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Blockchain-based student assessment and evaluation: a secure and transparent approach in jordan's tertiary institutions

Firas Tayseer Mohammad Ayasrah[1], Ala Shdouh[2], Khaleel Al-Said[3]

Abstract

Guaranteeing students' access to honest and fair assessment and evaluation procedures is of utmost importance in the field of education. The purpose of this project is to see whether it is possible to use blockchain technology to create a reliable and transparent grading system for students. In this research, smart contracts are utilized to mechanize the evaluative process, making it more transparent and less susceptible to bias. This research examines the effects of blockchain technology in the areas of assessment security, data integrity, and process efficiency via the use of both case studies and simulations. Data tampering issues, increased openness, and streamlined evaluation processes are all addressed by the blockchain-based method, as shown by the study's authors. This study considerably pushes the frontiers of educational technology forward by revealing the transformative potential of blockchain applications in the context of student evaluations. This highlights the potential for blockchain technology to improve the safety and fairness of educational settings for all students.

Introduction

The blockchain's recent development has been heralded as a revolutionary step forward that has challenged long-standing norms and prompted a reevaluation of what it means to be trustworthy, secure, and transparent in a number of different contexts. While blockchain was initially designed to support digital currencies like Bitcoin, it has now evolved into a flexible platform with uses far beyond the realm of crypto. The decentralized, irreversible, and transparent properties of this technology have piqued the attention of several industries, including banking, supply chain management, healthcare, and others. Blockchain technology, which was first created to support digital currencies like Bitcoin, is increasingly being recognized as a revolutionary concept with far-reaching implications in many other areas. The phenomenon's decentralized, secure, and transparent properties have attracted the attention of engineers, entrepreneurs, and innovators all around the globe. The study by Frizzo-Barker et al. (2020) represents a significant advancement in the discipline. Since the advent of eLearning platforms and, later, blended learning methodologies, the educational landscape has undergone dramatic change. Universities and colleges throughout the globe have sped up their transition to digital learning by giving students access to online platforms and learning management systems (LMSs) in light of the global spread of the influenza A virus, known as COVID-19. The introduction of blockchain technology is predicted to cause profound changes in the classroom. How schools manage student data and how students and instructors interact might be drastically altered by blockchain technology.

[1] College of Education, Humanities and Science, Al Ain University, Al Ain, UAE Email: firas.ayasrah@aau.ac.ae
Orcid: https://orcid.org/0000-0002-6477-000X
[2] General education and foundation program, Rabdan academy, Abu Dhabi, UAE Email: ashdouh@ra.ac.ae
[3] Department of Educational Technology, Middle East University, Amman, Jordan Email: kalsaid@meu.edu.jo

Reference: Jacob, Elias, and Raine (2022). Researchers have shown that blockchain technology may be used to improve the safety of e- learning solutions developed at universities, such as learning management systems (LMS), massive open online courses (MOOCs), and Web 2.0 applications. To maintain reliability and security, Fernández-Caramés and Fraga-Lamas (2019) suggest that blockchain technology should be included in future intelligent campuses. The use of blockchain technology and smart contracts in particular has the potential to improve online and hybrid classroom security, credibility, and transparency. This new approach may make it easier to keep digital portfolios organized, issue credentials in a timely manner, and improve the validity of assessments. It also has the ability tosubstantially improve school safety and student productivity.

Altinay et al. (2020) investigated the potential applications of blockchain technology in educational management. Researchers have focused on its usefulness in areas such as data storage, identity verification using machine learning, and content security. Bhaskar et al. (2020) conducted a comprehensive evaluation of 36 scholarly works on various aspects of education administration in secondary and higher education, including classroom teaching, student activity management, and related tasks. The researchers concluded that a blockchain-based system would greatly enhance the aforementioned processes; hence, they advocated developing such a system. Cheriguene et al. (2022) developed a comprehensive paradigm for online education that prioritizes the security of LMSs as a consequence of their investigation.

The primary objective of this structure is to improve students' and instructors' motivation to study by providing them with fair assessments of their performance. The authors suggest using incentive systems built on the blockchain as a tool to achieve this purpose. In the field of chemistry education, Ezeudu et al. (2018) recommended utilizing the Ethereum blockchain platform and smart contracts to manage student data. According to Wang, C et al. (2023), "ubiquitous learning" (U-learning) is a multimedia system meant to enhance communication between instructors and students within a safe, collaborative learning setting. A blockchain-based school information hub (SIH) was suggested by Bore et al. (2017). The purpose of this SIH is to enhance educational settings by gathering, evaluating, and acting upon data pertaining to students, educators, and institutional practices.

