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KHÁM PHÁ TIỀM NĂNG BLOCKCHAIN TRONG GIÁO DỤC: MỘT CÁCH TIẾP CẬN ĐỔI MỚI

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TÓM TẮT

Những tiến bộ công nghệ hiện đại như mạng 5G, các thiết bị thông minh và internet vạn vật (IoT) đã tạo ra một bối cảnh mới, nơi an toàn trong luồng dữ liệu là yếu tố bắt buộc. Trong bối cảnh này, công nghệ blockchain nổi bật như một giải pháp tiềm năng với khả năng cung cấp nền tảng an toàn và bất khả xâm phạm của các hệ thống. Blockchain là một sổ cái phân tán, không chỉ phục vụ giao dịch tài chính mà còn có thể lưu trữ bất kỳ loại dữ liệu nào một cách an toàn và bền vững. Mặc dù blockchain khởi đầu từ tiền mã hóa (Bitcoin), nhưng tính hữu ích của nó đã mở rộng sang nhiều lĩnh vực như lưu trữ dữ liệu, chứng nhận sản phẩm, y tế, khoa học và giáo dục. Trong lĩnh vực giáo dục, blockchain được sử dụng để cấp và lưu trữ chứng chỉ, hỗ trợ quản lý bằng cấp, đánh giá kết quả học tập, xây dựng hồ sơ học thuật và quản lý quy trình đào tạo. Bài viết này phân tích các tính năng và lợi ích của blockchain, trình bày các ứng dụng hiện tại trong giáo dục. Đồng thời thảo luận các lợi ích và thách thức khi triển khai công nghệ này trong lĩnh vực giáo dục.

UNLOCKING THE POTENTIAL OF BLOCKCHAIN IN EDUCATION: AN INNOVATIVE APPROACH

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ABSTRACT

Modern technological advancements such as 5G networks, smart devices, and the Internet of Things (IoT) have established a new digital landscape where dataflow security is a mandatory factor. In this context, blockchain technology stands out as a promising solution with the ability to provide a secure and invulnerable platform for systems. Blockchain is a distributed ledger, not only serving financial transactions but also securely and sustainably storing any type of data. Although blockchain originated from cryptocurrency (Bitcoin), its applicability has expanded into various fields such as data storage, product certification, healthcare, science, and education. In the field of education, blockchain is used to issue and store certificates, support degree management, assess learning outcomes, maintain academic records, and oversee training processes. This article analyzes the features and benefits of blockchain, presenting its current applications in education. At the same time, it discusses the benefits and challenges of implementing this technology in the field of education.

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1. INTRODUCTION

1.1 Cryptocurrency and Blockchain

The issue of transaction security is currently a major concern when financial transactions are carried out online between individuals and organizations or enterprises. Banks and other financial organizations are in charge of making sure that traditional transactions are legitimate and secure. However, this not only incurs significant costs that the parties involved must bear, but also allows intermediaries to record and completely control every transaction. After Lehman Brothers failed in 2008, the concept of bitcoin originally surfaced as a way to get around capital flow limitations. The initial cryptocurrency to be introduced was Bitcoin, with the aim of creating an alternative electronic transaction method that does not rely on intermediaries, while still ensuring direct transactions between users are safe and beyond doubt. The creation of Bitcoin is attributed to Satoshi Nakamoto—a pseudonym for a group of experts in information technology and economics— who were the first to outline the essential ideas for creating an e-commerce system free from financial institutions and unaffected by or manipulated by the government. Based on a peer-to-peer network, this system can guarantee secure and anonymous transactions by generating a public transaction history that is impenetrable by attackers through the use of the "proof-of-work" consensus method [1].

But the development of Bitcoin using blockchain technology existed beforehand, and this technology was not developed solely for the purpose of cryptocurrency. D. Chaum originally presented blockchain in its initial version in 1982. Chaum put forth a comparable transfer protocol, which S. Haber and W. Scott Stornetta expanded upon in 1991 by outlining the construction of an encrypted data chain [2]. It is important to clarify that Bitcoin and cryptocurrency in general, along with blockchain technology, are two completely different concepts. Blockchain is the system that supports, validates, authorizes, records, and guarantees the security and legitimacy of transactions, whereas cryptocurrency provides a way to carry them out.

1.2 The definition of blockchain

Blockchain is a data-containing chain of digital blocks. Each block in this data chain is securely connected to the one before it thanks to encryption techniques. Because of this, if someone tries to alter a block, the data chain will not be legitimate until all subsequent blocks are likewise altered; otherwise, all blocks after the altered block will be invalid [3].

