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Blockchain Education: as a Challenge in the Academic Digitalization of Higher Education

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Abstract

Over time, there haven't been many significant challenges to the higher education model. Even if the organization of lectures and learning experiences has changed due to the incorporation of increasingly sophisticated technologies, study themes are still evolving. The work being given here is an analysis of blockchain technology and its potential applications in the field of education, with a focus on the potential for upending the current value chain of academic institutions. Institutions act as central authority for providing and approving student knowledge as well as as a bridge between professors and those who would benefit from it (students). The main advancement of blockchain technology is the unbreakable digital transaction ledger, which can record almost any type of value exchange. They open up new possibilities when paired with other cutting-edge technologies like the internet of things and big data. They provide new opportunities for the decentralized sharing of education and the recording of knowledge and skills when paired with other cutting-edge technologies, such as the internet of things and big data. The end results include a thorough examination of the advancement of blockchain technology for educational purposes and a forecast of potential disruptions for educational institutions. There are currently apps targeted at decentralizing educational institutions using blockchain technology, which is developing at an ever-increasing rate. In the interim, a wider group of adepts continue to adopt the technique.

Keywords: Higher education, Education 4.0, Blockchain

1. Introduction

The world is changing at an alarming rate, introducing novel educational technologies, altering the traditional channels through which education was delivered, and altering the behavior patterns of employees and students.The perfect combination of these elements results in disruption.

The way students learn and behave in a classroom is changing because of technology.The widespread use of mobile devices, automated systems that assist us in our daily activities, access to a vast amount of information on demand, and tools that improve brain performance are just a few of the new technological educational trends [1].

In the past, entering the professional world necessitated possessing a "University Title."This is being questioned in today's world because of the rising cost of higher education, the emergence of alternative credentials that are flooding the market, and businesses demanding proven skills without regard to a particular university title or education [2].

On the other hand, higher education institutions have not changed much over time.The classroom's value chains have not changed, despite the constant introduction of new subjects and technology.They act as intermediaries between professors (knowledge) and students

(recipients), serving as a central authority by providing and validating student knowledge.Combining Blockchain technology with other emerging technologies like the internet of things (IoT) and big data and using it in education can offer opportunities to disrupt today's value chains by decentralizing educational exchange and recording of knowledge and skills.educational institution

2. Literature Review

The rise of cryptocurrencies is made possible by distributed ledger technology (DLT), which makes it possible to digitally transfer value using intricate algorithmic functions.The technology is the subject of rapid research (Fig.1).According to Google Scholar, there were only two academic articles published in 2012 that included the term "Blockchain" in the title.Since then, research has grown at an exponential rate, and Google Scholar searches now return over 2,010 articles with the term "Blockchain" in the title.

2.1 Distributed computing

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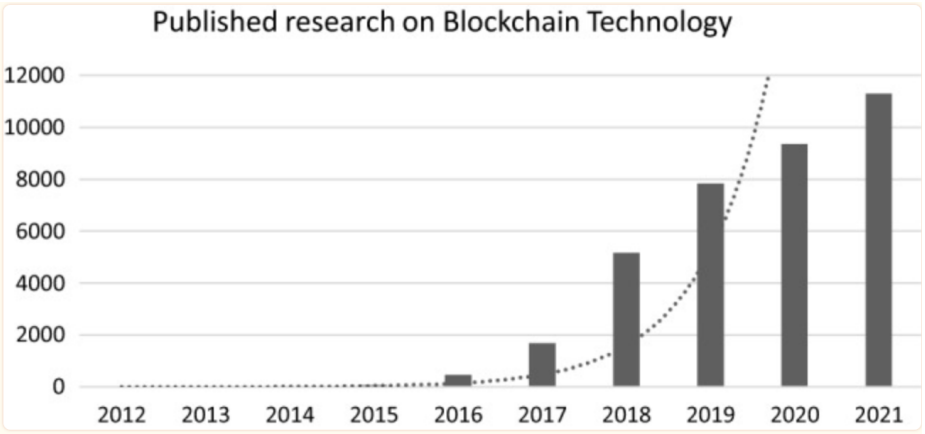