Block chain technology has emerged as a result of rapid technological progress and provides an opportunity to address the limitations of traditional assessment methods. Blockchain has the potential to create a trustworthy and open environment for student assessments because of its immutability, decentralization, and cryptographic security.

This framework may be used to address issues including data manipulation, faked credentials, and illegal access to student records. Blockchain has various applications, but further study and a complete solution are needed to realize the technology's full potential for improving student assessment and evaluation. The purpose of this research is to analyze the current state of student assessment and evaluation using blockchain technology in Jordanian universities, with a focus on its security and transparency (Beeton et al,.2021).

Overview of Block Chain Technology

The term "blockchain" is used to refer to the chaining together of data-holding digital blocks. Each data block is intended to have a sophisticated cryptographic connection to the one beforeit in the chain. The establishment of the data chain makes this kind of communication possible. Nofer et al. (2017) claim that if a block is altered, all following blocks must likewise be updated to preserve the validity of the chain. This is because each block in the chain must be secure for the entire thing to work. Failure to do so will result in the invalidation of all blocks after the one being updated.

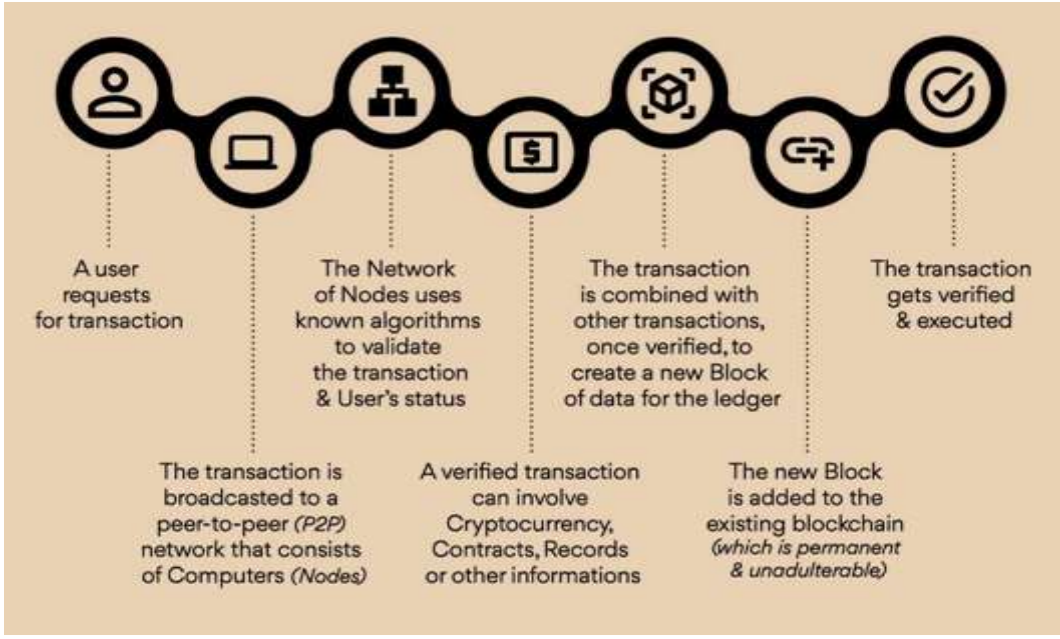

Fig. 1: Blockchain Functionality

Blockchain, a distributed ledger technology, offers a new way to manage and compile digitaldata. Gilder (2018) claims that many digital technology experts consider this to be the start of a new megatrend. However, the question of how effective technology may be in the classroom persists. There is no doubting the far-reaching effects it has. It may be used in a variety of contexts, including educational administration. A student's academic records, including their grades, papers, and certificates, are all stored on a decentralized ledger. It protects students as they demonstrate their knowledge on examinations and other activities, and it makes identity verification easier (STM Future Technology Institute, 2022).