To put it simply, blockchain is a distributed ledger that stores and verifies data. This ledger is open and unchangeable, thereby ensuring that all recorded data and transactions are valid and indisputable. The key distinction between blockchain and conventional ledgers or databases, however, is that individuals known as "nodes" maintain it rather than a central authority. Therefore, the ledger on the blockchain platform is not located in a single position but is distributed, maintained, and synchronized by all nodes, ensuring that all nodes with the same ledger are updated identically. When a transaction is executed, such as a money transfer, it is not confirmed by a central authority holding the transaction ledger (bank) but verified by all nodes (users) holding the same registry and updating it simultaneously. Thanks to this, there is no need for a trusted intermediary like a bank, as user trust is based on automatic transaction verification through software. In a peer-to-peer network of interconnected computers (nodes), data is exchanged. The system is more secure and legitimate the more nodes there are. This model guarantees that the security is better than that of the client-server system since the data is safely safeguarded and the system does not crash in the event of a node failure.

The four primary forms of blockchain are: Consortium *(permitted, controlled by a collection of organizations),* Private *(permitted, controlled by an authority),* Public *(permissionless, no central authority),* and Hybrid *(controlled by a single organization but with some permissionless processes)* [4]. Data in a public blockchain, like Bitcoin, can be written or accessed by everyone. In contrast, only those who are identifiable and trusted—such as those involved in internal transactions within a firm or organization—have access to the ledger in a private blockchain. The software of any particular blockchain platform dictates the kind of data as well as how the data is captured and validated.

1.3 The advancement of blockchain

Since its first application in the cryptocurrency Bitcoin, blockchain technology has been continuously improved by computer scientists, cryptography experts, mathematicians, and financial specialists. Blockchain 1.0 is mainly used for cryptocurrencies, foreign exchange payment systems, small-value transactions, and simple cash transactions [5].

An important first step in development was the introduction of smart contracts by the second-generation blockchain system [3]. Smart contracts are small computer applications that execute specific conditions and criteria (essentially a series of "if this then that" statements) before registering them on the Blockchain, and this process occurs without the need for third-party intervention [6]. This allows Blockchain technology to expand its applications to financial instruments such as loans, bonds, and other banking tools instead of being limited to cash transactions. Since then, Blockchain 2.0 has been applied to fields such as real estate, stock trading, smart contracts, and other financial sectors [7]. The next generation is Blockchain 3.0, which uses decentralized storage and communication, aiming to develop applications in fields such as e-government, healthcare, science, culture, and the arts [5-6]. The development of blockchain can be divided into three stages: Blockchain 1.0 represents the era of digital currency, Blockchain 2.0 marks the emerge of the digital economy, and Blockchain 3.0 reflects the expansion into the digital society [8].

Currently, research continues with Blockchain 4.0, promising to provide solutions and approaches that help Blockchain technology meet the requirements of businesses, especially the demands of the "Fourth

Industrial Revolution." Blockchain 4.0 aims to support supply chain management, financial management systems, workflow management, and asset management [7].

2. RESEARCH METHODOLOGY

Research on the use of blockchain in education has developed significantly in recent years, as studies propose systems to meet a range of needs in various educational fields. The European Commission's Joint Research Center (JRC) studies the prospects that blockchain technology offers for education, concluding that blockchain-based systems can be used to permanently secure certificates, automate credit recognition and transactions, maintain lifelong learning passports, verify multi-stage certification issuance, track intellectual property, confirm or receive payments from students, and provide student funding. [9]. In this article, a search was conducted on IEEE and Google Scholar to collect and analyze the most cited scientific papers from 2015 to the present. Approximately 64 publications related to the application of blockchain in education were selected for study. From the results of the above research and with the aim of providing an overview of ongoing studies, some of the most notable applications in the field of education are presented in the next section.

3. BLOCKCHAIN APPLICATIONS IN EDUCATION

3.1 Issuance and storage of diplomas and certificates

The issuance, storage, verification, and sharing of certificates and degrees is the most important area in the development of blockchain applications in education, aimed at addressing trust issues in this field [10]. Certificates and personal academic records demonstratean individual's skills and achievements, playing an important role in both education and the labor market: therefore, they need to be stored in long-term and tamper-proof ledgers. [11]. Many researchers believe that the application of blockchain technology can enhance transparency and efficiency [12], achieve decentralization in managing educational credential verification, and thereby reduce diploma fraud [13] as well as certificates forgery [14].

