer is the core of the system, written in Solidity. It contains functions such as addGrade() and getGrade() that define how grades are added to and retrieved from the blockchain. These contracts are deployed on the Ethereum testnet using tools like Remix IDE, and their immutable nature guarantees that once a grade is stored, it cannot be altered or removed.Data flow is unidirectional in terms of record-keeping: grades are written to the blockchain only once and read multiple times. This design maintains the integrity and auditability of academic records while ensuring that access control is preserved via wallet-based authentication. The system's design emphasizes decentralization, reliability, and scalability, making it a strong foundation for secure academic data management.

5.2.1. FLOWCHART

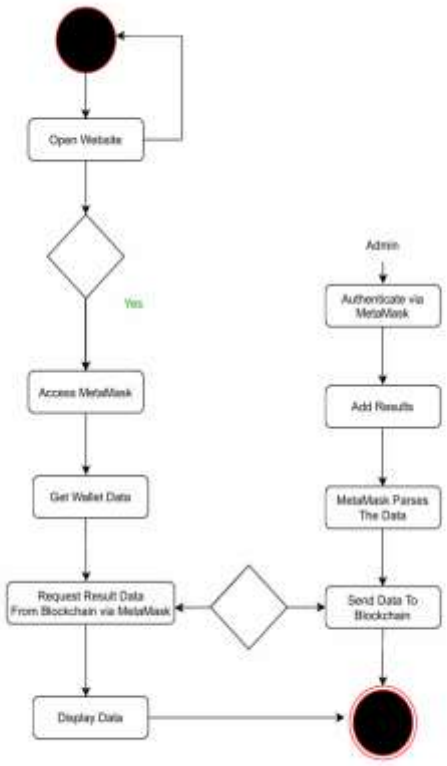


Fig-2: Flowchart

5.2.2. USE CASE DIAGRAM

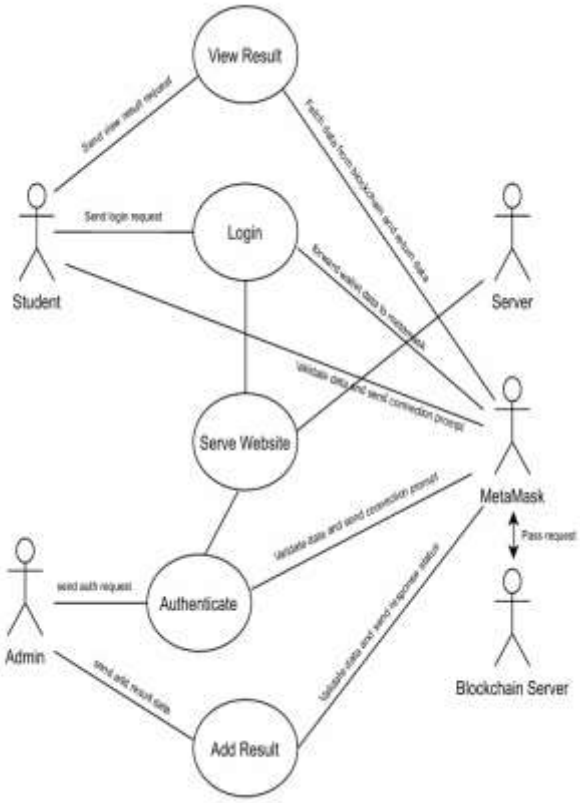


Fig-3: use case diagram

5.3. METHODOLOGY

The methodology followed in developing the decentralized student grading system is based on the integration of blockchain technology with a web-based frontend, enabling secure and transparent academic record management. The project begins with a requirements analysis phase where user roles (students, faculty, administrators) and their permissions are defined. This is followed by the design and development of smart contracts using Solidity, which contain the logic for storing and retrieving grades on the Ethereum blockchain. Functions such as addGrade(address, uint) and getGrade(address) are coded to handle secure grade entry and access using wallet addresses as identifiers.

The frontend of the application is developed using HTML, CSS, and JavaScript, offering a simple and interactive interface for users to perform their respective actions. Web3.js is integrated into the frontend to facilitate interaction with the Ethereum blockchain. It allows the web application to communicate with the smart contract, initiate transactions, and fetch data without relying on a central server. MetaMask is used for wallet-based authentication, ensuring that only authorized users can perform sensitive operations like submitting or viewing grades.