Fig 1. Published Research on Blockchain Technology

Blockchain networks come in three flavors: public, private, and semi-private (consortium). Through public networks, like Bitcoin and Ethereum, anyone with the software may view the Blockchain and possibly add to it. Private networks operate within an organization or consortia in a manner similar to an intranet. A few nodes are responsible for granting access to the network. These networks include Monero [5] and Multichain [4], as examples. Blockchain enables a distributed record of digital events in a chain of linked data, redundantly stored on every participant node, where additional blocks of data are added by consensus of the majority of the participants [8] in order to create a decentralized network in which no third parties control the information. Ripple (2018) is an example of a semi-private network that has a public-based design but is privately run by centralized software ownership [6]. Each form of Blockchain network has a structure that encodes its own set of trade assets and regulations [7]. To exchange assets across the network, users need a crypto wallet, which is local software. The wallet, which may be accessed through a web browser or installed directly on a device [7], offers a single network address and private key. The Blockchain application must be directly installed on the devices used by nodes. This program, which keeps a complete copy of the Blockchain, enables them to write directly into the ledger, validate network data, and synchronize all ledger copies [7].

The Blockchain's validity is constantly checked by the nodes using mathematical protocols to make sure it is the same as all other copies in the network. The version that is used by most nodes is considered to be the official version.This is referred to as "mining," and miners are compensated for their processing power with coins or tokens [10].Hacking or destroying records is extremely difficult with this method.Given that public networks such as Bitcoin and Ethereum already have hundreds of thousands of nodes and are constantly expanding, it would require altering more than half of the network's nodes.Furthermore, it would be necessary to eliminate all global ledger records in order to destroy the Blockchain [7].

Blockchain network's ledger only allows information to be added, resulting in new blocks for each recorded transaction.A chain of blocks is formed when each block is linked to the blocks that came before it in the network;Consequently, transactions can only be added, not edited or deleted [7].

The aforementioned features of Blockchain technology—distributed computing, accurate event tracking, revision by consensus, enduring quality of information, and resilient data infrastructure—lead to a differentiated value proposition that includes self-sovereignty and identity, (2) high levels of trust, transparency and provenance, (3) transparency and provenance of registered events, (4) immutability of registered events, and (5) disintermediation [7].

Grech and Camilleri [7] illustrates the ideas with three distinct illustrations.The national land registry is a good example of a centralized database, in which data is stored and processed on a single central node.A decentralized ledger, in which multiple parties share responsibility for a single central ledger, is one variation of this.For instance, when regional offices manage the national land registry, they each have the authority to store and process local transactions.In either case, the ledger cannot be accessed if the server is unavailable.The utilization of Blockchain as a distributed and decentralized ledger is the final illustration.The network is run by no single authority, and each node keeps a complete copy of the ledger.Consensus from the nodes is required for any ledger modification.Changes and additions can be made to any copy of the ledger, which will be recorded on each copy at each node (Fig. 1).2).

2.3 Applications of Blockchain Technology

Blockchain is not limited to cryptocurrencies, as previously stated;In point of fact, a variety of assets, including land titles, identification documents, certificates, and more, can be exchanged using it [7].The management of intellectual property rights [9, 11], the administration of open innovation processes [12], and the integration of the internet of things [13] are just a few of the new applications that continue to emerge as technology progresses and becomes better understood.Blockchain has been used in a variety of medical fields [11, 14, 15].In addition, it is being used in education to manage assets and financial resources and keep track of student records [7, 9, 10, 16–18], Sony [8, 19, 20], and others.

Three main opportunities for 2016 have been recognized by the Government Office for Science, UK [21] based on the distinctive qualities of the Blockchain technology: 1) Cryptocurrency exchanges; 2) the production of innovative third-party apps to provide new efficiencies; and, thirdly, the development of an innovative class of contracts known as "Smart Contracts," which is an intriguing potential that could result from the technology.

At its foundation, blockchain is a technique to build immutable records on a distributed network. By leveraging a distributed information model, consensus mechanisms like its firewall, and encrypted mathematical protocols, this trait enhances the network's security. This indicates that it is not limited to financial transactions.

2.4 Blockchian: Smart Contracts

According to Melanie Swan [22], there will be three uses for blockchain technology.The first stage of the technology's development is Blockchain 1.0, and its primary use is as an online cryptocurrency.Using the capabilities of smart contracts, applications for tracking property ownership, financial records, public records, and contracts will be found in the second stage, Blockchain 2.0.Blockchain 3.0, which envisions a future in which the technology makes secret information that would otherwise have been hidden openly accessible to the public through distributed networks, goes beyond smart contracts and financial services [11].