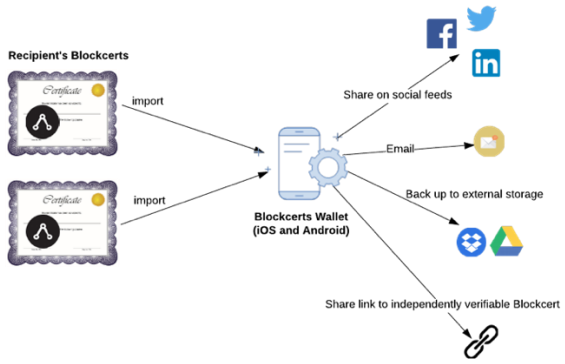

Figure 1. *Illustration of the process of managing and sharing electronic certificates using blockchain technology. Digital certificates (blockcerts) are created and stored on mobile devices, and can then be shared via social networks (Facebook, Twitter, LinkedIn), email, or stored on cloud services like Dropbox and Google Drive.*

The first application of this type was developed in 2014 at the University of Nicosia, Cyprus (UNIC), using blockchain technology to store and verify degrees, as well as manage certificates that students receive from MOOC platforms [15]. UNIC is also the first university to accept tuition payments in Bitcoin [16]. In 2017, the Massachusetts Institute of Technology (MIT) designed Blockcerts (a mobile application accompanied by BlockcertsWallet) based on the Bitcoin blockchain, using open-source libraries, components, and applications to issue and verify digital diplomas and professional certificates [17]. A typical example of the application of Blockcerts is the digital diploma from MIT [12]. MIT is also among the top universities that developed the Digital Credentials Consortium (DCC) - an infrastructure for digital academic achievement credentials in 2018. Blockchain for Education platform is another system based on Ethereum Blockchain that uses smart contracts to issue, verify, and share certificates [11]. The study by Castro & Au-Yong-Oliveira [13] also noted similar solutions based on Ethereum and smart contracts developed at the University of Zurich, the University of Lisbon, and the University of Science and Technology of Ho Chi Minh City (HCMUTE) in Vietnam.

Nespor proposed a blockchain certification platform, allowing higher education providers or employers to issue official certificates to students while ensuring a high level of information security [18]. And Steiu cited several other examples of blockchain-based certification and identity management applications implemented by educational institutions, including systems developed by Southern New Hampshire University and the European startup BCDiploma [19].

3.2 Verify personal achievement

Similar to the issue of issuing certificates or degrees, the recognition of academic programs also plays a significant role in education system. In fact, students can acquire skills and knowledge from both formal education systems and non-formal education programs such as massive open online courses (MOOCs). Blockchain technology can ensure the secure and authentic storage of recognized educational records [15], simultaneously supporting the construction of an electronic profile containing comprehensive information about all the knowledge a person has accumulated throughout their life [16]. This not only helps increase the transparency and reliability of educational certificates but also provides a comprehensive and flexible approach to managing personal educational records in the digital age.

Many universities and large enterprises have proposed recognizing learning as well as issuing badges certifying the knowledge acquired to simplify the process and ensure the authenticity of students' academic achievements. One of the most promising initiatives is the global higher education credit platform EduCTX. This platform is built on the concept of the European Credit Transfer and Accumulation System (ECTS) and aims to provide a reliable digital solution for the credit and ranking system of higher education, which is inherently still manual [20].

Figure 2. *An illustration of the digital badges system and course participation certificates from The Open University. The center of the image is a course participation certificate of an individual, surrounded by digital badges representing completed courses. These badges reflect the skills and knowledge acquired, and can be used to build a personal competency profile in education and career.*

OpenLearn is a system developed by Open University (United Kingdom), based on the public Ethereum blockchain and issues badges for its learning certifications [17]. OpenBadges was proposed by the Mozilla Foundation to create "digital badges containing metadata about skills and achievements." [21]. These badges can represent micro-credentials, certificates, and other types of certifications. OpenBlockchain is another project based on the Ethereum platform developed by the Knowledge Media Institute (KMi) in collaboration with British Telecommunications (BT) [22]. In the experiments, this Institute has applied digital badges to courses on the OpenLearn website and the FutureLearn MOOCs platform [12]. Disciplina is a platform that allows the creation of verified personal profiles based on academic and professional achievements [24]. Liu and colleagues proposed a system for assessing students' professional competencies, helping to connect educational institutions and businesses to share necessary information related to recruitment and industry requirements [25].

3.3 Learning management system security

The security concerns that learning management systems (LMS) and other online learning solutions (MOOCs, web platforms, etc.) may have in the context of higher education, according to researchers, can be resolved by blockchain technology. Blockchain technology should be used in future smart schools to provide security and transparency. For collaborative learning and online learning environments, this strategy—particularly the use of smart contracts—can offer unprecedented degrees of security, trust, and transparency. It significantly increases security and efficiency for both educational institutions and students, and it helps guarantee the authenticity of tests and assessments, certificates, and the storage of data in electronic portfolios, or e-portfolios [26].

To achieve this goal, the applications of blockchain in school management, particularly in record storage, student identity verification, and content security, are being researched by Altinay and colleagues [27]. A reliable online learning framework aimed at securing online learning platforms (LMS), thereby ensuring teaching quality and fairness in assessment, while also boosting the motivation of students and lecturers [28]. U-learning, a well-known learning platform, is made to promote efficient communication between teachers and students in a secure, cooperative learning environment [29]. Additionally, a blockchain-based School Information Hub (SIH) is intended to enhance the educational environment at the school by gathering, analyzing, and reporting data that can aid in decision-making [30].