Deployment and testing are carried out on the Ethereum testnet using Remix IDE, a browser-based smart contract development environment. MetaMask is connected to the testnet to sign and send transactions. During testing, various scenarios are validated, including grade submission by an admin, grade retrieval by a student, and unauthorized access attempts. Transaction hashes are recorded to verify that data has been successfully and immutably stored on the blockchain.

Throughout the process, emphasis is placed on decentralization, security, and transparency. The use of blockchain ensures that the system is tamper-resistant and auditable, while the smart contract enforces role-based access and data integrity. This methodology ensures that the final application provides a reliable and scalable solution to academic record management.

6. RESULTS AND DISCUSSION

The proposed decentralized student grading system was successfully developed and tested on the Ethereum Ropsten test network. The application allowed authorized users, such as faculty members, to securely enter student grades using their MetaMask wallets, and students were able to retrieve their results by entering their own Ethereum wallet addresses. Each interaction triggered a blockchain transaction, generating a unique transaction hash, which confirmed the data had been permanently recorded on the ledger.

The results demonstrated the effectiveness of using blockchain for grade management. Once stored, the grades became immutable, ensuring that no unauthorized changes could be made, thereby enhancing trust among stakeholders. Furthermore, the transparency of blockchain allowed students and third parties to verify the authenticity of academic records without depending on a central authority. The integration of MetaMask and Web3.js also ensured secure, real-time interactions with the blockchain, making the system easy to use for both tech-savvy and non-technical users.

During testing, the system proved resilient against common issues faced by traditional grading systems, such as data tampering and server failure. However, a few limitations were identified. For instance, each grade submission required a blockchain transaction, which incurred gas fees, and occasional network congestion caused minor delays in transaction confirmations. Additionally, the system currently supports only single-course grading and would require modifications to handle complex multi-course or semester-based evaluations.

Despite these limitations, the implementation validated the feasibility of using blockchain technology for academic record management. The system offers a high level of security, transparency, and data integrity, making it a promising alternative to conventional centralized grading platforms.

Fig-1 : Home Page

Fig-2: Check result

Fig-3: Result List

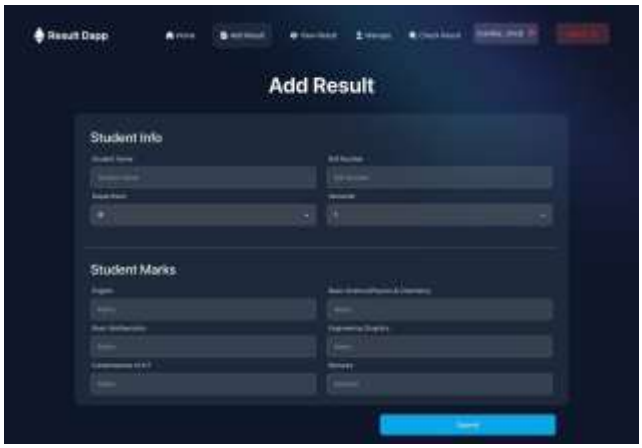


Fig-4: Add Result

Fig-5: Manage Admins

7. CONCLUSIONS

The decentralized student grading system developed in this project successfully demonstrates how blockchain technology can be applied to enhance the security, transparency, and efficiency of academic record management. By leveraging Ethereum smart contracts and integrating them with a user-friendly frontend via Web3.js and MetaMask, the system ensures tamper-proof

storage and secure access to student grades. This approach not only addresses the limitations of traditional centralized grading systems—such as data manipulation, unauthorized access, and lack of trust—but also empowers students and institutions with transparent, verifiable academic records.

Through successful testing on the Ethereum testnet, the project has shown that blockchain can provide a reliable infrastructure for critical educational data. The immutability and decentralized nature of the system ensure that once grades are recorded, they remain secure and accessible only by authorized individuals. Although certain limitations such as gas fees and network latency were identified, they do not overshadow the system's potential.

In conclusion, this blockchain-based grading system marks a significant step toward the modernization of academic processes. It lays the groundwork for future improvements, including multi-course grading, mobile DApp access, integration with national education portals, and real-time analytics. As blockchain adoption grows, such decentralized applications could become a standard in academic administration.

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