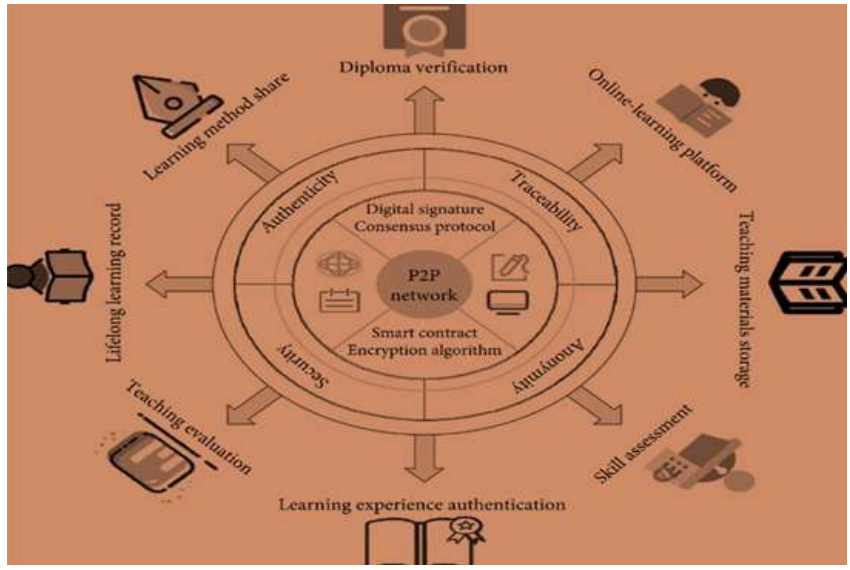

Fig. 2: Blockchain Architecture

Blockchain-Based Student Assessment and Evaluation

There may be several advantages to using a blockchain-based system for student assessmentand evaluation in terms of openness, security, and data integrity. As time has progressed, technology has become more vital to modern existence. Students, like professionals in many other industries, have little trouble learning to use the technology that has become so integral to the modern classroom. Students nowadays are characterized as "digital natives" since they grew up with technology and use it regularly for research and communication (Jones, Johnson- Yale, Millermaier, & Perez, 2009).

As technology becomes more pervasive in people's everyday lives, it will inevitably find its way into classrooms in an effort to make education more accessible (Gill & Dalgarno, 2017). To this end, Lara, Aljawarneh, and Pamplona (2020) note that the use of blockchain technology in educational settings is still in its infancy. Most educational blockchains are designed to keep track of assignments and student responses, but few provide a way to really evaluate whether or not students have learned anything. More studyin this area is needed so that schools may be built where students can feel safe and confidentin their teachers. (2918) Li, Guo, Zhang, Wang, Sun, and Bie with block chain's distributedledger, all nodes' data is identical, fostering transparency and maintaining confidence. The addition of smart contracts increases the system's safety. In 2019, Li et al.

Bitcoin and other digital currencies have made widespread use of blockchain technology, although this was not their intended purpose. But now it's making its way into academia as well, whether to facilitate decentralized record-keeping at educational institutions or to reward students with badges and letter grades. Blockchain technology may be of tremendous assistance in helping prospective employers assess the reliability of job seekers. Castro and Au-yong-oliveira, (201).

The benefits of this technology may be realized by students through the verification of their papers. Authors: Ramesh Goedert, Adriano Rogério Goedert, and Dênia Falco de Bittencourt Year: 2020. With the globe rapidly converging into a global village, it is likely that all educational evaluation will eventually be moved online, giving students and other stakeholders equal access to the process. (2020) S. Mahankali and S. Chaudhary J. Guo Li, G. Zhang Li, Y. Wang Li, and Y. Sun Bie Educators use a wide variety of techniques to gauge their students' progress during a course. Depending on the kind of work being evaluated, either a direct or indirect evaluation, as seen in Figure 3, may be performed. Alqahtani, Saeed; Shafi, Saeed; Bamarouf, Iqbal; Min-Allah; Shafi, Saeed (2019).

There are two primary types of evaluation. Mehmood, Abid, Farooq, and Nawaz (2020) state that students' progress may be monitored using either formative or summative assessment strategies. Both offline and online forms of assessment are possible. Direct assessment techniques are the focus of the evaluation models presented in this article (Kiskis, 2017). In educational institutions, there are a variety of issues that might develop throughout the assessment process. Problems with traditional evaluation approaches include bias, dishonesty, political interference, data loss, and paper leakage, amongothers.

When Mehmood and co. score, there is no canonical method of scoring. Teachers' freedom to offer grades based on their own judgment and preferences might lead to tensionwith their students. When Mehmood and co. Students' work in class and their written assignments are considered alongside more conventional forms of assessment like tests and quizzes for determining grades. This presents an additional challenge to teachers when evaluating students. Digital certificates are increasingly used to represent achievement in both face-to-face

and online education. They may be readily falsified or stolen, though, posing issues for worthy students. It was published in 2017 by Turkanovi, Hölbl, Koi, Herik, and Kamiali.

