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Blockchain Revolution: Enhancing Moroccan Higher Education for the Digital Age

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Abstract:- Analyzing the potential of integrating blockchain technology in higher education is a multifaceted undertaking due to the complex and contradictory nature of the higher education environment. in which conflicting visions of its mission, organization and governance coexist. The excessive expectations created around blockchain result in exaggerated promises and a certain widespread technological determinism. blockchain have created excessive expectations. This article aims to provide a balanced perspective by tempering enthusiasm and facilitating a deeper understanding of the underlying assumptions and vision of blockchain in proposals to revolutionize higher education and establish new educational ecosystems through digital technology, specifically blockchain. Blockchain has been hailed by some management and economic sectors with a vested interest in the new higher education as an emerging innovation, with innumerable benefits.

Keywords:- *Blockchain; Meta University; Moroccan; Higher Education.*

I. INTRODUCTION

The evolution of the digital society of knowledge and information is highlighted by the imminent advance of technology that impacts many areas, including education, this has enriched the development of the educational fact and transform and adapt the models in higher education institutions, in addition to improving the capabilities of the organization, as universities must be at the forefront of these technological and educational innovations, based on what has been raised (Hernandez, & al., 2022). Anthony (2022), argues that the current model of higher education is increasingly decentralized, heterogeneous, difficult to verify and validate, which leads to various open problems for each representative of the business model that involves the training of professionals for incorporation into the world of work, that is, trainers (regulated or not), students and employers. In addition, the authors state that it is increasingly common for students to receive training not only in regulated universities, but also by participating in massive open online courses (MOOCs), face-to-face or remote workshops, video tutorials, conferences, or video interviews, among others, in different institutions. All of these sources of knowledge, as well as professional practice itself, represent a spectrum that leads students to acquire skills that they must organize into a portfolio as they enter the world of work and the profession.

Bartolome, Lindín & Steffens (2022) argues that this line of work is only timidly hinted at. But it seems a quite likely consequence in the medium and long term, which will involve a radical change in the way education, institutionalized and systematized since the nineteenth century, is viewed, which could be transformed in the next century into something very different from what we know today as the education system. The blockchain would provide evidence of the acquisition of knowledge gained in various environments. Zhang, & al., (2022) suggest that the use of blockchain, and smart contracts will have significant value on centralizing learning around the student, so that the system would adapt to each student, rather than each student having to adapt to the system, as is the case today.

However, these visionary articles have not been translated into real solutions that can be implemented to date, and we can only observe approaches to this type of development. Blockchain, understood as a disruptive technology associated with crypto-currencies, particularly bitcoin, as its knowledge develops, its use becomes more widespread and its application extends beyond digital currencies, so this research essay presents a literature review of the object of study in the academic sphere (Zhang, & al., 2022).

In the field of higher education, it offers possibilities for the development and improvement of the management of the higher education system, in terms of control and monitoring of the development of the teaching and student learning process, and in the field of research, a contribution to the resolution of an important problem in publications, avoiding plagiarism, since everyone would have access to the information and the authorship and references would be known (Zhang, & al., 2022). The progress of this technology in the field of higher education is not as accelerated, due to the short time of its creation, 2009, but it has started to make inroads in this field with different innovations in some processes that were taking place in a traditional way, such as certifications, qualifications, student identity, personalized educational paths, payment of fees, intellectual property, among others. It is the renewal of these processes, based on the immutability of records in the blockchain and the possibility of guaranteeing the validity of all documents (Bartolome, Lindín & Steffens, 2022).

Given this scenario and the possibility of promoting innovative mechanisms in the academic sector, this research aims to present an approach to the state of the art of the applicability of Blockchain in Higher Education, describing the fundamentals and developments of this technology in this sector to know and reflect on the respective impact, in addition to the contribution to educational management in this digital society of knowledge and information (Bartolome, Lindín & Steffens, 2022).

Most people are not familiar with the term blockchain, not to mention the possible applications of using blockchain technology. Although researchers discussed the use of blockchain in the commercial area (Swan, 2017) several studies focused on how blockchain technology can be applied in education (Turkanović, & al., 2018; Chen, & al.,), This paper will discuss the critical terminologies of blockchain technology through a literature review, such as "distributed ledger", "blockchain" and "the verification mechanism". Also, the current applications of blockchain technology in education are reviewed. Then, the innovative applications of using blockchain technology in education and the advantages are presented with recommendation to use it in Moroccan higher education.

II. LITERATURE REVIEW

Digitalization is a tool for the innovative development of higher education, changing the demand for professions and the competencies of university graduates. Digitalization of higher education is a global trend that will only increase following the growth of the educational services market in general and online education in particular.

