European Research Studies Journal
Volume XXV, Issue 4, 2022

pp. 253-266

Blockchain in Education: The Best Teaching Models

Submitted 14/10/22, 1st revision 29/10/22, 2nd revision 17/12/22, accepted 30/12/22

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Abstract:

Purpose: *The usefulness of Blockchain technology due to its many advantages, in the form of off-the-shelf solutions, is conquering many sectors of the economy, such as finance, insurance, retail, industry, healthcare, logistics or public administration. The main aim of this paper is to identify the best teaching models for implementing Blockchain into the teaching process in higher educational institutions.*
Design/Methodology/Approach: *The research method emloyed in this study was a model for evaluating online courses, covering topics related to Blockchain and data collection using the Delphi method. The experts were selected from among academic teachers with knowledge and experience in the field of Blockchain technology, who conduct their research in the IT and / or economic space.*
Findings: *Not only Blockchain technology itself is important, but also exploring and learning about business transformations involving Blockchain (checking out available solutions on the market, tracing how the process of implementing Blockchain in new entities and projects).*
Practical implementation: *This technology is under continuous evolution and we have not yet fully explored the limits of its applications. Blockchain is also a new paradigm for digital data management and learning. Due to the rising role of Blockchain, univeristies should include Blockchain in their education offer.*
Originality/value: *The article fills the knowledge gap in the field of supporting the developing Blockchain environment in the context of introducing Blockchan into the teaching process.*

Keywords: *Blockchain technology, assessment model, blockchain courses.*

JEL codes: *C52, I21, O32.*
Paper type: *Research article.*

Funding: *Publication prepared on the basis of materials created as a part of the EU funded "Generation Blockchain" project (www.generationblockchain.eu). Views and opinions expressed in the publication are those of the author(s) only and do not necessarily reflect those of the European Union or the National Agency. Neither the European Union nor NA can be held responsible for them.*

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1. Introduction

The usefulness of Blockchain technology due to its many advantages, in the form of off-the-shelf solutions, is conquering many sectors of the economy, such as finance, insurance, retail, industry, healthcare, logistics or public administration. All reports and publications on the subject agree on the possibility of significantly increasing efficiency in almost every area of human life and economic processes. From the technical point of view, Blockchain is relatively young, but its development continues to gain acceleration as favorable regulatory conditions and supportive policies have emerged in addition to economic stimulation.

Every month, new applications and projects are being developed that break the barriers of scalability and performance, while surprisingly reducing the cost of deployment and operation. Blockchain is under continuous evolution and we have not yet fully explored the limits of its applications. The markets are certainly in a pre-consolidation stage currently, but the first initiatives to merge private platforms with public networks are already emerging. These processes should not be held back, but rather the emphasis should be on stimulating experimentation and innovative attempts, including in the area of system integration and migration (PIIT Report, 2018).

2. Literature Review

Blockchain is a new paradigm for digital data management and learning. Many researchers take the position that it represents a new megatrend of the digital world (Gilder, 2018). But can it play an important role in the education process? There is no doubt that it does on several levels. For example, it finds application in the organization of education, e.g., through the implementation of decentralized platforms containing grades, documents or diplomas of graduates, or the authentication and security of processes related to the verification of knowledge such as exams (STM Future Technology Institute, 2022). In addition, it represents valuable knowledge, which can and even should be taught.

Blockchain functions at the interface with other technologies such as artificial intelligence, IoT, Big Data. These solutions are slowly infiltrating the practice of teaching, for example, by technically supporting grading, supervision or profiling. This makes these techniques, despite their undoubted benefits, seem culturally invasive and may imply serious ethical questions.

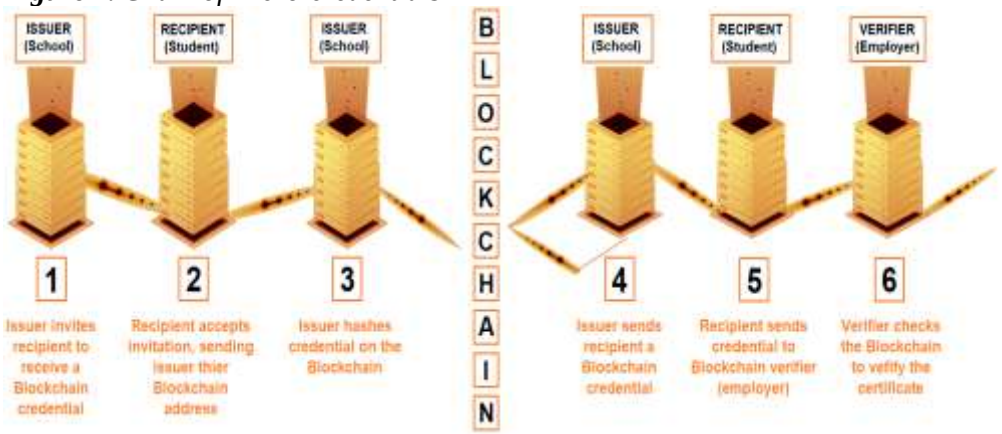
The traditional conveyance and transfer of knowledge, primarily through schools and universities, is a time-honored, valued and important determinant, representing intellectual development, progress and enhancement of daily life. However, on the other hand, in order to function effectively in a modern, dynamic and convergent environment, educational entities should be characterized by openness and high

