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Blockchain and Micro-Credentials in Education

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Abstract: Micro-credentials can provide easily accessible and transparent evidence of skills or knowledge that have been certified by an authority, based on small units of learning. The recognition and transfer of credits is becoming essential, as an increasing number of students are studying at different institutions, often at the same time, online or in traditional settings. "Blockchain is a type of database that stores data in an "open, peer-to-peer (P2P) network that favors communal functionality in lieu of a centralized controlling entity" (Columbia Engineering Bootcamps, 2021, para 5). The development of blockchain (https://theconversation.com/demystifying-the-blockchain-a-basic-user-guide-60226) holds promise of becoming a useful facilitator for supporting the storage and dissemination of micro-credentials on a global scale. Besides providing effective data security and privacy, blockchain can also facilitate maintaining and disseminating credentials, while ensuring that access is readily available for students under their control. Because of its immutability, blockchain can be used to confidently attest to students' accomplishments and is therefore particularly appropriate for micro-credentials.

Keywords: micro-credentials, blockchain, education, credentials, qualifications

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Blockchain et micro-certificats dans l'éducation

Résumé : Les micro-certifications peuvent fournir des preuves facilement accessibles et transparentes de compétences ou de connaissances qui ont été certifiées par une autorité, sur la base de petites unités d'apprentissage. La reconnaissance et le transfert des crédits deviennent essentiels, dans la mesure où un nombre croissant d'étudiants étudient dans différents établissements, souvent en même temps, en ligne ou dans un cadre traditionnel. "Blockchain" est un type de base de données qui stocke des données dans un "réseau ouvert, de peer-to-peer (P2P) qui favorise la fonctionnalité communale au lieu d'une entité de contrôle centralisée" (Columbia Engineering Bootcamps, 2021, para 5). Le développement de la chaîne de blocs (https://theconversation.com/demystifying-the-blockchain-a-basic-user-guide-60226) promet de devenir un facilitateur utile pour soutenir le stockage et la diffusion des micro-certifications à l'échelle mondiale. En plus d'assurer efficacement la sécurité et la confidentialité des données, la chaîne de blocs peut également faciliter la conservation et la diffusion des titres de compétences, tout en garantissant un accès facile aux étudiants sous leur contrôle. En raison de son inviolabilité, la chaîne de blocs peut être utilisée pour attester en toute confiance des réalisations des étudiants et s'avère donc particulièrement adaptée aux micro-certifications.

Mots-clés : micro-certification, chaîne de blocs, éducation, titres de compétences, qualifications

Introduction

Micro-Credentials

Micro-credentials provide easily accessible and transparent evidence of skills or knowledge certified by an authority, based on small units of learning. Often issued as badges, students can use micro-credentials as proof of their qualification for employers and others. They can also use micro-credentials to accumulate credits, otherwise known as *laddering*, towards a specific qualification. In this way, micro-credentials can lead to more formal credentials such as certificates, diplomas, and degrees. Students can use micro-credentials as evidence when transferring their credits from one institution or organization to another in the same country or internationally. Higher-education institutions can use micro-credentials to track student work, progress toward goals, and credentials earned. In turn, students can use their micro-credentials to monitor their academic progress, share credentials earned at their previous and current institutions, and keep records of the informal learning activities they have accumulated (Contact North/Contact Nord, 2018). The accelerated changes made by many institutions towards hybrid and other forms of learning as a result of COVID-19 have increased the use of micro-credentials and their benefits.

Blockchain Technology

Blockchain is a digital ledger distributed on a network. The ledger is hosted on geographically distributed networks of databases that store information. The blocks in the chain are secure, verifiable, and permanent.

Blockchain technology holds promise of becoming a useful facilitator for supporting the storage and dissemination of micro-credentials on a global scale. The digital ledger created through a blockchain cuts out the middle party. With blockchain technology, there is no centralized governing authority and no need for an intermediary to control transactions between individuals or institutions. The transactions are secured with encryption, verified, and recorded by the network nodes. Blockchain can be used to facilitate trust relationships among two or more people or institutions without the need for a central authority. The original records cannot be deleted or changed, and all transactions can be easily traced because each new block in the chain is time-stamped. In this way, blockchain supports secure decentralized networks of information. Data loss is not possible when no single node holds all the information (Sun et al., 2018). Thus, authentication can be achieved with enhanced performance and reliable scalability. A blockchain can be used by institutions and students to track the student's progress and their earned credentials, while also ensuring privacy.

Using Blockchain Technology for Micro-Credentials

Bitcoin is the best-known implementation of blockchain, but blockchain technology is not limited to financial transactions. Other information can be housed in a blockchain including micro-credentials. Unlike bitcoin, educational uses of blockchain require permission from the owner of the data. Others can only view micro-credentials housed in a blockchain if they have permission.