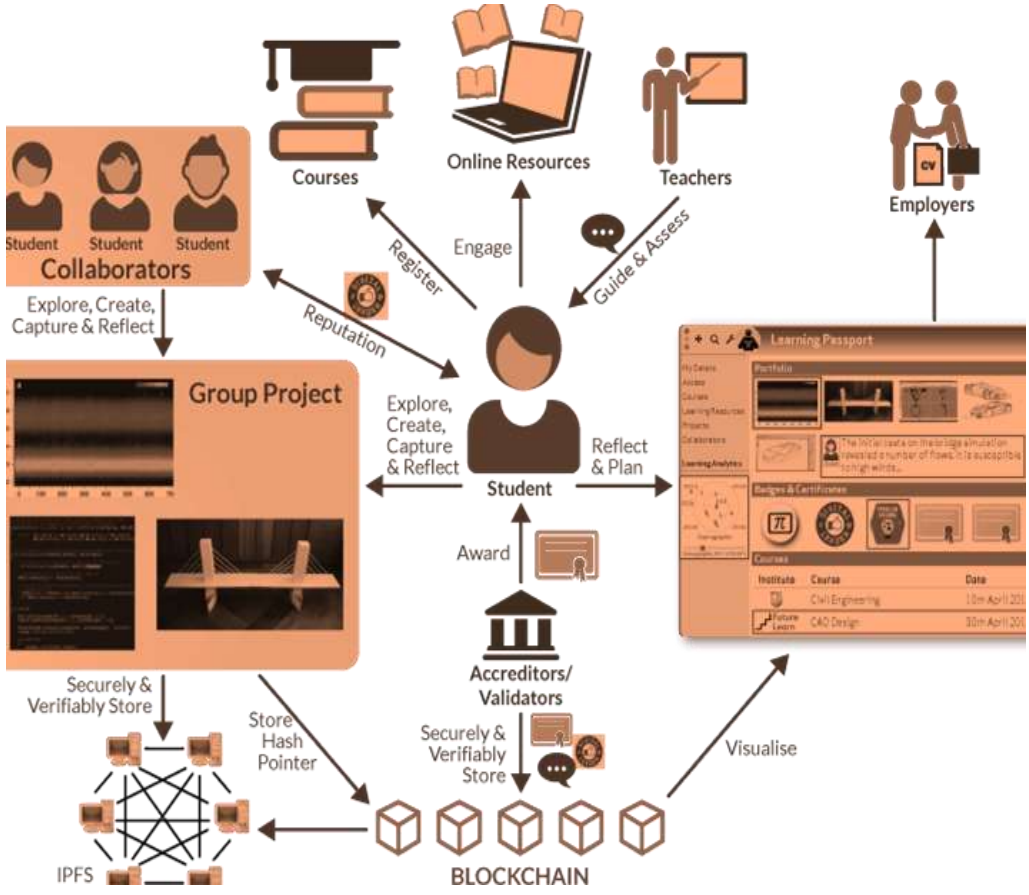

Fig. 3: Blockchain Interaction Model

Digital certificates, transcripts, and student records: Blockchain technology makes these documents unchangeable and verifiable by anyone with blockchain access. The certificate may be verified even if the issuing entity no longer exists, since the records are maintained in a shared distributed ledger.

Replace paper: Blockchain will replace paper with digital documents, transcripts, degrees, certifications, and more. We no longer need to worry about losing or securing our documents. Immutable documents are more credible and may be requested by employers, institutions, students, and others. Copies won't require certification. The blockchain will confirm and consolidate everything.

Credentials: Our unchangeable certificates and credentials will be kept on the blockchain and accessible through our digital wallets at any moment. We can simply authenticate our certifications and expertise on the blockchain if an employer needs to.

Accessibility of records: teachers, students, and anyone else may see credentials and information through a smartphone app called a digital wallet.

Tuition fees: Some schools are accepting bitcoins for course costs. Why not pay your fees

using the cryptocurrency, you have in your wallet or mining

Validation of information: MIT and block chain company Learning Machine issued over 100 digital degrees to graduates in 2018 using the bitcoin blockchain (Coin Idol, 2018). There will be no false degrees or certificates. Your degree will be stored on an immutable blockchain that you may share with future employers on your résumé or LinkedIn.

Motivation for students: Students may be rewarded with tokens. Better course performance means more tokens. These digital tokens may be implemented using the blockchain. Students might use tokens to pay for extra courses, tuition, or to convert them into cryptocurrencies in their digital wallets.

Connection between students and employers: With these blockchain-based digital tokens, pupils with more tokens may be on a leader board or seem more interesting to prospective companies looking for qualified applicants. Verifying how many tokens pupils earned in class might help assess applicants' skills (Esmaeili et al 2022).

Rewarding high-quality content: This methodology might compensate instructors, instructional designers, and content providers as well as the token system does for students. Students will receive more tokens for superior material and courses. These tokens will be transformed into cryptocurrency that educators may cash out or keep in their wallets.

Challenges of the Proposed Blockchain-Based Student Assessment and Evaluation

Slower transactions and scalability challenges: Educational databases hold so much student data that block sizes have increased. Since each blockchain transaction requires Mara-Florina (2020) peer-to-peer verification, scaling becomes difficult as blocks rise. These slow transactions may hinder education's adoption of blockchain-based solutions.