dynamism in absorbing novel ideas and innovations, especially from the ICT area (Park, 2019).

Despite its great potential and its very expansive and annexationist nature, Blockchain remains most strongly linked to the IT and economic dimensions (Gatteschi *et al.*, 2020). It can be interpreted as: "A database, similar to a cadaster of real estate titles, extended to events, covenants, patents, licenses, or other permanent records. All are hashed together mathematically from the origin of the series, each record distributed and publicized on decentralized Internet nodes" (Gilder, 2018).

Its most important function remains the elimination of uncertainty about the authenticity of identity and information, thanks to sharing of this data by all parties involved and the use of additional, meticulously planned, however powerful, virtual cryptographic tools (Park 2021). An example of such authentication chain using micro-credentials in the relationship between school, student, employer is presented in Figure 1.

Figure 1. *Chain of micro-credentials*



Source: *Own elaboration based on Cognizant 2019.*

Supporting education through the implementation of Blockchain-based solutions will involve the need to store and manage highly sensitive personal data in a decentralized network. This fact determines that every effort should be made to minimize any risk of unauthorized access by unauthorized entities. This raises the question of whether this type of information should not be secured in accordance with established system regulations developed by experts.

Good practice in this regard can be observed, for example, in India, where the "SPDI Principles" (Processing of Personal Data/Information and/or Sensitive Personal Data/Information) were introduced as early as 2011 (Chacko *et al.*, 2021; Walia *et al.*, 2021). According to them, business entities and other institutions that collect, receive, possess, store or process sensitive personal data in electronic form must

comply with a number of principles established by law. In view of this, any educational entity wishing to use Blockchain technology will have to inform its students/trainees about the implications of using this tool like the fact that once stored, the information cannot be deleted (Sankar *et al.*, 2021).

Blockchain is in constant evolution. It is improving and changing not only its source code and IT architecture but also new application areas (Hashmani et al., 2020; Boiko, 2021). This multidimensional evolution is correlated and mutually driving. Its stages are presented in Table 1.

Table 1. *Evolution of Blockchain technology*

LEVEL	**APPLICATION**
Blockchain technology 1.0	Cryptocurrencies as a peer-to-peer cash payment system
Blockchain technology 2.0	Applications in stocks, bonds, loans, smart property, and smart contacts, dapps (Decentralized Applications), DAOs (Decentralized Autonomous Organizations), DACs (Decentralized Autonomous Corporations)
Blockchain technology 3.0	Government, health, education, science, literacy, culture, cybersecurity, IoT, web services, voting, supply chains and art
Blockchain technology 4.0	Business usable platform to create and run applications thus converting the technology to fully mainstream

Source: *Own elaboration based on Park, 2021; Mukherjee et al., 2021.*

In most cases, the technology in question is used in education mainly as an element to support administration and teaching processes or in the context of administrative interaction with students (Clark, 2016) (e.g., "smart contracts managed in blockchain systems could establish conditions under which a student would receive a certificate from a provider, and a series of those contracts could define a full degree program. As these students' progress toward degree fulfillment, their blockchain records could be tracked automatically and shared in real time with potential employers" (McArthur, 2018)).

Successes in supporting the technical aspects of teaching using Blockchain came very early. As an example, a successful implementation by a Japanese company in February 2016 included "open and secure sharing of academic proficiency and progress records" (Sony, 2016).

Similar to authentication in cryptocurrency transactions, in teaching Blockchain can be a promoter and guarantor of openness, equality, security, accessibility, efficiency and even fairness (Atienza-Mendez *et al.*, 2019). Some of the more advanced considerations have led to more adventurous and abstract projects. One of these is the tokenization of educational outcomes, for example, in the form of digital units earned for completing specific tasks, which could be held in special digital "learning portfolios." Their dimension earned in a specific unit of time could form the basis for promotion and grading (Chen *et al.*, 2018).

