Online Exam Enhancement Using Blockchain

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Abstract: *This paper proposes a novel Learning Management System (LMS) built on the Ethereum blockchain to address these concerns. The system leverages MetaMask wallets for secure student authentication and utilizes smart contracts to automate grading and plagiarism detection, providing immediate feedback and enhancing learning efficiency. Robust security protocols ensure data integrity and prevent exam malpractices. This innovative approach fosters academic fairness, reduces instructor workload, and facilitates comprehensive student performance analysis, paving the way for a secure and efficient future of online education.*

Keywords: Blockchain, Ethereum, MetaMask wallet, LMS, Smart Contracts, Auto-grader, Plagiarism Detection, Immediate feedback, Online exam, Security management.

1. INTRODUCTION

The traditional examination system, with its reliance on paper, pencils, and centralized administration, is facing a growing wave of challenges. Concerns about security breaches, data manipulation, plagiarism, and fairness are casting a shadow over the integrity of educational assessments. In this context, blockchain technology emerges as a transformative force, promising to revolutionize online examinations with its inherent advantages of decentralization, immutability, and transparency.

Imagine a scenario: Students worldwide take an exam simultaneously on a secure online platform. Their responses are encrypted and stored on a distributed ledger, accessible only to authorized parties. An automated grading system powered by smart contracts instantly evaluates answers, providing immediate feedback. Plagiarism detection tools scan submissions in real-time, ensuring academic integrity. And the entire process, from question generation to scorekeeping, is governed by transparent, immutable records, fostering trust and accountability.

This is the power of blockchain-based online examinations. Let's delve deeper into the key components of this model and compare it to the traditional system.

1.2 Components of BLMS:

Blockchain: A distributed database that securely stores and verifies all exam data, including questions, answers, and grades. Think of it as a tamper-proof, public ledger accessible to authorized participants.
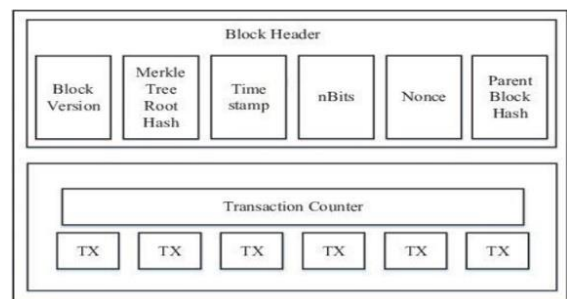

Fig 1: Blockchain Block

Ethereum: A popular blockchain platform that supports smart contracts, self-executing code used to automate grading, plagiarism detection, and other processes.

MetaMask Wallet: A secure digital wallet used by students to access the exam platform and store their credentials.

Smart Contracts: Automated programs on the blockchain that govern exam rules, grade answers, and manage data access.

Auto-grader: An AI-powered tool embedded within smart contracts to provide immediate feedback on objective questions.
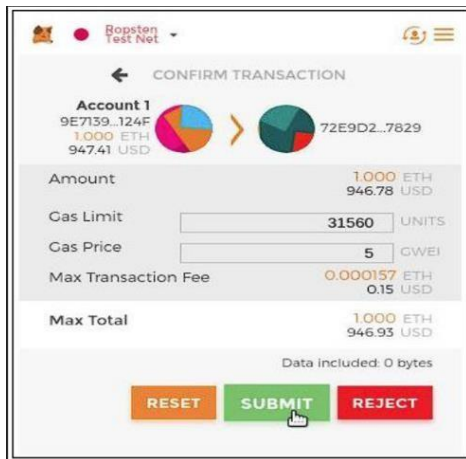
Fig 2: MetaMask Wallet Creating Transaction

Learning Management System (LMS): An online platform that integrates with the blockchain to deliver exams, manage student accounts, and facilitate communication.

Plagiarism Detection: Software integrated with the LMS to scan student submissions for originality and flag potential plagiarism attempts.

Immediate Feedback: Students receive instant scores and insights into their performance upon completing the exam.

Online Exams: Assessments conducted entirely online, eliminating logistical challenges and geographical barriers.

Security Management: Robust security protocols built into the blockchain infrastructure safeguard exam data from unauthorized access and manipulation.

1.3 The Future of Online Examinations:

While challenges remain in terms of cost, user adoption, and technological integration, the potential of blockchain-based online exams is undeniable. This innovative approach promises to revolutionize the way we assess knowledge, promote academic integrity, and create a more secure, efficient, and equitable learning environment for all.

As we move forward, it's crucial to embrace technological advancements like blockchain and explore their potential to enhance the educational landscape. The future of online examinations is bright, and blockchain technology holds the key to unlocking a new era of secure, transparent, and efficient assessment.

