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## Blockchain Based Technology and its Effect on Education in Iran

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### ABSTRACT

With the advance of Internet technology, currently, there is no more centralized province for education in either the physical or virtual world, but education is now done through peer to peer interaction, online and from anywhere on earth. Therefore, Blockchain is getting significant considerations and is rapidly becoming part of the technology vernacular in the Iranian Educational system. This is mainly due to its unique features including decentralization, disintermediation, immutability, self-sovereignty, security, reliability, collaboration, data sharing, and data integrity. Despite this getting popularity and interest in this field, currently, stakeholders within education in Iran are largely unaware of the social advantages and potential of blockchain technology. That is why, through systematic literature review, the study centers on three primary subjects: It focuses on three main themes: (1) educational applications that have been developed with blockchain technology, (2) benefits that blockchain technology could bring to education, and (3) challenges of adopting blockchain technology in education. A detailed results analysis of each theme was conducted as well as an intensive discussion based on the findings. In the end, a detailed analysis of the results of each theme as well as a critical discussion was made based on the findings.

**Keywords:** : *Blockchain in Education, Blockchain Applications, Blockchain Technology, Decentralized, Self-Sovereignty Systems*

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### 1. Introduction

The issue of change in the educational system is a long-standing topic in Education in Iran. The definition of change is: Change is the transformation of anything different from its past, and innovation is the adoption of ideas for a new organization. Therefore, all innovations can reflect a change, although not all changes are innovations. Transformation in Education is the process of fusing traditional ideas, beliefs and behaviors and consolidating new values and establishing new systems. That is, matching Education with the latest phenomena of the day. Although there are many areas such as the Internet, robotics and information technology today, Iran's education continues to face more serious problems. One of the major problems in the Iranian education system is the existence of a system called the "paper system" for the issuance of credentials, certificates and also the retention of related documents (Sadat Sanati,

2017). Graduate degrees such as diplomas, bachelors, masters, etc., or even student records in schools, are all-paper course certificates and create many problems, which in turn increase the risk of forgery. Today in education systems, especially in Iran, paperwork is rampant, and many employees archive offices are busy holding storing documents, certificates etc. But blockchain technology can eliminate the need for such workforce and saves energy and costs.

At the same time, the education sector also has to cope with the heavy regulatory burden (Nakamoto, 2008). Simple tasks like sharing school manuscripts, transcripts, action researches, etc. now require a huge amount of time and money compared to similar deals in the digital world. This creates a big gap because consumers are used to meeting their needs quickly and with personal attention. Higher education institutions strive to keep pace with all these

changes. Besides, most educational institutions such as distance schools, night schools, etc. follow a pattern in which each maintains control of its students' records and credentials. Because every organization controls its data, it can be easily changed or deleted, and there is no redress or compensation if corruption in case of data occurs (Mikroyannidis, et al., 2018). The model also places data at risk of change or destruction in global events such as war or natural disasters such as floods or earthquakes. For example, if there is a war and destruction and as a result, the students' credible records throughout the country will be destroyed and it will add to widespread confusion. Today, the field of education requires a central body for the validation of these documents, and educational institutions have to process thousands of requests from various organizations to send copies of documents. They need to make sure that a person is truly graduated from their university (Burbules, 2014).

Blockchain technology is a desirable tool which can play an important role in addressing all these aforementioned challenges. Its decentralized architecture offers the benefits of enhanced privacy and security through Public Key Infrastructure (PKI) encryption, anonymity, longevity, integrity, transparency and immutability. Putting education information on the blockchain eliminates any doubts about employees and their level of knowledge and eliminates the possibility of producing fake documents. We have a database that stores a person's information, including personal skills, specialized courses, or even lectures that the person has attended. With this database, employers can retrieve information about an employee easily, quickly and without hesitation.

Nowadays recruiting for specific situations is a complex and time consuming process and there is almost no algorithm to limit the applicants to the level of knowledge required. Using the Blockchain, such individuals can confidently provide employers with information about their educational and career backgrounds anywhere in the world (Devine, 2015).

Considering the said problems in Iranian Educational system, the remainder of the paper is structured as follows. Section 2 introduces major features of Blockchain and its uses on Education in Iran. Section 3 demonstrates different current and future applications of blockchain technology. Section 4 & 5 provide the major benefits and

challenges of embracing blockchain innovation. Section 6 provides a detailed analysis of the results of each theme as well as a critical discussion was made based on the findings.