Complexity and technical knowledge: Blockchain technology requires knowledge of cryptography, consensus mechanisms, and distributed ledgers. Teachers and school administrators may lack the technical expertise to use and secure blockchain-based solutions.

User adoption and interface: Blockchain software needs simple interfaces. If new technology is hard to use, educators, students, and administrators may resist adoption. Blockchain technology should operate smoothly and easily (Yela et al,.2022).

Risk of Error: Blockchain data encryption is irreversible; therefore, block mistakes cannot be undone. Instead, a new construction block must be created and used.

Privacy Vulnerability: Blockchain's public and private keys preserve secrecy. Users may use their public key to buy without revealing personal information. However, Meiklejohn et al. (2013) demonstrate this. Kosba et al. (2016) contend that blockchain cannot provide transactional privacy since all transaction values and public key balances are public. A recent Barcelo (2014) study found that Bitcoin transactions may disclose personal information. Ahmad, A. B et al. (2023) also linked user pseudonyms to IP addresses, even when users were shielded by NAT or firewalls.

Proposed student assessment and evaluation approach

This section covers the suggested method flow. Our investigation utilized an ethereal blockchain. Ethereum has Ether (ETH) and Solidity, a programming language. Decentralized Ethereum is a blockchain network for confirming and documenting transactions. A POW consensus mechanism is utilized. The recommended work is schematically shown in Figure 4.