2. Literature Survey

A lot of researchers provide different perceptive to provide an appropriate approach for securing online exam results. In this section, we will discuss some of the approaches.

Jain et al., 2021, had proposed a model for the e-learning platform in which student pay for the examination using crypto then solve the exam and then this data are saved as smart contract in the blockchain network, however they make the students enter their addresses and it is saved to the database that it can be tempered with by changing the address of student to another address so the student result can be not accurate.

Shinde, 2022, have implemented a system for online exams with face detection to ensure students can't cheat during the exam and after the student finishes the exam the system can calculate marks and show the results.

Fagbola et al., 2013, had proposed a webapp online exams to support the examination process and fix some of problem that exist in various webapps like automatically logging of the student upon expiration of allotted time. It is developed to address those problem that facilitate other aspects of the examination process like supporting auto-submission, auto marking and examination result report generation. likewise, it is also built upon front-end development of the web like HTML and Microsoft Visual Studio development environment with the use of SQL Server as the database of the webapp that will sane everything about the examination process. But as illustrated in Figure 4, every conducted process will be stored in centralized location but in all the previous systems, they have used a centralized database in which the data can be manipulated, so, this means that the results obtained from the system aren't reliable but blockchain here can solve this problem.
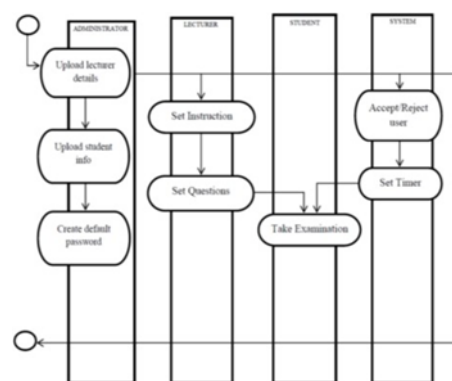

Fig 3: System Architecture

Features	Traditional System	Block-based based System
Security	Vulnerable to data breaches, hacking, and tampering.	Highly secure with tamper-proof data storage and cryptographic verification.
Transparency	Lack of transparency in grading and score keeping.	Transparent audit trails for all actions on the blockchain.
Efficiency	Time-consuming manual processes for exam administration and grading.	Automated processes with smart contracts and auto-graders for efficiency.
Immediate Feedback	Limited or delayed feedback for students.	Real-time feedback and detailed performance insights.
Plagiarism Detection	Often reliant on manual or software-based methods with limitations.	Integrated plagiarism detection tools for increased accuracy and efficiency.
Accessibility	Geographical limitations and logistical challenges.	Global accessibility and flexibility for online exams.
Scalability	Difficulty in scaling for large exams or student populations.	Highly scalable infrastructure to accommodate large-scale assessments.

Table 1: Traditional vs. Blockchain-based Online Exam Systems

Pee et al., 2019, had they designed online testing system based on blockchain and CP- ABE encryption in which the system admin provides specific teacher for every test being taken to set the questions by using their private key this to restrict access authority using CP-ABE algorithm. Students can enter their exam and after saving their scores in the blockchain for ensuring their integrity and they are not manipulated. This system protects the exams scores and characterized by its higher security.

X. Yang et al., 2022, proposed a new verification framework designed specifically for centralized ledger databases (CLD). This framework aims to achieve two essential goals: robust external auditability and rapid verification. The core concept behind this framework is known as Dasein verification, which combines the elements of what, when, and who validation to establish a formalized approach to ledger auditing. Additionally, they provide an overview of the system structure employed in the proposed framework, along with the findings from its performance evaluation. The evaluation results indicate that the framework demonstrates a remarkable 23-fold increase in verification throughput and a significant 500-fold reduction in latency when compared to Hyperledger Fabric in notarization applications. Then to solve issue for the CLD regarding the timestamp as the time of a transaction is important because it can be used to determine its authenticity and validity. For example, if a transaction is claimed to have been made at a certain time, but the time verification shows that it was actually made at a different time, then the transaction may be fraudulent. LedgerDB can solve it based on the paper It proposes a two-way timestamp pegging protocol. In which both the digests of data and the actual data are submitted to the trusted third party. This means that the attacker cannot

tamper with the data without also tampering with the digests of data. As CLD that provide verifiable timestamps, uses one-way timestamp pegging protocol that can arouse infinite time amplification problem. LedgerDB solves the problem of securing the data in a manner that is difficult to be tempered by a hacker or attacker. But in our case here, we needed the blockchain network itself, as based on our proposed model, we use a private blockchain network to verify the student first if it belongs to the university by using his private key, with which he can take the exam. Then we use a smart contract to save his data to the blockchain network, where it will be secured.