A. The current model of higher education digitalization

The current model of higher education is becoming increasingly decentralized, heterogeneous and difficult to verify and validate, resulting in a number of open problems for each representative of the business model involved in training professionals for incorporation into the world of work, students and employers. It is increasingly common for students not only to receive training from regulated universities, but also to be trained through participation (through studies directed from these universities or as a result of proactive independent study) in massive open online courses (massive open online course [MOOC]), in face-to-face or distance workshops, in video tutorials, in talks or video interviews, etc. (Bartolomé, Bellver, Castañeda and Adell, 2017).

All these sources of knowledge, as well as the professional praxis itself, represent an endless range that originates in the student the acquisition of competences that must be put into play at the time of their incorporation into the professional world. However, it is very difficult to quantify, value and validate such knowledge when it does not come from regulated studies dependent on a centralized administration (Caño, 2016). And even coming from regulated studies, the design of each curriculum is so varied that the student is forced to make a very extensive compilation of written documents, as well as to take access tests and interviews of all kinds in order to be able to guarantee the skills and competences he/she has acquired. From the point of view of universities, there is growing criticism from the employability field that university education is often unable to adapt quickly and flexibly to the training needs of the labor market with an adequate time-to-market.

B. Blockchain Technology Basics

Blockchain is a technology that allows to keep records of information in a distributed, decentralized, synchronized and very secure way, respecting identity and privacy (Miraz, & al., 2020). These records do not allow alteration, undoing or rewriting of what has been stored. Any institution can obtain many benefits if it correctly applies the Blockchain, which also prevents falsifying or deleting the recorded information, this being a fundamental characteristic, the immutability of the chain (Shin, 2019).

Loignon (2017) defines Blockchain as a digital record of transactions, distributed throughout the network and whose copies are identical on each member's computer, where no central authority governs therein. Any actor in the network can view log entries and record new transactions, disagreements are resolved by consensus of the majority of members. Miraz, al., (2020) argues that these transactions are grouped into blocks which are then linked together, forming a blockchain, hence the name Blockchain. The data in the blocks is encrypted and cannot be decrypted in theory, so once stored, the information can no longer be erased. In essence, the Blockchain contains an accurate, time-stamped and verifiable record of every transaction.

In the same sense, Allende, & al.,(2023) argues that Blockchain, is due to the structure of this record, consisting of sets of transactions that are organized and stored in blocks. Which are ordered chronologically and have an identifying number, an alphanumeric code known as hash and digitally signed by the person who proposes or validates the block. Regarding the use of this technology in the education sector (Bhaskar, & al., 2022).

Thus, predictions suggest that it will directly affect the management of many internal processes, allowing in a simple way an automated management of grades and exams, in addition to avoiding any type of fraud such as plagiarism or change of grades. A very important aspect in Blockchain corresponds to Smart Contracts, Allende, al., (2023) argues that they allow establishing and defining how and who can carry out transactions. These are contracts in which a series of clauses are defined and specified, such as the controls to be met by the merchandise mentioned in the previous section and the final payment agreed in case these are exceeded. These are incorporated into the blockchain in the network, which guarantees their security and provides the appropriate environment for their automatic processing (Bhaskar, & al., 2022).

In the educational field, Bartolomé, Bellver, Castañeda and Adell (2017) argues that, the basic model of curriculum design responds to a fragmentation of the program into small blocks (read activities, units, lessons...) that the student goes through according to his own needs and aptitudes. Each unit translates into an intelligent contract that will be resolved when the subject has acquired the knowledge or skills satisfactorily. Based on the above, smart contracts can be used in universities for the development of student control and monitoring processes, based on a set of clauses that can address all academic and administrative issues related to student identity, learning path, accreditation, certification, grades, payments, intellectual property, among others. Blockchain works as a distributed database, in which the pairs are cryptographically secure, because it can only be updated through consensus among the nodes, all participants that are in the distributed network. The mechanism through which the transactions performed by the nodes are validated is by means of a consensus algorithm, which focuses on executing cryptographic operations.

C. Blockchain Technology and Higher Education

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The technological evolution in the information and knowledge society, merits the incorporation of technology in educational processes to promote its transformation and educational innovation. According to the experts, Bartolomé, Bellver, Castañeda and Adell (2017) education is one of the next scenarios where Blockchain technology, can offer a transformation and change in educational centers, especially in universities, where it could be applied both inside and outside the classroom, in the construction and management of personalized learning paths. Blockchain technology is commonly used for the issuance and verification of educational certificates such as diplomas, transcripts, student competencies, achievements and professional skills that can be checked by employers worldwide (Alammary et al., 2019). The impact that Blockchain has had on higher education can be evidenced, around the development of applications to meet specific needs, in addition to the different opportunities it offers to students, professors and institutions to optimize the academic and organizational processes that are developed, corresponding to the management of certifications, digital identity of students, educational uses, intellectual property, payment processes, among others (Rajnak, & Puschmann, 2020).