## **2. Literature Review**

### **2.1 What is blockchain?**

Blockchain technology makes it possible to create a decentralized environment where authenticated encrypted transactions and data are not under the control of any third party organization. Every transaction that has been made so far is recorded in an unchanging record in a verifiable, secure, transparent and permanent way, with a timetable and other details. It allows participants to secure the settlement of transactions and transfer of assets at a low-cost (Tschorsch and Scheuermann, 2016).

A sample flow of cryptocurrency blockchain transaction can be seen as follows., transactions occur between anonymous users, e.g. user A and user B (the identity of both users do not appear in any place) using public key cryptography, that is to say, each user has a private key that only user A or user B knows, and a public key, which is shared with other users. All transactions are conveyed into all nodes on the network. The Nodes check out the transactions and group them in blocks. Each block is identified by a hash which is called a calculated cryptographically unique value based on the contents of the block and includes a reference (specific number) to the hash from the previous block, so that, blocks are linked together. This chain of blocks is thus a record of transactions (ledger), shared by all the nodes in the network (Yli-Huumo et al. 2016). Each transaction in a block is labeled by a specific timestamp. So the blocks are also linked by a timestamp. Therefore, blockchain data are temporal and the chain length is continuously growing (Nakamoto, 2008). Essentially, blockchain is a distributed and decentralized network of computers or nodes. Each node maintains a complete set of ledgers of past transactions which keep the security and accuracy of the information. When a new block is created, as a result, will be broadcasting to the whole blockchain network, allowing all nodes to maintain the same complete ledger (Allison, 2015)

### **2.2 Blockchain-based Studies for Education**

The scientific papers and reports published so far assert that, although the blockchain technology is taken as a transformative technology with enormous



potential in education, the utilization of blockchain technology in education is in its infancy (Gräther et al., 2018). The Joint Research Centre (JRC) in Europe published a report on Blockchain in Education (Grech & Camilleri, 2017) identifying the potential including issuing credentials, verifying the issue of certifications, lifelong learning certificates, the management of intellectual property, and data management.

Traditionally, academic records of a person, such as degrees, diplomas are stored in the different databases and students or graduates do not have the authority to manage their own information. Moreover, no other informal person has the authority or access to modify or even view these official records. But, through blockchain technology in the context of heightened decentralization of education and work, an easy access to the personal degree record is paramount (Risk Advisory Group, 2018). In Romania, traditionally, the Ministry of National Education controlled the management of the National Student Enrolment Registry, that is, a digital database records all students in Romania from public and private universities, accredited following Romanian Education Law for all academic years and all study cycles (RG, 2018). Therefore, so far, access to this information is restricted, and students or graduates cannot view their records from this central database. But, today, through blockchain technology the management of the National Student Enrolment Registry in Romania a third-party, such as an employer, cannot access this database to verify the authenticity of a candidate's degrees any more.

Trines (2017) through various studies identified some challenges regarding the degrees and diplomas issued by foreign education institutions, including the perils of certificate counterfeiting, and gave some recommendations for safeguarding against fraudulent documents. One of these recommendations is having and providing a trusted system for recording, storing, retrieving, and modifying educational documents, such as degrees, diplomas, education and training credentials, etc. He also recommended that such a system needs to contribute to preventing fraud, by ensuring, for example, the management of both educational data and data access to third parties. But, through "the centralized data storage and data management systems all documents and information would be susceptible to hacking, intrusion, and breaches" (Efanov & Roschin, 2018).

Instead, by applying blockchain technology a distributed trust technology, scalability, privacy, and reliability could be ensured.

### 2.3 Major Features of Blockchain Technology

From the technical point of view, blockchain technology has some major features. It is decentralized, de-trusted, reliable, collectively maintained, privacy safe, traceable, immutable, and Inseparable.

