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Blockchain In Education

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ABSTRACT

This paper discusses the opportunities and challenges of applying blockchain technologies in the education sector. The key blockchain-in-education applications discussed are the digitalization and decentralization of educational certifications and the enhancement and motivation for lifelong learning. Additionally, market adoption and innovation challenges highlight that blockchain-in-education is a relatively immature innovation that governance bodies within educational institutions often disregard or perceive cautiously.

Keywords: Blockchain technologies, digitalization, decentralization, motivation

Blockchain has been extensively discussed as the foundation technology behind cryptocurrencies and lately as a data storage opportunity that can generate significant, beneficial impact in previously unexplored industries such as manufacturing, healthcare and education. The paper will explore two key questions. First, how can blockchain technology improve the performance of educational institutions and their students' learning? This question will analyze three different segments that may benefit from blockchain solutions: (1) educational organizations (*e.g.*, universities, start-ups, NGOs) that may be looking for ways to enhance the efficiency and security of students' data storage and management; (2) learners who may benefit from more engaging, reliable, and sustainable ways to accumulate, attest, and share knowledge; (3) employers who are looking for reliable, secure methods to assess the validity of students' skills and certifications. This paper will discuss the incentives, fears, and overall goals of

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these three parties and analyze blockchain as a solution that may generate both individual and collective value through educational applications.

What is blockchain?

Blockchain is an immutable, decentralized database — a chain of "blocks" which store information such as transactions' dates, times, amounts, and/or participants (participants on the blockchain are usually not personally identifiable). There are different types of blockchains: public, private, and permissioned.

A pubic blockchain allows anyone to join and contribute to the network. This way, public blockchains are valuable in that they provide truly decentralized, democratized and authority-free operations. Unlike public blockchains, permissioned blockchains only allow verified participants, such as the members of an organization, who are invited and validated before joining the network. The third type of blockchain is private; private and permissioned blockchains are similar, but a difference between them is that private blockchains are owned and maintained by a single organization.

There are multiple mechanisms that ensure the security of a blockchain. For instance, each block within the blockchain stores a hash of the previous block. A hash function takes an input of variable length and produces an output of fixed length. This way, hashing within the blockchain (*i.e.*, hash chain) makes it very difficult to change previous blocks, thus ensuring immutability. Additionally, the miners who add blocks on the blockchain are incentivized to ensure the integrity of the network by disproving any malicious transactions.

The state of blockchain in education research

It is worth noting that the use of blockchain in education is still in its incipient phases, which affects the access to and the quality of available research on the topic. Although the volume of literature on the application of blockchain to education has been increasing in the last few years, it is still fragmented, and no systematic review has yet been conducted on the topic. Similarly, "today's blockchain technology may not be evolved enough to scale for all use cases. This is a particular concern for the education platform use cases. Given that blockchain exploration in the context of the education industry is so recent, many of the currently influential blockchain-in-education initiatives have not yet been widely researched and documented.

BLOCKCHAIN IN EDUCATION

Empowerment for learners (self-sovereignty)

Through blockchain, data (*e.g.*, credentials, skills learned, etc.) associated with students' identity

is not owed by a central administrator such as a university, but by the student. Students have an opportunity to store their lifelong learning data (both from inside and outside of classroom), fully own it and control who has access to it (*e.g.*, employers). This way, learners can prove that the credentials in their resumes are accurate and have more control over what can be accessed by their employers.

It is worth noting that even when students benefit from blockchain "wallets" where they can store all their learning data and share it with diverse parties (students being complete owners of their identity-related data), they still benefit from the support of their professors, thus not being alone in their learning journeys.

Security and efficiency enhancement for educational institutions, businesses, and learners

Blockchain has the potential to ensure the identity, privacy, and security of students' data. As shown earlier in this paper, blockchain offers security and validity by ensuring immutability through its hash chain. For instance, students cannot alter past educational certification stored on the blockchain, while they may easily do that with paper records. Additionally, privacy is ensured through blockchain not storing the data, but rather a hash of the data. Optionally, the data may also be encrypted before being stored on the blockchain.

In terms of efficiency, diverse blockchain-powered efficiency applications that include record-keeping uses such as digital credentials and intellectual property management, streamlining of diploma verification and fast and reliable student payments. These applications save money and time not only for educational institutions, but also for employers and individual learners.

Trust and transparency integration

Blockchain ensures that students cannot alter their grades, degrees, and certification, thus offering employers the guarantee that the job applicants indeed have the necessary skills to succeed in the workplace. Thus, blockchain becomes a "trust anchor of one truth for credentials". Additionally, this anchor also offers the opportunity to create better matches between job seekers and employers. More broadly, as distributed ledger technologies support learning and secure academic records, they enhance the relationships among "colleges, universities, employers, and their relationships to society" through the integration of trust and transparency in the skills transactions and sharing processes.

Applications of blockchain in education

In their systematic review of blockchain-based applications in education, Alammary, *et al.* (2019) highlight twelve categories of applications.

1. ***Certificates and identity management:*** Devine (2015) argues that through blockchain, students' academic records become public and easily shareable with employers and universities for further personal development opportunities. This way, "the accredited educational timeline could be used to make projections of future potential based upon individual student learning histories". This application benefits students, by offering them an empowering tool to track and share their academic progress, but also employers, who can rely on accurate, true representations of students' potential based on academic achievement (trusted verification).