Nowadays, online exams and quizzes are very important in any learning management system but it is important to obtain the results with high reliability, accuracy and tamperproof from LMS. However, the problem is that most of them are using centralized databases which are not the best ways to store results as anyone can access the database and change records.

3. Methods

Step 1: Blockchain Platform Selection:

The initial step involves deciding on the blockchain platform, with the choice narrowed down to Ethereum or Hyperledger Fabric. This crucial decision sets the foundation for the subsequent development phases.

Step 2: Decentralized Storage Integration:

A hybrid approach is adopted, incorporating both IPFS and off-chain storage. Off-chain storage handles large or sensitive data, while IPFS storage is designated for

decentralized content, user credentials, certificates, grades, and similar smaller data sets.

Step 3: Smart Contract Development:

This stage focuses on defining and implementing the logic for smart contracts. Core functionalities and rules governing user registration, authentication, content management, course processes, assessments, grading, certification issuance, and potential payment transactions are outlined. The smart contracts, coded in Solidity, are then deployed onto the selected blockchain platform.

Step 4: Frontend Development:

Choosing React as the frontend framework and Web3.js for blockchain interaction, this step involves creating user interfaces tailored for students, instructors, and administrators. The interfaces cover diverse aspects such as content access, course navigation, assessments, exams, auto-grader functionality, student performance analysis, and graphical representations of student performance.

Step 5: Backend Development:

Node.js is selected for server-side logic, handling user accounts, permissions, content management, course delivery, assessments, grading, certification management, blockchain interactions, and potential external integrations. Optionally, RESTful APIs are defined for seamless communication between the frontend and external systems.

Step 6: Integration and Testing:

This phase involves connecting the blockchain, storage, frontend, and backend layers to ensure smooth communication. Robust error management mechanisms are implemented, addressing exceptions and providing informative feedback to users. Comprehensive testing, covering functionality, performance, and security aspects, is conducted to identify and address bugs, performance bottlenecks, and vulnerabilities.

Step 7: Deployment Maintenance:

The final step encompasses choosing the development environment, setting up infrastructure, deploying smart contracts onto the blockchain, and launching both the frontend and backend components. Regular monitoring of system health and usage metrics is established, allowing for continuous updates and bug resolution to maintain an efficient and reliable learning management system (LMS).

4. Result and Discussion

Each student received a unique username, password, and private key from the college. The private key was required for submitting answers to the blockchain network. The exam process began with students logging into the Dedicated College LMS and selecting the course for the exam. If a student forgot to enter their private key into the MetaMask wallet before starting the exam, the system detected this and displayed a popup message prompting them to insert their private key.

We encountered another issue where some students attempted to use private keys obtained from the internet or other departments within the university. However, the system verified every private key, extracting the student's account ID and checking if it belonged to the college network. If the account ID did not match the college network, an error popup message was shown, directing the students to insert the private key provided by their college.

Once the students began the exam, they answered the questions presented randomly, utilizing the features available in the Moodle LMS. After completing all the questions, the students submitted their answers to the blockchain network, where their answers and grades were securely stored. Some students attempted to submit their answers multiple times after taking the exam, but the system rejected these subsequent submissions. Each time a student made a submission, a flag was placed on their account ID, preventing duplicate submissions. As a result, their wallet transactions failed, and an error message was displayed to them.

Upon successful submission of their answers to the blockchain network, a new block containing the student's exam final result and their answers was created and added to the blockchain network. This block and its details can be viewed through Ganache.

Once the students have submitted their exam answers to the blockchain network, administrators can log in to a specially designed dashboard to access the students' exam results. This dashboard directly retrieves the results from the blockchain network, as depicted in Table. The utilization of blockchain in storing examination data has demonstrated successful implementation in this case study, ensuring transparency and accuracy. This approach was seamlessly integrated with one of the most renowned

Learning Management Systems (LMS).