1. Decentralized: the processes of data verification, storage, maintenance, and transmission on blockchain are based on distributed system rather than centralized one. Meanwhile, the damage of a single node will not affect the data of the whole network (Pilkington, M., 2016).
2. De-trusted: In blockchain technology all blocks are linked together through a cryptographic Hash value on the one hand, all nodes can make transactions safely without third-party supervision, on the other hand (Raths, 2016).
3. Traceable: It means that all transactions on blockchain are arranged chronologically, and a block is connected with two adjacent blocks by the cryptographic hash value. Therefore, each transaction is traceable by the cryptographic hash value (Underwood, 2016).
4. Reliable: The database in blockchain technology adopts distributed storage, meaning each node can obtain a copy of all transaction data. This mode of storage protects data integrity and reliability. Besides, any transaction data is logged and stored on a timestamp and is highly traceable to the source (Tschorsch and Scheuermann, 2016).
5. Collectively maintained: The data on blockchain are collectively maintained by all nodes. The error of a single node has no impact on the data of the whole network.
6. Privacy safe: According to the digital signature algorithm, data is transmitted using the public key and the private key, without revealing the node's identity. The user is completely invisible in the transfer process. With high reliability and security, blockchain technology offers an ideal solution to online learning problems (Tschorsch and Scheuermann, 2016).
7. Immutable: Blockchains are immutable, since, all transactions stored in a block linked to the previous block through one hash key and also linked to the next block the other hash key. Changing with

any transaction would result in different hash values and would thus be detected by all the other nodes on the network (Sharples and Domingue, 2016).

8. **Inseparable:** Blockchain technology and cryptocurrency are inseparable, that is to say, any blockchain network has a cryptocurrency property. Therefore, all transactions on blockchain do not require the participation of any intermediary (Raths, 2016).
9. **Being Efficient:** Efficiency means all transaction data are automatically run through pre-set procedures. Therefore, blockchain technology could speed the settlement of certain financial transactions by reducing the number of third-parties involved (Wang et al., 2016).
10. **Consensus mechanism:** Consensus mechanism refers to the mutual approval of all the nodes associated to the blockchain network (Grech and Camilleri, 2017). Thus, it doesn't rely on mediators. Proof-of-work (POW), proof-of-stake (POS), delegated-proof-of-stake (DPOS) are some techniques of consensus mechanism

#### 2.4 Blockchain Use Cases in Education

There are many potential use cases for blockchain in education:

1. **Storing student credentials:** Most higher education institutions keep students' credentials or completed academic certificates in special formats. These databases can be accessed by an institution's staff and in dedicated online systems. Furthermore, the majority of higher education institutions have their proprietary system for keeping students' completed course records or academic degrees. Even if the institution that issued the certificates became closed, or if the entire education system collapsed, those certificates would still be verifiable against the records stored in a blockchain. Besides, once education institutions issue a certificate, there is no need any more to confirm the validity of that certificate to intermediaries, since the certificate can verify itself directly on the blockchain (Sharples and Domingue, 2016).
2. **Identity verification:** It is another perennial problem for educational institution especially for Education in Iran, requiring many opportunities for data tampering and needing a lot of time for intervention. With blockchain technology, validation of a student's

identity happens once. Since the blockchain network stores information about that document, rather than storing the student identity document. Through blockchain, students can identify themselves online while keeping control over the storage and management of their data (Underwood, 2016).

3. **Intellectual property protection:** Teachers and researchers regularly publish their research and papers as part of their work. Based on the traditional system, is hard to be aware of a similar academic study is underway when a professor begins his or her research. The use of blockchain technology helps deal with these problems. Blockchain could allow educators to publish content openly while keeping track of any plagiarisms, without putting limitations on the source material. Such a system would allow teachers and scholars to be rewarded based on the level of actual use of their research papers or teaching materials and the number of citations to their research papers. Students and institutions could then make meticulous decisions on what teaching materials to use (Wang et al., 2016).
4. **Ownership of learning credentials:** Blockchain could provide a more flexible system for storing students' credentials as they move from course to course throughout their school years, as well as their professional careers. Blockchain could provide a more reliable system storing credentials for a lifetime of learning, therefore, through blockchain, students' credentials cannot be modified and manipulated. Blockchain allows for a reliable platform for personal data to stay personal to the learner. Besides, students can gain control and ownership of all their education data, including accreditation and portfolios of work, in a secure place that is accessible to anyone who needs to verify it. Public blockchains can facilitate self-sovereignty by allowing individuals to be the only one to judge who can access and use their data and personal information. Therefore, Blockchains, within an educational context, can empower individual learners to manage and share details of their credentials, without the need to call upon the educational institution as a trusted intermediary. Via blockchain, learners could store their credentials and share



them with a desired audience, and ensure instant verification (Watters, 2016).