Fraud related to school and academic records is a serious problem worldwide. Studies conducted on this issue show that more than 100,000 higher education diplomas are purchased in the U.S. every year (Fake Schools, 2020) (noting that a large part of this number may be documents certifying doctoral degrees). Such a large number testifies to the low security of these documents and the difficult and lengthy process of establishing their authenticity.

This is due to the multiplicity of ways to realize the fraud, buying a fake document at a fake school, buying a document that is a forgery of the original, buying an original document using illegal practices issued by a genuine educational entity and, finally, buying a diploma or graduation from a "non-existent" university that is nothing more than a for-profit company and a "printer" of academic documents (Ezell *et al.,* 2012).

All of these practices are very dangerous and pose a real threat to people's lives and health, especially if a person with a fake diploma is hired in a responsible position. It is of great concern that, based on data collected in a study by the Ohio State University, there may be two million physicians practicing in the United States alone who possess false documents allowing them to practice their profession (diplomas or licenses) (Gibson, 2017).

Despite several initiatives to reduce this practice, their effectiveness has left much to be desired. However, Blockchain can come to the rescue, which, based on a decentralized and transnational verification infrastructure, will prevent fraudsters from impersonating professionals. If a Blockchain-based solution had a global dimension, it would be possible to verify every employee and check the credibility of their credentials in real time from anywhere in the world (Smolenski *et al.,* 2021).

An example of the use of blockchain in education can be Woolf: "as the first university built entirely on a blockchain architecture, Woolf promises to disrupt the economics of higher education by providing new opportunities for both students and academics." (Woolf, 2022). A group of Oxford academics have taken the initiative to create the world's first university organizationally based on Blockchain technology. This is how Woolf University was established. Blockchain has been used to ensure regulatory consistency and honor regulations, minimize and even eliminate bureaucratic processes through their computerized automation, and effectively manage and protect students' sensitive data while authenticating their achievements and acquired skills. Oxbridge-style tutorials are the primary teaching material (Woolf, 2022; You Tube, 2022).

3. Research Methodology

The main research methodology emplpyed in this paper encompasses in-depth study of the literature on the subject and analysis of secondary data. The aim was to select the best public teaching offers related to Blockchain technology. The educational

offer was to be addressed not to specialists in the field in question, but to all interested parties with basic IT knowledge and skills. Courses and studies both in the stationary and online learning system were taken into account. In order to correctly identify the best teaching models, the Delphi method was used. The experts were selected from among academic teachers with knowledge and experience in the field of Blockchain technology, who conduct their research in the IT and / or economic space. Ultimately, eight experts were selected.

The first stage of the project was the development of a proprietary evaluation model by the experts in question. The model obtained a coherent form already in the second round of expert consultations. It was developed in January 2022. Its critical and most important elements were defined as substantive content, ease of access, affordability, scope, dimension of final competences and opinions of trainees.

The second stage concerned the creation of a list of fifteen best teaching models. Significant discrepancies in the opinions and assessments of experts appeared. A serious obstacle was also the enormity of the existing offers and the dynamically developing IT technologies, which resulted in a rapid increase and fluctuation of the topicality of the substantive message.

This stage lasted three months - from February 15 to May 15, 2022. The final result is presented in Table 2. Due to significant disproportions and lack of clear coherence in the scoring, the ranking of records was abandoned. Table 2 contains 17 instead of 15 positions, which is due to ex aequo places.

4. Findings

One of the fundamental characteristics of information societies is the need to constantly own professional skills, ensuring that retraining is easy and fast (Dutton, 2004). The more important an employees' position and value in the labor market, the more important it is for them to improve their know-how and gather experience. In the world of high-tech professionals, change happens very quickly. What was crucial yesterday and allowed a competitive advantage today is irrelevant. From the employer's point of view, a professional who consistently fails to learn new things becomes expendable.

A sector encompassing ICT and economic knowledge, which is characterized by very high deployment dynamics and even greater development prospects in the near future, is Blockchain. Of course, depending on specific needs, it is not necessary to assimilate all the knowledge related to this technology, but only general information and that part which is acutely needed for the task at hand. However, despite the fact that: "Blockchain is a new but powerful tool that has the potential to change the way we think about finance, engineering, and, perhaps most importantly, law (…) the educational resources are lacking." (Youngblom, 2022).