USN	Student Name	First Ques.	Second Ques.	Third Ques.	Fourth Ques.	Fifth Ques.	Complete Date	Malpractice	Student Grade
141558	Marwan Mohsen	2	0	0	0	2	Saturday,19 December 2023, 9:13 AM	NO	33.33%
141559	Abdullh Ashraf	0	0	0	0	0	Saturday, 19 December 2023, 9:27 AM	YES	0%
141560	Tamara Emad	0	5	0	0	2	Saturday, 19 December 2023, 9:40 AM	NO	50%
141561	Afaaf Mohamed	0	5	0	0	2	Saturday, 19 December 2023, 9:40 AM	NO	50%
141562	Amit Kumar	0	5	0	0	2	Saturday, 19 December 2023, 9:40 AM	NO	50%
141563	Mithula Gowda	0	5	0	2	2	Saturday, 19 December 2023, 9:13 AM	NO	66.66%
141564	Mamata M C	0	5	0	0	2	Saturday, 19 December 2023, 9:13 AM	NO	50%
141565	Mansa Gowda	0	5	0	0	2	Saturday, 19 December 2023, 9:13 AM	NO	50%
141566	Hariya Das	0	5	0	2	2	Saturday, 19 December 2023, 9:13 AM	NO	66.66%
141567	John Doe	2	0	0	0	2	Saturday, 19 December 2023, 9:13 AM	NO	33.33%
141568	Najrana Khatun	2	0	0	0	2	Saturday, 19 December 2023, 9:13 AM	NO	33.33%
141569	Namra safdar	0	5	0	2	2	Saturday, 19 December 2023, 9:13 AM	NO	66.66%
141570	Sara Hussain	2	0	0	0	2	Saturday, 19 December 2023, 9:27 AM	NO	33.33%
141571	Sudipto C	2	0	0	0	2	Saturday, 19 December 2023, 9:27 AM	YES	0%
141572	Ashwani G	2	0	0	0	2	Saturday, 19 December 2023, 9:27 AM	NO	33.33%

Table 2: Admin Dashboard to show students data from blockchain

The conducted exam in our case study exemplifies the reliability and transparency of storing data on the blockchain network. Throughout the study, the data remained 100 percent accurate, with no instances of data loss. The system proved to be highly reliable and secure, effectively safeguarding against unauthorized access and manipulation.

This paper establishes that adopting blockchain technology for storing examination data can offer a trustworthy and secure solution, enhancing the integrity and transparency of the assessment process. By leveraging the capabilities of a well-established LMS and incorporating blockchain technology, the case study successfully demonstrates the potential benefits of this approach in the context of academic examinations.

We proceeded to compare the performance of the system before and after implementing blockchain security measures. In the traditional system without blockchain, the storage and management of examination data relied on centralized databases or servers. This approach often introduced vulnerabilities, such as potential data loss, unauthorized access, or manipulation. The system's reliance on a centralized authority also limited transparency and made it difficult to ensure the integrity of the examination process.

In contrast, after implementing blockchain technology to secure the system, we observed several notable improvements. First and foremost, the decentralized nature of the blockchain network provided enhanced

security and eliminated the risk of a single point of failure. The use of cryptographic techniques ensured the immutability of data stored on the blockchain, making it virtually tamper-proof.

The transparency of the blockchain network allowed for increased accountability and trust in the examination process. Each transaction and block on the blockchain could be independently verified, providing an audit trail of all student submissions and results. This transparency also minimized the potential for fraud or manipulation.

Furthermore, the integration of the blockchain with the existing Learning Management System (LMS) provided a seamless user experience. Students could securely submit their answers to the blockchain network, ensuring the authenticity and integrity of their submissions. Admins could easily access the exam results through a dedicated dashboard that directly retrieved data from the blockchain network.

Overall, our comparison between the traditional system and the blockchain-secured system highlighted the numerous advantages of incorporating blockchain technology in the context of examination data management. The blockchain approach provided improved security, transparency, reliability, and protection against unauthorized access or manipulation. These findings demonstrate the potential of blockchain in revolutionizing the way examination data is stored and managed, ultimately enhancing the overall examination process.

5. Conclusion

In conclusion, the integration of blockchain technology into online exams represents a transformative leap in ensuring the integrity, security, and reliability of the assessment process. The utilization of Ethereum smart contracts has proven instrumental in securely storing and retrieving exam results, surpassing the capabilities of traditional decentralized storage mechanisms like those found in Moodle LMS.

Moreover, the incorporation of advanced features such as an eye monitoring system, student performance analyzer, auto-grading system, and plagiarism detector further enhances the overall examination experience. The eye monitoring system ensures exam authenticity by preventing unauthorized activities, while the student performance analyzer provides valuable insights into individual learning patterns. The auto-grading system streamlines the assessment process, saving time and reducing manual errors. Simultaneously, the plagiarism detector safeguards the integrity of the evaluation process, fostering a culture of academic honesty.

Together, these features, when integrated with blockchain technology, create a comprehensive and foolproof online exam system. This not only addresses existing challenges in data security and reliability but also sets a new standard for trustworthy, transparent, and technologically advanced assessment methodologies. The amalgamation of blockchain and innovative examination features establishes a robust foundation for the future of online educational assessment.

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