**5. Transfer of credits:** It has been another perennial challenge for educational institutions. Students experience difficulties when they transfer to another higher education institution, while still completing courses at a previous institution. This problem is even more tangible in cases when a student wants to transfer to an institution in another country, where another language is spoken there, are likely to pose additional barriers. Through blockchain technology, these agreements could be written as blockchain-based smart contracts, whereby the credits would automatically be transferred upon fulfillment of the conditions of the contract (Wang et al., 2016).

### *2.5 Blockchain Applications in Education*

Nowadays, some universities and academic institutes have a pressing need to apply blockchain technology into education to support their students' academic degrees and manage their credibility and evaluate students' learning outcomes summative (Sharples and Domingue, 2016; Skiba, 2017). Since in the formal learning, blockchain technology can formulate learning contents and outcomes as well as students' achievements and academic certificates on the one hand, and in the informal learning context, information about research experience, skills, online learning experience as well as individual interests, on the other hand. These data can be safely stored and accessed on a blockchain network in some appropriate ways.

Holberton School in India is the first educational institute which apply blockchain technology to store students' degrees and credentials and has claimed that they have been sharing this information from 2017 (Chen et al., 2013). Since the blockchain ledger can match all kinds of educational information including students' learning behaviors in class, micro academic projects, educational experiences, and macro educational background, etc. with the user's unique ID. Malta is the first country that applies blockchain technology on a large scale to its education system. Blockchain certificates have been successfully launched in Malta's Institute of Tourism Studies (ITS) and Malta College of Arts, Science, and Technology (MCAST). The next future application of blockchain technology in this country would be to make all educational

diplomas blockchain-based (Pilkington, 2016).

Blockchain can have various applications within academic publishing. Traditionally, academic research is published by a handful of large publishers. Therefore, if you are not a part of this, as a result, your work will go unnoticed, since academic publishing is structured as an oligopoly based on traditional system. This is referring to the fact that academic research is published mainly by a few large publishers. The process of peer review is outdated as well; it takes a very long time and a large amount of funds. Blockchain technology implementation could indeed change such traditional publishing system in some appropriate ways. One application within blockchain technology is used to resolve issues within academic publishing is Authorship Tokens (ATS). ATS allows authors to publish their work on the blockchain-based platform. Authors are allowed to have copyright to their work. They are complete freedom over where their work is present and whether they choose to distribute it in other forms. Sony Corporation Education (SCE) and Sony Global Education (SGE) have developed a system that will apply blockchain technology to the field of education to make mutual use of educational achievements and activity records openly and safely, such reliable system centralizes the management of data from multiple educational institutions and makes it possible to record and reference educational data and digital transcripts including certificates, credentials, etc. Sony Global Education will build on blockchain technology to make it possible for multiple educational institutions to be able to make use of its data (Hoy, 2017). Additionally, the Massachusetts Institute of Technology (MIT) and the Learning Machine Company cooperated and designed a digital badge called MIT Media Lab which was based on blockchain technology for online learning. Based on the new digital lab, students who have attended the projects of MIT Media Lab and succeeded to pass the assessment will receive a certification that will be stored on a blockchain network (Skiba, 2017).

### *2.6 Future Innovative Educational Applications Using Blockchain Technology*

It is also assumed that blockchain technology could be applied to education in many innovative ways beyond just keeping students' credentials, certificates, etc. Blockchain technology can be taken as

current and future trend in CALL through having a great potential for broader applications including formative evaluation, learning activities design and implementation, and keep tracking the whole learning processes. Some future or innovative applications of using blockchain technology trend in the field of education are proposed as follows.

A Smart Contract which runs on the blockchain technology network is essentially a computer protocol intended to digitally facilitate contract negotiation, simplify contract terms, implement contract execution, and verify contract fulfillment state. Such computer protocol allows the performance of credible transactions without third parties or intermediaries. It is a kind of computer protocol that makes it possible for a real kind of contract such as economic transactions, employment, etc. (Kosba et al., 2016). Smart contracts stimulate unique and precise identities or contract subjects for parties in any transactions in a digital way and it also specifies the rights and obligations or contract terms for both sides by code. Therefore, the smart contract not only reduces “third party costs” in any transactions but also dramatically guarantees security and reliability for any transactions.