Blockchain technology makes the certification process faster by allowing employers to save time spent verifying academic results. It offers benefits to the education sector by providing a secure platform to share student data, reduce costs, ensure visibility and build trust (Rajnak, & Puschmann, 2020).. Blockchain technology maintains a complete record of courses in time-stamped data blocks in sequential order. Old and new blocks of data cannot be removed and the cryptographic algorithm prevents data corruption (Wang, 2022).

Bartolomé, & al., (2017) state that the starting point for the use of Blockchain in education is accreditation. of the curriculum vitae, in addition to other applications to portfolios, evidence of learning, badges in gamified applications, among others. These authors point out that it may take years for a relevant implementation in the educational area. However, these authors mention that changes are occurring rapidly and possibly the speed of this implementation will be more conditioned by the rapid social adoption of technology than by the success of these experiences. Around possible and probable real applications of Blockchain in education, Grech and Camilleri (2017) argues that the accelerate the end of "paper-based certification" systems, "automate credit recognition and transfer", store and verify the complete record of formal and informal learning achievements throughout a person's life, who will be able to automatically verify the validity of certificates awarded to him or her without contacting the organization that issued them, track the uses of materials under intellectual property, reduce the costs of data management for educational organizations, streamline payments to some institutions with ad hoc cryptocurrency, school checks or scholarships. In this same sense, Roebuck (2019) argues that it is too early to talk about Blockchain in education, however, he highlights that there is research, which is presented in this article, promising advances and innovations in the area, likewise the mentioned author shares five ways in which this technology is revolutionizing higher education.

Pelletier (2018) agrees that researchers will be more willing to share their scientific accomplishments while maintaining control over them through blockchain. Ultimately, this will lead to greater trust and interdisciplinary collaboration. Layne (2019) emphasizes that blockchain technology will simplify the university admissions office. The list of services provided by admissions offices and dean's offices is broad, covering both initial work with applicants and organizational support for students, including academic travel. Depending on the size and structure of the university, the list may include both traditional tasks and specific responsibilities (credit accounting in connection with the transfer of students from another institution, language and cultural support, time management training, financial assistance, etc.). Blockchain even at the stage of admission the university will be able to suppress fraud related to falsification of grades, legitimacy of sports and other achievements, grounds for benefits, distortion of personal data, etc. According to Haque, & al., (2023), blockchain will contribute to the popularization and legitimization of online learning, which will significantly reduce unemployment around the world, it will give the chance to get an online education to those people who have no opportunity to get offline, and further help with job placement, as all diplomas and certificates contained in blockchain are official and reliable, as blockchain allows standardization of certificates and diplomas obtained through online learning, which means that the technology will allow in future to legitimize online learning

Regarding the type of use of this technology, some authors propose categorizations based on certain applicability criteria. Swan (2015) proposes the following:

- Blockchain 1.0 refers to applications related to crypto-currencies, such as transactions, payment systems and fund transfers.
- Blockchain 2.0 is oriented towards smart contract applications for economic and financial activities, such as financial transactions, mortgages, real estate, etc.
- Blockchain 3.0 includes applications for areas such as public administration, health, science, among others.
- According to Swan (2015), there are three types of blockchain based on access and visibility of transactions:
- Public blockchains, which anyone can access and whose transactions are public (for example, Bitcoin and Ethereum).
- Private blockchains, where access is by invitation (e.g. Hyperledger, R3 and Ripple). -
- Hybrid blockchains, which combine the above elements, where nodes join by invitation but transactions are public.

The momentum of this technology is due in large part to the fact that some platforms are available under the open-source regime, as well as the commitment of governments, multilateral organizations, and large corporations to promote its adoption.

D. Implementation of blockchain

Although blockchain technology is in the top 10 of Gartner's trends (2018), it is essential to understand it and clearly identify the benefits of its application, taking into account its capabilities, limitations and the technical capabilities required for its implementation. According to Gartner (2018) these technologies are still immature, insufficiently tested and largely unregulated. As far as implementation is concerned, the consultancy notes that CIOs are not developing plans for the application of this technology. This situation is attributed to the complexity of its approach, the lack of specialised profiles for its application, among others.