2. ***Enhancing and motivating lifelong learning:*** Blockchain also has multiple applications within the educational process — making teaching and learning more engaging and fun.In this context, Devine (2015) claims that students and teachers show "frustration with many of the standard online learning tools", which fail to effectively engage learners. Therefore, he explores blockchain's Open Source framework as a potential tool that may "provide improvements or enhancements to the existing online teaching and learning experience".

The scalability challenge

The scalability challenge is the "slow speed blockchain transactions" challenge. Educational systems have large amounts of data collected on many students, which leads to an increase in blocks sizes. As the number of blocks becomes larger, transactions on the blockchain require more time given that each transaction requires peer-to-peer verification (*e.g.*, Bitcoin technology can only handle three to seven transactions per second). Thus, scalability may be a significant impediment when blockchain-in-education solutions are explored and potentially adopted on a wide scale.

Another potential challenge that may arise with scalability is that Proof of Work (PoW), the popular consensus protocol, wastes significant amounts of electricity energy, as highlighted by Zheng, *et al.* (2017). For instance, it is widely known that within one year, the BitcoinPoW takes the amount of electricity needed to power a country like Switzerland.

It is worth highlighting that a key, first step that must be taken when analyzing the challenge of blockchain scalability within education is deeply understanding the nature (*e.g.*, technical implications, market adoption aspects) of each blockchain-in-education solution. Once this is accomplished, suppliers of such solutions may decide whether scalability is indeed an issue or not, based on the type of educational application they develop. For instance, for credentialing, the volume of transactions on the blockchain may be low and thus scaling may be a minor issue in such a context. However, in the context of transacting educational tokens to motivate lifelong learning or paying for tuition fees on the blockchain, scalability may be more of an issue, given the relatively low number of transactions per second currently enabled.

Data privacy and security

As Alammary, *et al.* (2019) highlight, ensuring privacy while providing security on the blockchain is very difficult to achieve, yet it is crucial especially when a student's career may be at risk (educational credentials and certificates). Beyond the challenge of guaranteeing transactional privacy through public and private keys, the problem of having transactions visible to everyone who has access to the blockchain should also be considered, since this data may be collected and made public elsewhere. However, in order to overcome these issues, data may be kept on the blockchain in encrypted form. Another option would be to keep the data off the blockchain and only store a hash of that data on the blockchain.

The market adoption challenge

Multiple educational institutions remain reluctant towards adopting blockchain technologies. Some of the reasons behind this lack of trust may consist of the lack of necessary knowledge and skills on how to manage students' data on a blockchain platform. This shows that the first step in successfully integrating blockchain solutions within educational institutions may be educating school administrators on how to apply and maintain such applications internally. Thus, raising awareness and educating academic governance bodies about the benefits, implementation, and maintenance of blockchain-in-education solutions is a key first step in generating market adoption in the higher education globally.

The innovation challenge

It is to be claimed that the blockchain technology is immature and rapidly changing, which often causes blockchain projects to be "prone to failure and abandonment with upward of 90 percent never coming to fruition". Because of that, researchers often claim that the mentality when approaching blockchain-in-education solutions should be one of a pilot mindset; all the parties involved in the blockchain education process should carry careful risk analysis on an ongoing basis.

A vision for the future

It is hard to predict how and whether blockchain will have a significant, sustainable impact in education. lifelong education is becoming increasingly necessary in a world driven by fast-paced technological progress, the need for blockchain-backed credentialing may increase as well. On the other side, suppliers of blockchain-in-education solutions such as the Digital Credentials Partnership aim to build ecosystems of educational institutions that use standards that they define. However, they are also aware of the necessity, yet difficulty, of building sustainable business models and market adoption strategies in order to ensure that their visions come to life.

Overall, the world has transitioned from perceiving blockchain as the key technology behind cryptocurrencies to a technology that has potential in new industries such as healthcare and education. While the technology has seen some successes in fields such as supply chain, it is still in an incipient, "prototyping" phase in the education industry. In order for blockchain-in-education solutions to generate beneficial impact at scale, the private sector and the public sector must unite and ideally coordinate their efforts to test, research, develop, implement, and fund such innovations.

Additionally, it is worth noticing that blockchain should not be perceived as a threat or replacement for educational institutions, but rather as an innovative technology that can provide value across a wide range of educational processes — making learning more engaging and effective, cutting down costs, improving trust, and providing enhanced security and privacy.

CONCLUSION

This paper discussed key benefits of applying blockchain in education, such as empowering learners, enhancing security and efficiency for educational institutions, businesses, and students, and generally integrating more trust and transparency within transactions in our society. While analyzing applications of blockchain in education, the study focused on certification and identity management initiatives and applications that motivate lifelong learning. In parallel, challenges were discussed across a wide range of areas: legal, scalability, data privacy and security, market adoption, and innovation.

The goal of this paper was to compile useful insights that may guide those who try to answer an essential question. Can blockchain improve the educational process? This is a broad, tough, and intimidating question to answer, but this analysis provided some guidance in treating this fundamental query.

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