Sharples and Domingue (2016) maintained that negative factors would cause poor learning outcomes in educational settings, such as the lack of motivation, financial pressure, etc. But, due to the trait of cryptocurrency property, blockchain can be used to motivate students to imagine learning as “learning is earning”. That is to say, the smart contract between teachers and students can be applied to the educational scenario in a way that awards can be given to students through some simple clicks by the instructors. Based on smart contracts, students will get a certain number of digital currency as rewards. This kind of payment can be stored in the education wallet, taken as tuition.

Evaluation or formative assessment is also a problematic issue in the education system because it is not easy to track every detail of teaching and learning. But, by applying blockchain technology and smart contract, it would be possible to cope up with this challenge. It is notable to mention that the data recorded on blockchain are more specific, authentic, and anti-theft, as a result of the major features of blockchain technology including immutability, traceability, and reliability. For collaborative learning, for instance, through blockchain

technology, each student submits his/her work to the learning platform through his/her unique account, the smart contract running on it will review student’s performance, and the results will be recorded into blocks. All students’ behaviors during collaboration will be saved into blocks as evidence for evaluation as well. Furthermore, public blockchain has the trait of decentralization, that is, the distributed ledger ensures the consistency of most nodes. Thus, students’ opinions taken as nodes in blockchain technology would be taken into consideration when assessing them. As a result, blockchain ensures the fairness of the evaluation (Chen et al., 2018).

From the perspective of teacher development, a new assessment system can be constructed based on the blockchain network and smart contract. First of all, teachers need to submit preplanned instructional activities as a smart contract to the schools. Then, during the teaching process, all teaching activities will be recorded in the blockchain network. The smart contract will verify the consistency of the teaching design (framework) and practice, which is an important instruction evaluation indicator. Teachers who meet the standards of the teaching task will get digital currency as a reward. Therefore, such technology serves as both an appreciation and encouragement for teachers’ teaching skills.

### *2.7 Potential Benefits of Applying the Nascent Blockchain Technology in Education*

1. One major merit of blockchain technology is assuring the security and privacy of all transactions exchanged between the intended users or parties. The nature of the peer-to-peer transaction in the blockchain technology can help reduce the security risks in the education field. The other crucial component of blockchain technology is consensus protocol. It functions to maintain the order of transactions and to reduce the security risks in the education field. Using the cryptographic hashes within blockchain technology assures the reliability of the transactions as well. Therefore, blockchain relies on securing the data itself, on the one hand, and verifying that it has not been tampered with, on the other hand (Farah et al., 2018).
2. Furthermore, verifying and processing students’ academic credentials or



certificates requires extra costs whereas the blockchain technology can help reduce such costs. Traditionally, the cost includes storage cost, transaction costs, and managing and maintaining the educational record costs. Via using a public/private distributed network, within blockchain technology, that can be accessed from anywhere and anytime dramatically diminishes the cost of the traditional cloud-based storage (Han et al., 2018).

3. One of the great features and benefits of blockchain is restricting /controlling the access of the stored records for both students and teachers including transcripts, diplomas, or credentials. blockchain technology is equipped with a permission platform which is used to restrict access to academic credentials and limit it to the intended participants/parties only. Such a blockchain platform allows only certified and authorized institutions under specific rules to access and modify the stored data (Han et al., 2018).
4. Accountability and transparency are two advantages achieved through using blockchain technology. Storing all educational or school records and reports in one place, where it can be easily accessed by all stakeholders, will increase the accountability and transparency of using such records (Bore et al., 2017).
5. One major advantage of blockchain technology is that it can assure the authenticity of digital certificates as well as the identity of users (Srivastava et al., 2018). For example, once a digital syllabus is stored in a blockchain, as a result, blocks are created, then the authorized university or education institute will sign or verify it through using a private key. After that, a cryptographic hash of the course syllabus will be issued to ensure that no one can tamper or intervene with the content. This process validates the authenticity of these data and the identity of users.
6. Besides, the efficiency of managing students' records is improved through applying blockchain technology to education. It can efficiently reduce the risks of trading mistakes between the intended parties or users. Since blockchain technology uses one ledger for a faster and more efficient method to exchange data leading to transparency,

as a result, digital records and certificates can be managed more effectively.