Employers want to know what credentials job applicants have, which institution(s) granted those credentials, and when. All of this is stored as a permanent record.

Discussion

Benefits of Blockchain Technology

Blockchain in education is in the very early stages of adoption. Nevertheless, experts have highlighted the primary benefit of blockchain in education, which is to store and share micro-credentials (Casey, 2019; Clark, 2016; Pianko, 2018; Sharples, 2016). Benefits accrue to educational institutions that use blockchain. Blockchain enhances the efficiency and security involved in storing and managing data, thereby allowing students to attest to their knowledge and employers to assess the validity of applicants' skills. Unlike the present norms for institutional certification, blockchain data is associated with the individual student, not the institution. With blockchain, the student owns their data and has full control over who can access it. Because students cannot alter the information in the blockchain, the legitimacy of their grades, certificates, and diplomas is ensured (Steiu, 2020).

Credit Transfers

Belshaw (2016) contended that "blockchain plus badges equals rocket fuel for verified trusted credentials." Credit transfer among institutions is supported by more than badges. Other micro-credentials and open standards also support credit transfer. Xianmin et al. (2017) proposed the blockchain degree-certification system that led to the decentralization of educational processes. The blockchain

can hold and protect verified and untampered certificates and examination results for students with time-stamped dates.

It is becoming essential for students to have their credits recognized and transferred. An increasing number of students are studying at more than one institution, often at the same time, and using both online and traditional settings. Because of its immutability, blockchain can be used to confidently attest to student accomplishments. In contrast, a paper diploma or certificate may not be fully trusted. Institutions and employers typically approach institutions directly for an original paper copy. With this system, institutions control both the issuing of credentials and the credit transfer process. The process can be very cumbersome and inefficient. As more and more students gain credentials from multiple institutions and even private organizations, this process of going back to the source becomes increasingly untenable. The student needs control of the process used to share their credentials and blockchain provides a solution (Raths, 2016).

The Traditional Transcript System

The transcript systems traditionally used by institutions can be cumbersome and inefficient. If an institution is uncertain about a student's credentials or unable to provide a certificate upon request, this can be a serious impediment to the student trying to advance their career. Digital systems and blockchain provide the basis for an effective system for storing and distributing transcripts in a secure and accessible fashion (Nazaré et al., 2016). Pianko (2018)

refers to digitization as "the death knell for the embossed transcript." With blockchain, students can acquire "stackable credentials;" in other words, they can follow a pathway to greater competencies by using micro-courses. The micro-courses can be accumulated into a course equivalent with official credit recognition. The U.S. Department of Labor describes these stackable credentials as "a sequence of credentials that can be accumulated over time to build up an individual's qualifications and help an individual move along a career pathway to further education" (U.S. Department of Labor, 2010).

Student Control of the Blockchain Process

Mikroyannidis et al. (2018) have explored how Smart Blockchain Badges can be used for data science accreditation. The process begins when the trusted institution issues the certificate and creates a blockchain. Next, the student sends a Public Key to the institution, requesting that a transcript be sent to a potential employer. Then, the institution adds a Hash Certificate to the blockchain. Before the certificate is forwarded to the employer, it is shared on different nodes and verified (Holotescu, 2018). Students keep the Public Keys for their credentials in an offline wallet. The offline wallet helps students create and share their Public Keys and delete them if they will no longer be used. There remains an ongoing need for a high level of trust in the institution that issues the certificates. Also, each certificate is only useful when it is tied to a specific person, so maintaining the privacy of the data is essential.

The process gives students a high degree of control. With blockchain, ownership of the data rests with the individual, not the institution. The credential is preserved in blockchain, thus reliably ensuring the validity of the record. Blockchain can also be used to collect micro-credentials or badges to be submitted to institutions for prior learning assessment. However, should students be able to choose which parts of their history they share? Should students be able to omit blocks of information about themselves that they do not feel are appropriate or could damage their reputation? Should they be able to create different narratives for diverse purposes? Should they be able to highlight and hide their experiences? The immutability of blockchain causes its own problems, especially when mistakes cannot be erased. Watters (2016) asked, "What happens if a student wants or needs a fresh start?"

The Impact of Blockchain on Educational Institutions

As we have shown, blockchain provides a platform for awarding qualifications, licensing, and issuing accreditation to manage student records. Blockchain also provides a permanent distributed record of the educational institution's reputation and output. Blockchain gives students more control of their academic records, which has the capability of disrupting and further democratizing education. Rooksby and Dimitrov (2017) implemented an Etherium blockchain system for student grades and cryptocurrency in a university. They found significant "tensions" between the centralized and distributed systems,

including those of trust mechanisms, openness boundaries, and procedural values.