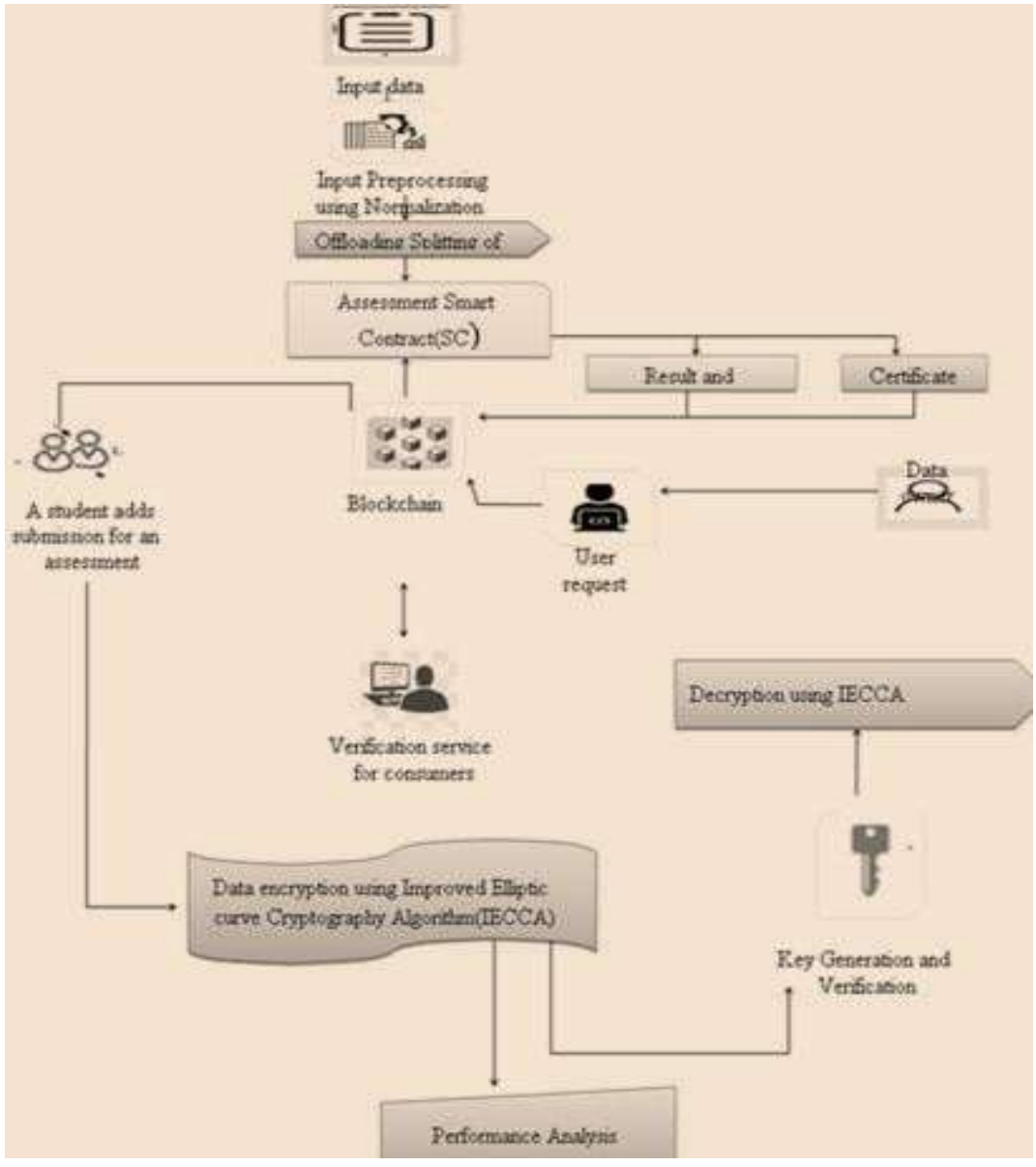

Figure 4. Schematic representation of the proposed method

Assessment smart contract (SC)

Smart contracts are transactional scripts like relational database maintenance systems. Peerscan only modify the blockchain state via blockchain transactions, which trigger smart contract code. Pre-programmed programs might recommend blockchain changes to peers. If the network agrees, the changes are made. Approved changes are permanent.

In our hyper ledger composer environment. Every transaction checks contractual conditions using input data and blockchain state. If the evaluations pass, network consensus may generate or adjust blockchain resources per contract criteria; otherwise, the transaction is rejected. The evaluation smart contract concept is presented in Figure 5.

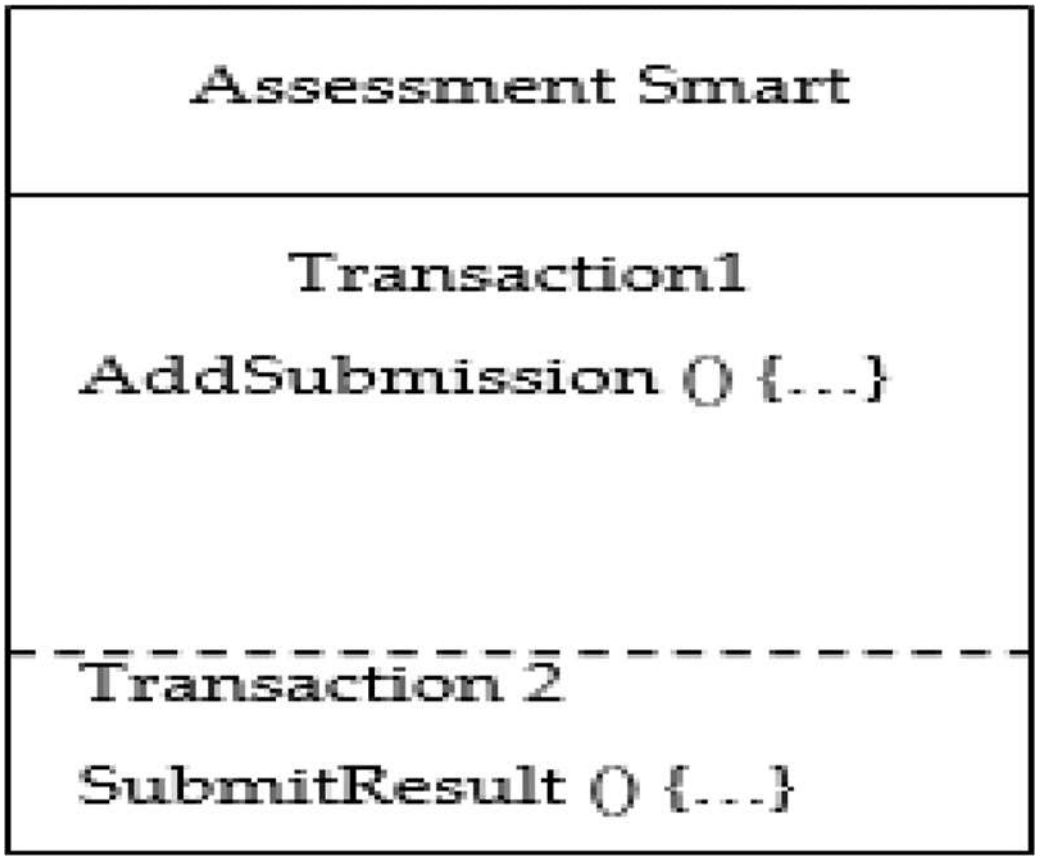

Figure 5. Assessment of Smart Contract (SC)

The learning user may submit a certification request to the department of education after finishing course studies, and the education authorities will verify course credit balances. If course credit balances reach the appropriate level for completion, the education authority and learning user individually compile and digitally sign a thorough digital certificate. Double-digital-signature digital certificates are permanently recorded on the blockchain as new digital certificate blocks. The learning user's certificate wallet receives the learning accomplishment score, and the course digital certificate credits are taken from the course credit wallet.