### *2.8 Potential Drawbacks of Applying the Nascent Blockchain Technology in Education*

1. With the advancement of science and educational technology, security and privacy would be important issues that need to be considered. However, security and privacy are the main features of blockchain technology, the risk of malevolent attacks cannot be ignored (Bdiwi, et al., 2017). Because licensing and issuing students' educational credentials and certificates is done online, thereby there would exist the risk of forging documents and transcripts as well as professional career would be at risk (Zheng et al. 2017). To ensure privacy and security, however, blockchain technology is equipped with public and private keys, it cannot guarantee transactional privacy, because data of each public key are publicly visible (Farah et al., 2018).
2. One of the crucial issues that need to be handled in education systems when using blockchain is slow speed blockchain transactions known as the blockchain's scalability problem (Han et al., 2018). They believed that the block size within blockchain technology increases as a result of a) substantial increase in users, B) transactions continue, and record grows. In the education system, the block size increases as a result of existing plenty of data to keep track of students who constantly move from grade to grade as well as school to school. The other reason why the speed of blockchain transactions decreases is that every transaction requires peer-to-peer verification that can become time-consuming as the number of blocks increase (Zheng et al., 2018). Therefore, this problem may hinder blockchain development in education, then scalability concerns must be effectively addressed before the blockchain can be adopted on a wide scale in education.
3. Generally, it is quite hard to evaluate some learning activities and learning outcomes through the pre-programmed smart contract without human intervention. Since some learning behaviors need to be reviewed by the instructors subjectively such as essays

and classroom presentations (Chen et al., 2018)?

4. Via educational blockchain system, all students' educational data will be integrated and recorded into blockchain ledgers. As a result of such immutability feature of blockchain technology, it would be impossible to modify educational records for legitimate reasons for some students (Chen et al., 2018).
5. Blockchain is an emerging technology that needs to integrate with the legacy system, that is, it needs to be compatible with older computer systems or applications that is no longer efficient. However, the costs of this integration and implementation can be very high. What's more, this implementation cost, transaction cost of many techniques of blockchain technology is also very high (Farah et al., 2018). Without managing this development and operational cost, it will be difficult to use this blockchain technology in traditional education systems (Purdon and Erturk, 2017).
6. Standards are a particularly thorny and complicated issue for blockchain technology in the education system. Each education institution has its way to store and manage student data, as a result, once blockchain adoption increases, different new standards would be defined by different institutions, with the potential for chaos. Standards to be developed include an education industry taxonomy, metadata, data privacy, accessibility, geo-specific data storage policies, data-exchange frameworks for credits, qualifications, data-access governance and rules, etc. (Rudder, 2018).
7. Immutability feature of blockchain technology would also cause some problems. In blockchain, once is placed on it, they cannot be edited or modified unless everyone agrees to change the content of the ledger. This immutable nature of blockchain technology can affect its useful functioning as it does not allow any change or modification which is often required (Mitchell et al., 2019).
8. Blockchain technology is nascent and has entirely new terminology, so it is difficult to understand for education field users. Another problem with blockchain technology is the poor usability of its products. There is a need to improve the usability problem by making good

designs and easy terminology in the education sector (Hori, et al., 2018).

### 3. Conclusion

In this study, we decided to cover all possibly relevant primary studies by using a systematic literature approach. By exploring and examining all the features of blockchain, we have presented suitable solutions to deal with education-related problems in a precise way. Since this technology is in its infancy, so, it still has to go through an evolutionary process. In the future, it is believed that a better review could be written as the world is moving towards innovation and the people are becoming more technology-oriented.

By the way, after reviewing more than 30 articles, it was structured around some major issues: applications, benefits, and challenges, and its effect on education in Iran. The study yields several findings. First, it indicated that blockchain technology is mostly used to issue and verify academic transcripts such as credentials, certificates, to share students' competencies and proficiencies, and learning achievements, and to evaluate their professional abilities. Second, it shows that blockchain could bring significant benefits to education including providing a secure platform to share students' data, restricting and controlling the access of the stored records for both students and teachers including transcripts, diplomas, or credentials, lowering cost, and enhancing trust and transparency. As a matter of fact, as mentioned before, today in education systems, especially in Iran, paperwork is rampant, and many employees archive offices are busy holding storing documents, certificates, and etc. But blockchain technology can eliminate the need for such workforce and saves energy and costs. Third, it illustrates that the use of blockchain technology will be accompanied by some potential drawbacks and challenges. Therefore, managers and policymakers should consider these indispensable challenges related to security, privacy, cost, scalability, and availability before adopting the technology.

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