Camilleri, Inamorato dos Santos, & Grech (European Commission, Joint Research Centre, 2017) contend that certification is only one of the activities open to disruption by blockchain. They claim that blockchain is capable of disrupting "any field of activity that is founded on time-stamped record-keeping of titles of ownership." This includes the following educational fields: qualifications, licensing, accreditation, records management, intellectual property, student management, and student payments. Other educational systems open to disruption by blockchain include big data analysis, intelligent educational platforms, and networked learning communities (Xianmn et al., 2017). Most vulnerable are institutions maintaining antiquated, opaque, and hierarchical centralized systems, regardless of whether their systems are analogue or digital (Levin, 2016b). Levin (2016a) envisions a role for blockchain in tracking institutional assets such as textbooks, equipment, and furniture. He claims that, "Done right, it could even help slay the 'waste, fraud, and abuse' dragon."

State of the Art

There are several implementations of blockchain in education. One of these is Stacks (https://www.stacks.co/), formerly Blockstack, which adopted the Proof of Transfer Protocol (PoX). This protocol could be a key tool in fully realizing a user-owned Internet in a secure way. The Massachusetts Institute of Technology (MIT) led creation of the Digital Credentials Consortium on using blockchain. Sony

is developing an entirely new open and secure educational infrastructure using blockchain (Sony, 2017; Sony Global Education, 2020). University College London's, Centre for Blockchain Technologies is registering and verifying their degrees by blockchain (University College London, 2018). The European Union Joint Research Centre, which studies student mobility and transfer credit issues, claims that blockchain will end paper-based certificates, increase learner control, and reduce costs, but only if open standards are adopted (European Commission, Joint Research Centre, 2017). Holberton School of Computer Science and Software in San Francisco claims to be the first in the world to deliver certificates using blockchain (Barbier, 2015). The small European country of Malta has embarked on a major initiative to become a "blockchain island," creating a supportive legal environment for blockchain implementations, and supporting research into blockchain applications in finance, healthcare, and education. Diplo-Me intends to create a blockchain-based international ecosystem for qualifications and certifications that focuses on individual learners (Lantero & Marchionni, 2019). Sharples and Domingue (2016) propose a blockchain to support the academic reputation of faculty. Others are creating virtual worlds and decentralized lands using blockchain-based platforms like Open Sea (https://opensea.io) and Super Rare (https://superrare.com). Cryptovoxels (https://www.voxels.com) is a fully virtual world based on Ethereum blockchain (Vass, 2020).

Moreover, micro-credentials shown on blockchain badges can be used in extremely high-stakes situations. A blockchain could be used to prove an indisputable connection between the content provided and the micro-credential

(Belshaw, 2015). Alternatively, as Belshaw explains, "blockchain plus badges equals rocket fuel for verified, trusted credentials." This allows for rock-solid credentialing on a level usually reserved for international banking (Belshaw, 2016).

Challenges of Blockchain

In considering blockchain as a large system, users should be aware that it could be vulnerable to unexpected failures. The persistence of blockchain could become a hindrance. For example, if unwanted, fake, or illegal content is accidentally or maliciously added to a blockchain, it cannot be removed. There is also a lack of talent with blockchain skills. Implementing blockchain in educational environments has its own challenges: the difficulty of changing established systems, legal questions on data ownership, limitations in storage space, and privacy protection. The slow speed and more especially the high-energy cost of creating and maintaining blockchain are also concerns. However, Sedlmeir et al. (2020) argue that this is not a given and can be alleviated with compromises between performance, security, and energy consumption. Although there is evidence that institutional blockchains consume more energy than centralized systems, private blockchains consume "many orders of magnitude less than that of cryptocurrencies" (Sedlmeir et al., 2020). Sedlmeir et al. argue that the additional energy cost of switching to blockchain from a centralized application is not excessive. Compared to cryptocurrency, the energy consumption of blockchains is negligible. However, there is a shortage of useful blockchain applications that can be adopted or adapted for specific uses. Also, with

blockchain, there are real risks of regulatory interventions by governments, and hacking by unauthorised individuals and organizations.

Conclusion

Blockchain is particularly appropriate for micro-credentials. Besides providing effective data security and privacy, blockchain facilitates the maintenance and dissemination of credentials. Blockchain ensures ready access for students and data that is under their control. Pereira (2016) considered blockchain the perfect infrastructure for an ideal education system. He argued that blockchain needs education more than education needs blockchain but recognized that blockchain can provide real value to "those at the top and at the bottom of the power structure."

Educational institutions and companies can use blockchain to create a traceable and usable record of their students' accomplishments. Blockchain can also ensure the sustainability and accessibility of official credentials. All the records are secured and permanent (Jones, 2018). This can become very important if an institution changes its name or even disappears. Xianmin et al. (2017) take the experience of blockchain in finances to suggest other modes of blockchain application in education besides credentials. These include systemic decentralization, big data, intelligent platforms, self-organization, and learning community development.

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