The suggested platform allows blockchain-based assessments. The blockchain peers do the precise calculations and agree on the final score for smart contract evaluations, reducing the chance of manipulation. We aimed to encourage educators to evaluate with maximum openness and publicly record adjustments or contingent interventions by standardizing assessments into a series of open stages executed by a peer group to reduce teacher-student conflict (Wu et al,.2022).

We examined assessors and automated marking. Assessor grading is when a professor grades a student's work using their best skills. This format uses any normal marking technique, but scores are input digitally and recorded in the blockchain. Machine-assisted testing provides findings and feedback to the assessor. It reduces physical effort and provides real-time feedback. These marking approaches are becoming increasingly common, particularly in computer science. Figure 6 shows how two transactions were expected to finish the assessment of smart contracts.

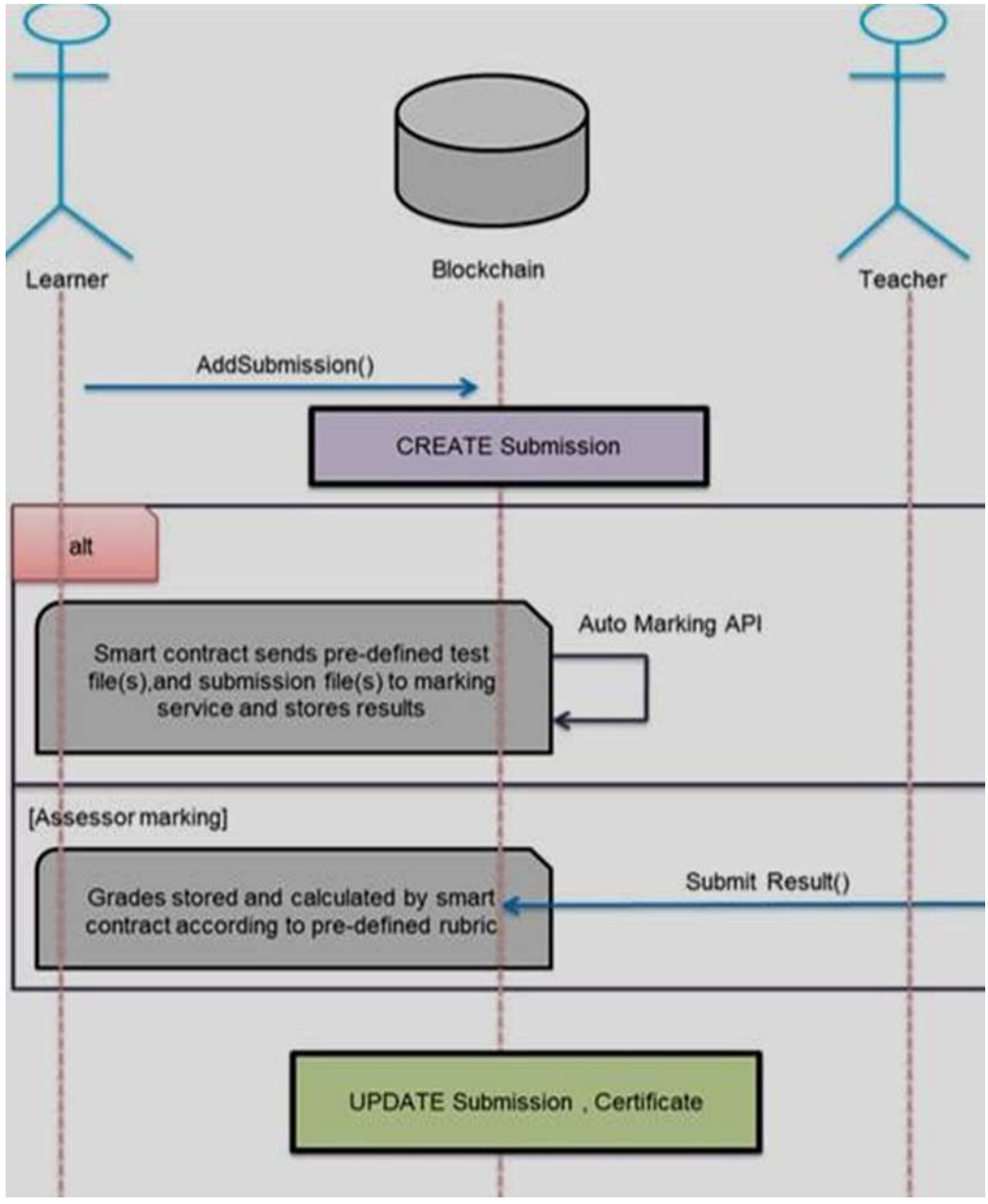

Figure 6. Diagram representing transactions (blue arrows) for an assessment effort

References to changed submission resources with pass marks must be provided in certificate resources to prove evaluation satisfaction for both the ADDSUBMISSION and SUBMITRESULT procedures. A student records an assessment attempt on the blockchain using the ADDSUBMISSION transaction.