However, being an expert in this field requires in-depth knowledge, with all aspects of Blockchain – from its history and principle of operation, to its role in cryptocurrency systems, startups and new projects, to the ability to effectively "read," edit and create new code. In addition, in order to search for opportunities more effectively, it is necessary to learn about all possible interdisciplinary interactions of this solution with other fields, as well as to constantly follow technical innovations and develop your skills through practice.

The concept of learning Blockchain in six steps seems very interesting. These are (Iredale, 2021):

- STEP 1: basic knowledge and principle of Blockchain technology (definitions, features, types of Blockchain, smart contracts),
- STEP 2: how Blockchain-based platforms of large corporations function (e.g. Hyperledger, Ethereum, Corda),
- STEP 3: Blockchain's role in improving a number of services, technologies and economic fields (what are better solutions, what ventures are currently underway, how financial services will change in the near future),
- STEP 4: enroll in a professional, certified course on Blockchain (learn how Blockchain can improve your business, get a certificate for completing the course, treat the knowledge gained as capital),
- STEP 5: look for opportunities to leverage your knowledge and find potential areas in your industry that can be improved with Blockchain (seek self-improvement and self-education, conduct research and read the news),
- STEP 6: explore and learn about business transformations involving Blockchain (check out available solutions on the market, trace how the process of implementing Blockchain in new entities and projects went).

This concept implies differentiation of the level of initiation, due not only to the difficulty but also to the ranges of desired knowledge. In economic terms, this approach eliminates the need to create specializations, as it appears to be complete, but at the same time utopian, because it envisions multifaceted learning and acquisition of skills that are possessed by a very small group of people, and which were accumulated over a very long period of time.

Despite the relatively correct holistic coverage of economic aspects and the identification of Blockchain's functional assumptions and applications, the six-step model is not and cannot be an effective and viable teaching model, but only an auxiliary tool indicating diverse scopes of knowledge.

There are many practical models for teaching Blockchain. Their main assumptions are aggregated in Table 2.

Table 2. *Blockchain teaching models*

INSTITUTION	course (C)/study (S)	stationary (S)/online (O)	multilevel	dedicated	additional materials	introductory course	issues related to cryptocurrencies	certificate, diploma
iMi, (imi 2022)	C	O	yes	no	yes	yes	yes	yes
CEBP, 101Blockchains, (CEBP 2022)	C	O	no	no	yes	yes	yes	yes
Coursera, Princeton University, (Coursera 2022)	C	O	no	no	no	no	yes	yes
edX, Berkeley University of California, (edX 2022)	C	O	no	yes	yes	no	yes	yes
Udemy, (Udemy 2022)	C	O	no	yes	no	no	yes	yes
Columbia Engineering, (getsmarter 2022)	C	O	no	yes	yes	no	yes	yes
IMD, (IMD 2022)	C	O	no	no	yes	no	yes	yes
University of Cape Town, (UCT 2022)	C	O	no	no	yes	no	yes	yes
NUS, National University of Singapore (NUS 2022)	S/C	S/O	no	yes	yes	no	yes	yes
RMIT, Royal Melbourne Institute of Technology (RMIT 2022)	S	S/O	no	no	yes	no	yes	yes
UZH, University of Zurich, (UZH 2022)	other	S	no	yes	no	no	yes	yes
MIT, Massachusetts Institute of Technology, (MIT 2022)	C	O	no	yes	yes	no	yes	yes
Hong Kong Polytechnic University, (HKPU 2022)	S	S	no	yes	yes	no	yes	yes
UCL University College London, (UCL 2022)	S/C	S/O	no	yes	yes	yes	yes	yes
CUHK, Chinese University of Hong	S	S	yes	yes	yes	no	yes	yes

Kong (CUHK 2022)								
UNSW Sydney (UNSW 2022)	S	S	no	no	no	no	yes	yes
California State University, Chico (CSU 2022)	C	O	yes	no	no	no	yes	yes

Source: *Own elaboration based on surveys conducted.*

Table 2 is divided into 9 sections. The search for educational units offering Blockchain teaching was conducted exclusively via the Internet. The following aspects were taken into account:

- Is the content offered in the form of a course or official studies (other forms should be considered unprofessional and unreliable, they have also been omitted from these considerations)?
- Does the teaching take place exclusively remotely, i.e., is there the possibility of traditional on-site transfer of knowledge?
- The multilevel nature of the offered didactic content – i.e., is there dedicated material for beginners, intermediate and advanced learners, or has one material been created for all interested parties?
- Dedicatability – i.e., profiling the material for a specific audience (e.g., a person in a specific profession). Has the material been divided into thematic groups covering different courses/studies?
- Availability of additional learning material, e.g., in the form of webinars, podcasts, videos on YouTube or documents posted on e-learning platforms, etc.
- Has the provider prepared an introductory course to familiarize the user with very preliminary knowledge? This is especially important when learning online.
- Does the given course/study include topics or dedicated material on cryptocurrencies and the cryptocurrency market?
- Certification of the completion of course with an appropriate and reliable document (certificate or diploma).