3.4 Managing competencies and learning outcomes

A system is designed to track how well pupils succeed in their assignments. This method generates a learning block that includes every student's whole academic history [31]. A suggested educational setting that offers pupils immediate assistance and insightful criticism. This setting is intended to improve learning by utilizing a variety of abilities, promoting critical thinking and problem-solving, and fostering improved teamwork and communication [32]. The decision-making system is introduced to test the knowledge and expertise of students. This system was developed to serve the construction of an evaluation, measurement, and management system for students' operational competencies [33]. Last but not least, Purnama and associates suggest Student-Centric Blockchain Learning (SCi-B), a three-part system (E-Course, E-Portfolio, and E-Assessment) that can improve the educational process and raise the validity of student evaluations [34].

3.5 Application of blockchain in language learning

The field of language learning can clearly benefit from the application of blockchain technology, such as creating a "Digital Personal Language Certificate," designing language tests, building a language learning progress control system, or designing and evaluating language courses. Blockchain can be a reliable platform to build an authentication system in schools, providing access to information about the impact of schools on learners' language proficiency. Blockchain can help create a ledger to store the certificates (degrees, grades, training processes) that learners have achieved, including both official certificates (from educational institutions) and unofficial ones (from websites, applications, MOOCs). Any interested company or group can access this information by storing it on a public blockchain. Traditional operations, such the granting of intellectual property rights and payment procedures, can greatly benefit from smart contracts [35].

There is currently very little research on the use of blockchain technology in language learning. Nonetheless, some noteworthy research efforts have been carried out. Blockchain-based online language learning platform to properly and honestly track students' progress in learning English. Using smart contracts, this system can manage students and learning resources while offering four features: querying scores, recording final scores, calculating final scores, and documenting learning behaviors. Teachers can lessen their complicated burden and provide accurate evaluations of their pupils' learning behavior with the use of such a system [10]. the adoption of a blockchain-based pilot course to test the potential of blockchain in course design and assessment at Chinese universities. The study team discovered that rethinking online courses using blockchain technology could enhance instruction and foster confidence among online education stakeholders [36]. Bin Wu and colleagues presented an online English learning platform based on blockchain technology and genetic algorithms with the goals of increasing work efficiency, improving exam fairness and flexibility, and standardizing exam workloads. This system helps to "liberate" lecturers and professors from traditional examination chores by managing tests, question banks, test papers, and grading functions. Furthermore, the system generates English examinations and evaluates the exam's content and difficulty levels [33]. Using Ethereum and smart contracts, Song & Shen have created an online platform for learning foreign languages. This system's modular design makes it appropriate for usage in academic settings and seeks to improve the general efficacy and caliber of online language instruction [37].

In addition to studies on the application of blockchain technology to language learning, a highly encouraging commercial trend is also starting to take shape. With more than 250 million users, English Forward is one of the biggest English Q&A websites. To speed up the learning process and offer a more complete way to engage with teachers, translators, and other English specialists, the website has integrated a blockchain application. According to the organization, this approach can guarantee the simplicity, incentive, integration, and teamwork that the present English Forward community needs. Increased efficiency in monetizing teachers' expertise in a transparent and competitive way, faster and more effective completion of learning activities, easily verifiable and more secure assessments and certifications for teachers and students, and encouraging more companies to adopt blockchain are some of the anticipated benefits that can be attained. Additionally, ensuring widespread adoption of this platform and achieving better financial returns from blockchain technology are also anticipated benefits. and use blockchain technology to improve financial returns on this platform [38].

4. CONCLUSION

Blockchain technology appears to have a lot of potential for use in education, as seen by the systems and applications that have been described. The studies have concentrated on enhancing the quality of online education, assessing and recognizing students, monitoring the learning process and measuring results, and designing and implementing learning activities. Future attention might also be directed toward fields like lifelong learning and vocational education, where there will be a greater need for blockchain-based certification in the years to come. There may be advantages to introducing innovative, safe, and streamlined procedures, particularly with the use of smart contracts. This would guarantee cooperation and partnerships not only between educational institutions but also between teachers and schools, as well as between teachers and students. Last but not least, blockchain can be used to encourage educators and learners by rewarding them for reaching predetermined benchmarks or objectives with badges or virtual money.

Secure data movement and storage are essential in the new world being ushered in by technological advancements like 5G networks, smart and connected gadgets, and the Internet of Things (IoT). Blockchain technology can play a significant role in this new reality because it can lower costs, speed up transactions, and provide the foundation required for systems to operate securely and impenetrably. It can also open up new and creative service and application opportunities.

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