According to Grech and Camilleri [7], "small computer programs stored on a Blockchain, which will perform a transaction under specified conditions" are the definitions of smart contracts, which can declare things like "transfer X to Y if Z occurs." Smart contracts function as programmed triggers that carry out pre-agreed transactions without the use of intermediaries [10].The most fundamental definition of smart contracts is "a set of promises specified in digital form, including protocols within which the parties perform on these promises [23]."One possible application for the technology is automated billing [9].

Because they are self-executing, smart contracts can be embedded on a Blockchain and the transaction will take place without the need for third parties or intermediaries once the conditions are met [7].They make use of the Distributed Ledger Technology's immutability, decentralization, and direct mediation capabilities.

Some of their potential applications include financial instruments, self-governing processes, decentralized gambling, student loans, and legal procedures [23–25].It is possible for an ecosystem to be completely self-sustaining, self-governing, and self-regulating because smart contracts are merely a tool for automating interactions between participants.Established protocols that take the form of mathematical algorithms make it possible.This ultimately results in the freedom to operate without interference or involvement from third parties.

2.5 Projects Review: Blockchain in Education

Devine [10] proposed two possible applications for Blockchain in education. One of them draws an example from the financial application of Blockchain and uses Smart Contracts to shape an autonomous learning experience. To reflect learning successes, a unit of value is produced with the teaching and learning activity on one side and the monetary value on the other. In this paradigm, which he called "Blockchain learning," teachers take on the role of miners, laying down educational building blocks and producing learning opportunities through their instruction, much as how students generate ready-to-spend money. In the second application, students who work for the institution in exchange for compensation are compensated via blockchain technology. The initial application, as was indicated before, was compatible with Blockchain 1.0.

The Blockcerts open standard for Blockchain credentials was created by the MIT Media Lab in collaboration with the software developer Learning Machine.Users can register official records on the platform, which gives them "the capacity to possess and share their own official records" [30].

Hoy [11] discussed how Blockchain could be used to make it easier for libraries to identify, store, and share authorship data. Blockchain may, for instance, use a timestamp to confirm journal article versions. Hoy [11] discusses how such an application has already been put to the test for the verification of medical science archives by Irving and Holden [14]. Another application that Hoy mentions is the use of Blockchain as a digital rights management (DRM) technology, which enables digital materials to be uniquely recognized, managed, and transferred. These programs could be used in schools to accurately track pupils' academic achievements.

Bore and co.16] worked on a Blockchain-enabled School Information Hub (SIH) for the Kenyan education system with the intention of enhancing the process of record keeping there.They discovered issues that could be resolved using the capabilities of Blockchain technology.Establishing verifiable control points and managing compliance assurance (data) could, for instance, address the reliability of a transfer student's records by guaranteeing the immutability of recorded transactions and the non-repeatability of operations.These features enable school registers to keep irreversible records of all entries and changes, guaranteeing their accurate attribution through modern methods, and ensuring the immutability of entered data through cryptographic algorithm network consensus.The above-mentioned Blockchain application aimed to address four primary issues: (1) maintain a trustworthy record of students and teachers enrolled in public schools to avoid additional costs caused by "ghost" teachers or students.2) Making the school system's budget allocation and spending more transparent and accountable.3) Enhancing the learning environment by linking student and teacher performance data.fourthly, enhancing the learning experience through the development of individualized education programs.

Chen and others [32] looked at how the features and benefits of Blockchain technology could be used in education and looked at how smart contracts could be used by teachers and students to do teaching and learning activities.For instance, facilitating the idea that "learning is earning" [9], in which students can earn tokens for learning topics funded by a marketplace, Chen et al. among other applications[32] also mention the utilization of smart contracts for evaluation procedures that take advantage of the technology's immutability, traceability, and dependability.Students could, for instance, submit their work to a learning platform, where a smart contract will evaluate their performance and record the results in blocks. These blocks would serve as evidence for the evaluation of all kinds of student works and behaviors.

2.6 Categories for Innovation from Blockchain for Education

A number of publications claim that the technology might be applied to the storage of student records that could then be made publically available to outside parties, offering a safe and permanent record that is resistant to data loss [9, 10]. Since the University of Nicosia already manages its academic certificate records on a Blockchain network, third-party users might directly authenticate a student record by accessing the University Blockchain [36]. Sony [19] has created a system for the authentication, distribution, and rights management of educational institution records using Blockchain technology. Blockchain-based records might allow for the incorporation of original works, artistic innovations, and other types of intellectual activity [37].