Platforms such as Udemy or edX contain a variety of courses most often supported by academic entities. Table includes data related to specific sample courses. Sometimes Blockchain learning was offered in a form other than a course or degree program, e.g. as optional subjects – lectures on Blockchain Programming at the University of Zurich (UZH 2022).

Courses were usually scheduled for 5-6 weeks but mini-courses of a few hours were also offered – these, however, were tried not to be included in this compilation (e.g., Nanyang Technological University, NTU-FTA Series – Enterprise Blockchain course, scheduled for 8 hours in online form and ending with a certificate (NTU 2022)). Universities offered studies (depending on the organization) lasting from 1-2 years.

The most balanced and transparent educational offering is at University College London, where there is a free online course for beginners (Introduction to Blockchain and Distributed Ledger Technology (DLT)), a certified professional course (DEC, Online Certifications for Blockchain, Digital Assets & Web3 Professionals), and degrees for engineers (Emerging Digital Technologies MSc) and economists (Financial Technology MSc) (UCL 2022). Only in the case of the Chinese University of Hong Kong, multi-level degree programs were offered to allow for continuation and further exploration: postgraduate and doctoral degrees (CUHK 2022).

In 2021, the information platform CoinDesk (CoinDesk 2021) conducted a survey of 230 universities, with a view to create an overall ranking that includes education involving Blockchain. The academic institutions represented all continents except Antarctica. The methodology included an assessment of five criteria: quality and contribution to research in the field, Blockchain educational offerings, collaboration with practitioners and business, cost of study, and academic reputation of the institution. Based on the results, a map was created showing the geographic location of the most thriving universities in the Blockchain context. This is included in Figure 2.

Figure 2. *Location of universities providing Blockchain education*

Source: *Youngblom, 2021.*

The largest groupings were reported in the United States, Asia and Europe. This fact can be identified with the manifestation of increased interest and number of Blockchain technology implementations in these regions. The top 5 of the ranking (i.e. entities that scored more than 90 points out of a possible 100) are included in Table 4. It is interesting to note that in only 9% of cases education was completed with the possibility of obtaining a degree, 6% – a bachelor's degree and in 3% – a master's degree (Youngblom, 2021).

Table 3. *Top 5 ranking of the best universities in the field of Blockchain*

RANKING	SCHOOL	SCORE
1	National University of Singapore	100.00
2	Royal Melbourne Institute of Technology	97.65
3	University of California Berkeley	93.26
4	University of Zurich	91.66
5	Massachusetts Institute of Technology	91.57

Source: *Youngblom, 2021.*

The Internet contains a great variety of forms to explore Blockchain knowledge on your own. One of the most popular and extensive is IBM's official website dedicated to Blockchain technology. It is possible to find there a lot of free materials and tools, which include: publications, content posted on the site, webinars, videos posted on YouTube, newsletters, a blog, etc. (IBM, 2022).

5. Conclusions

The study showed that the success in teaching Blockchain can be achieved through collaboration between practitioners, economists and computer scientists. The combination of these three sources of knowledge should be adapted to the specific field of study – little economics and a lot of computer science for engineers, computer scientists and technical specialists, and a lot of economics, a lot of case studies and little computer science for future economists and executives.

With respect to the latter, considering potential professional tasks in the future, it can be concluded that only a small fraction of business or management school graduates will need to explore advanced cryptographic mechanisms or master programming at an advanced level. For the majority, in order to effectively operate in the market and participate in ventures involving or based on Blockchain, only a basic technical knowledge of the principles of operation and possibilities offered by this technology will suffice. They do not need to be computer scientists or cryptographers responsible for designing a specific platform/application/service, but only managers implementing these solutions and looking for market opportunities (Sandner *et al.,* 2022).

Based on the considerations made, as well as the literature review and conclusions drawn from the study, it can be concluded that the potential of blockchain technology has not yet been fully exploited in the education sector (mit 2022), and both in an administrative context and as a subject of study. "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" (Steiu, 2020).

Hence, the study implies a number of further studies, e.g., how to implement Blockchain at all stages of education - from primary school through high schools, to

universities and e-learning, or how to increase the efficiency of using Blockchain. In addition, the study also provides practical knowledge to teachers and university representatives, proposing a Blockchain framework for teaching models.

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