Submissions are private and immutable on the block chain. Our approach zips and converts data to base64. When supplied files are too large, a data server may need to record them using a block chain checksum. Algorithm 1 outlines the assessment of smart contract transactions

Algorithm 1: Method of Assessing SC Transaction ADDSUBMISSION

- SUBMITRESULT INFORMATION TO ADD (input)
- Create an account for object submission.
- If evaluation and assessment are done by a machine, then
- Retrieve test files from the blockchain.
- Send documents to be graded by the service.
- Obtain Marking Service Results
- Based on the results so far, revise the submitted asset.
- If the outcomes are successful, then
- Revision of the Certificate
- The termination condition is met when the specified condition evaluates to true.
- Alternatively,
- Pair the submission with an instructor.
- Alternatively,
- transaction complete
- Conflicting transactions are rejected.
- acceptance of the return transaction
- transaction complete
- data sent through the SUBMITRESULT transaction
- Find a solution
- Submittal object UPDATE
- Then, if the grade for the submission is good,
- Certificate of UPDATING
- finish if
- finish the transaction

- **Automated marking**

The ADDSUBMISSION transaction may immediately provide automated assessment results. Test files for automated marking are stored on the blockchain and transmitted to the relevantextrinsic automated marking provider alongside student submission files.

We created one basic automated marking service in our demonstration system. A standalone web application checked string equivalence. This basic equivalence check showed the blockchain's automated testing capabilities.

- **Assessor marking**

The course instructor upgrades a submission's blockchain assessment result for assessor marking via the SUBMITRESULT transaction. Grades may be computed by educators, software, or blockchain SC. We developed the final of these in our system since the grade estimate algorithm would already be preserved on every blockchain peer in the pre-defined assessment procedure.

Teachers submit grades using a grade description grid. Pre-determined percentages and rules define smart contract pricing. Teachers might then adjust the final marks using comments. It makes Mark's moderating more apparent.

- **Credential generation**

Evaluation transactions on the blockchain give an immutable record of student progress. Our platform's credentials are always traceable to prior transactions, which learners may verify and make public. Optional SIGNCERTIFICATE transactions allow teachers to show and approve blockchain certificates. It simulates real-world "degree conferral" methods. It concludes automatic due diligence before a student obtains a course certificate. The syllabus or course structure may need several signatures.

Conclusion

The use of blockchain technology in the area of student assessment has considerable potential for the improvement of long-standing issues and the complete overhaul of the way education is now practiced. Due to the cryptographic safeguards provided by the blockchain, all assessment data is trustworthy and immutable. Permanent records ofstudent achievement are essential for any credible academic assessment system. From assignment creation and submission through evaluation and report production, the blockchain's smart contracts might automate a number of formerly manual processes.

This automation reduces the burden of administrative work, cuts down on human error, and streamlines procedures. Blockchain technology ensures that assessment data can never be compromised or deleted. This function ensures that historical assessment data may be accessed and used without any loss of quality.

The study revealed both the possible benefits and the potential problems of a blockchain-based assessment system. The hurdles include the incorporation of new technology, the change of present methods, the upfront costs, and the broad support from educators.

Direction for Further Studies

Future plans for the projected adoption of blockchain-based student assessment and evaluation are presented in this section.

Use of the Checker: The serial number and encryption key for the verifier app are both presently entered manually by the user. In the future, the app will likely feature a QR code scanner built right in, allowing students to show a QR code to a verifier for rapid verification without the need for the verifier to manually input a serial number or password. Another goal is to improve education about the app's functionality so that users can avoid falling into scams using unofficial copies. Next, we need to give universities more control over the application by allowing them to set their own preferences for things like the distribution of encryption keys, the configuration of custom gateways, the display of a log of certificates issued along with their current status (pending, confirmed, or declined), the hash of a transaction, and other crucial information.

Furthermore, the institution may adjust the maximum number of certificates added simultaneously to meet their needs based on the parallelization approach employed. The certificates will be added in bulk, and an import/export file is in the works to facilitate this. The certificates may be created and signed on several machines. One scenario is that certificates are created on personal computers belonging to authorized individuals and then signed and distributed on university systems. The third anticipated component is the method of distributing the encryption key, which will be determined by how the institutions create the link for the students but should, by default, be sent through email.

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