As the technology becomes more well-known, sophisticated applications continue to emerge, the majority of which are based on analogies of the value transaction with financial tokens. These applications alter the meanings of the terms "value" (for instance, "intellectual value") and "mining" (the allocation of value blocks).

The first group consists of (1) student records and identities; presents three main obstacles: (a) maintaining the privacy and security of digitally stored data, (b) the accuracy of the recorded information, and (c) studying time.In this scenario, institutions' data could be securely encrypted using Blockchain technology. Within the chain, the recorded and encrypted data would remain valid and official;this would be useful for all kinds of student data, like certificates and records. A Blockchain system may be able to recognize students for everything they learn, independent of settings, such as within a university course, on professional experience, life experience, and more, with the development of adequate tools.

(2) New pedagogy is the name given to the second category. Universities rely on the reputation of their academic models to reassure outside parties about the caliber of education pupils get. The traditional learning model used at many colleges is somewhat comparable, with teachers functioning as transmitters and students receiving a one-way message. It's probable that in the digital age, such a paradigm is no longer appropriate. Since material is easily accessible online, self-paced computer learning systems could teach situations where there is a correct and wrong solution. Students collaborate, discuss, and engage in debate over projects at the same time. New pedagogy models would be built on learning by doing in a heterodox learning process where students capitalize on what they have learned in issues they are enthusiastic about, as in the example of Ethereum co-founder Vitalik Buttering [20]. An approximate representation of this paradigm is the Thiel Fellowship program, which awards "$100,000 to young people who want to build new things instead than sitting in a classroom" (Thiel Fellowship, n.d.). Blockchain enables new forms of collaboration. The Consensus System (ConsenSys) [38], one of the first projects to be created using the Ethereum code, is one example. Each user of the Ethereum platform has a token that represents a portion of the project. The main classroom objectives are agility, openness, and consensus, which means determining what needs to be learnt, assigning tasks to each student, deciding on their roles, duties, and rewards, and recording these rights in smart contracts.

(3) The cost of education is the third category. Blockchain technology enables (a) payment mechanisms, (b) learning plans that are established under smart contracts, and (c) a reliable proof-of-truth mechanism, such as to confirm if students signed up for MOOCs completed the course, took the tests, and mastered the material [22]. By funding specific students to attain certain learning goals and paying them accordingly, the Blockchain "pay for success" plan [22] may enable private businesses to promote the development of talents in which they have an interest. This would hold students accountable for their development. To

encourage the use of acquired skills, the Blockchain database might connect skills with market demand. A student could, for instance, pay back his student loan by instructing others in the material he previously mastered. When the system reaches that stage of development, it will be able to accurately determine the worth of each subject covered in the learning curriculum, allowing funding sources to cover the full cost of a student's education in exchange for future profits [20].

2.7 Blockchained education analysis: methodology

According to Satel [39], innovations can be divided into four categories: sustaining, disruptive, breakthrough, and fundamental research. For the sake of consistency and clarity of meaning, the latter category shall be referred to as fundamental research. The accuracy with which the problem is specified and the accuracy with which the domain is defined are the two elements that determine these categories.

3. Result and Discussion

The majority of the reviewed Blockchain projects deliver "Core" growth (improvement) and continuous innovation.Most of these projects use Blockchain technology to create new tools or methods for replacing outdated technology.These projects usually make small changes to innovation "Categories," like making student records easier to find or making them safer.However, these innovations do not alter the established model of academic institutions and are not "game changers."The established model mechanism utilized by educational establishments performs better as a result of the impact.

There were fewer programs, including Sony's official records and data integration [16] and [19], that included "Related" growths in addition to "sustaining innovations." Thanks to Blockchain technology, these initiatives provided capabilities to the "Category" of innovation that was before impractical. Like Bore et al. [], Sony [19] wants to integrate artificial intelligence into the Blockchain platform for the management of "Identity and students records."16] Sony [19] is incorporating data analytics to correlate information by utilizing the reliability of the Blockchain platform's data.

Sharples and Domingue [9] propose a new educational system and learning platform based on the capabilities of Blockchain technology. In the context of "New pedagogy," such a platform is a "Disruptive" innovation because it changes how education is accessed, provided, and graded.Because it would make education accessible to new users and markets, such a platform also provides "New" growth.

4.1 Disruption of Blockchain

When compared to centralized databases, blockchain technology immediately enhances information security, dependability, and resilience.It shouldn't come as a surprise that the first generation of Blockchain applications was just a "one-to-one" replacement for the old media, which were centralized databases (the first step in technology evolution).In addition, as stated in the preceding second step of technology evolution, new technology will be derived from Blockchain technology's functionalities, as with the creation of Smart Contracts and NFTs. Blockchained education presents a significant obstacle for higher education institutions like universities.Blockchained education may be able to provide the same levels of "trust" with mathematical algorithms by making use of new technological infrastructure and value chains. Universities depend on trust gained through reputation [18].

In a system in which a user could trade educational products without worrying about their intellectual value, education is reduced to a marketplace of knowledge and reputation [9]. This is an emerging concern of the trading of an educational asset.However, more research is needed on this subject.

4.2. Meta University for Digital Education

The effects of the COVID-19 pandemic in 2020 demonstrated the significance and value

of digitizing education.It is difficult for educational establishments to rapidly transition from the traditional classroom to the virtual classroom [47].Before COVID-19, a single course was required of students in some states, like Florida in the United States [48].In addition, the newly implemented strategies of online learning might continue to be incorporated into the academic curricula when schools reopen [49].Students and teachers alike face new challenges in the digital classroom.For instance, professors face difficulties recalling student learning evidence, and students may face difficulties due to the lack of human interaction in the learning process.

Since then, information technology has come a long way. Not only is the new generation of students and professors familiar with and proficient with information technologies, but also the number and quality of tools for online education have increased [51].However, despite the fact that the gap has narrowed, recent studies still point to performance differences between online and in-person education.For instance, a meta-analysis conducted by [52] compared 192 participants in either face-to-face or asynchronous online learning conditions with 189 participants in webinar conditions.They found that face-to-face and asynchronous learning performed significantly better than webinars, but that the difference in performance was statistically insignificant.On the other hand, it might be a sign of how fast online education is catching up to traditional education.

Educational establishments that lack the infrastructure or systems required to transition to the digital education era are more likely to experience disruption.Blockchain technology can be used for online education to solve two issues: the need to verify the quality of the increasingly available digital content and the need to gather evidence of the learning process.Blockchain technology has the potential to become the system of choice for the digital education revolution by enabling the Meta Blockchain University Network.

The Meta University Blockchain may make use of a public or open blockchain.This will enable an exponential flow of users to create content on this new network and use its resources, which will result in multiple content coexistence within the Blockchain Meta University Network (BMUN) from an operational standpoint.Once created, custom blockchain network applications can be developed using payment tokens and an exponential flow of users and nodes.

4. Conclusion

The majority of the proposed applications of Blockchain technology in educational institutions are sustaining innovations that merely substitute one technology—current databases—for another—Blockchain platforms—while making limited use of the improved characteristics offered by the novel technology, such as accessibility and dependability. The "Educational Costs" and "New Pedagogy" approaches have been impacted by a few disruptive applications that have been envisioned.However, a Blockchain platform may not replace educational institutions in the near future because neither the technology nor the satellite infrastructure may be ready to support a change in the existing model.

In order for an educational or academic organization to fully utilize the capabilities of Blockchain technology and become a fully functional academic ledger that will replace current educational institutions, a number of technical issues must be resolved.

By implementing an ID token system on student activities, also developing crypto wallets using Blockchain can ensure the security of student information, and strengthen university standards for validating student activities, not only as confirmation of access for campus or classrooms but security solutions at universities and direct interaction with students. . This can also be supported by ensuring student identity during online courses, Blockchain technology already has the potential to overcome a number of problems related to student ID security. The research and development division of each university may be responsible for the creation of the Blockchain system and its implementation in activities.

By opening up a stream of new projects and creating platforms for the development of new concepts, whether from professors or students, educational institutions can innovate in these new technologies as part of educational development.However, regardless of whether the objective is to simply remain relevant to global technological advancements or to enhance the

university's business model over the long, medium, or short term.Keep in mind that as part of the 4.0 revolution, the next logical step is to begin introducing blockchain technology to educational institutions.The infrastructure necessary to completely transform the educational institution model may not yet exist because Blockchain technology is still in its infancy.However, we are able to draw the conclusion, based on the research's observations, that the challenges associated with putting this system into operation are rooted in the same thing.

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