On the other hand, some companies are identifying how to use the technology, although the lack of proven use cases raises concerns about its viability. However, this situation could change quickly considering that more and more cloud services are integrating blockchain as a service into their service portfolio, including recently Amazon Web Services (Gartner & Panetta, 2017).

In addition, blockchain technology helps to reduce grade fraud. In the past, there have been numerous cases of grade fraud. However, it can be avoided by using blockchain to award and manage the student degree now. Miners around the world verify, validate and maintain data that matches users' identification and stored in the blockchain, blockchain's distributed ledger is immutable and reliable (Haque, & al., 2023), immutable and reliable. Therefore, trustworthiness and authority are assured, which will significantly reduce grade fraud. In addition, blockchain can be used as a bank of capacity-currency transformation specifically, the blockchain learning ledger records detailed information about the learning experience of learning experience and tracks the development of their knowledge and skills. knowledge and skills(Pina, A.Torlà, Quintero, et Segura, 2017). All of these can be transformed into a kind of digital currency and stored in a blockchain network according to a comprehensive set of standards. Students will be rewarded for their rewards through their study efforts, which is called “learning is earning” (Pina, A.Torlà, Quintero, & Segura, 2017).Some schools have also started implementation with this concept, for instance, (Pina, A.Torlà, Quintero, & Segura, 2017).claimed a kind of educational reputation currency educational reputation called Kudos, like Likes on a facebook post. a facebook post. It can be used to measure learning outcomes and is stored in a virtual wallet.

E. The Meta-University

According to Kosasi (2022) blockchain will enable the University of the 21st century to become a network and an ecosystem. In this sense, innovators have a great opportunity to create a relevant educational experience, for students anywhere, assembling the world's best online learning materials, and allowing students, from wherever they are geographically located, to organize their learning journeys with the support of a network of tutors and facilitators who are specialists in the different areas of knowledge. According to Kosasi (2022), to develop these schemes for students, universities will require profound structural changes, and educators will need to work collaboratively.

Some Blockchain experts see great potential in its application in the educational area, Grech and Camilleri (2017) note that the research addresses the value that Blockchain can bring in the education sector, through an approach that explores its potential for digital accreditation of personal and academic learning. Grech and Camilleri, (2017) explain how this disruptive technology can transform institutional norms in a favorable way and empower students in its use in a responsible, secure, fast and transparent way,

Carneiro and al., (2018), raise some possibilities of the use of Blockchain, due to the fact that it is a network that allows to execute processing and perform storage in a shared way. The mentioned authors highlight that its use can be observed in some aspects of these institutions, corresponding to:

-Exchange and validation of circulating information in universities;

- -The creation of online digital identities to perform the services offered by the university;
- -Debureaucratization of administrative procedures with reduction of operational effort; (d) Security mechanisms and university data and information;
- -Collaboration in the development and monitoring of the Institutional Development Plan (PDI);
- -Access to citizen information, especially with regard to the implementation of the Open Data Plan of the Institution.

Currently some universities and colleges have applied blockchain technology in education, and most of them use it

to support the management of academic degrees and the summative assessment of learning outcomes (Pina, Torlà, Quintero, & Segura, 2017; Batubara, Ubacht, & Janssen, 2018; De Freitas 2018). Blockchain technology can formulate the entire transcript. In the formal learning context, this includes learning content and learning outcomes, as well as students' academic achievements and certificates. Subsequently, in the informal learning context, this includes information about research experience, skills, online learning experience, as well as individual interests. This data can be securely stored and accessed in a blockchain network in an appropriate manner. The University of Nicosia is the first school to use blockchain technology to manage students' certificates received from MOOC (Massive Open Online Course) platforms. Sony Global Education also used blockchain technology to create a global assessment platform to provide services for storing and managing degree information. In addition, the Massachusetts Institute of Technology (MIT) and the company Learning Machine cooperated to design a digital badge for online learning based on blockchain technology. Students who have attended MIT Media Lab projects and passed the assessment will receive a certification that will be stored in a blockchain network [9]. In addition, Holberton School is the first institute to apply blockchain technology to store degrees and has stated that they will share this information from 2017 onwards. The blockchain ledger can match all kinds of educational information with the unique identification of the user. It includes learning behaviour in class, the experience of academic micro projects and macro educational training, etc

F. Future innovative educational applications using blockchain technology in Moroccan higher education

Blockchain technology can be applied to higher Moroccan education in many innovative ways beyond diploma management and achievement assessment. For both learners and professors, blockchain technology has great potential for broader application perspectives in formative assessment, design and implementation of learning activities, and tracking of all learning processes. Some innovative applications of the use of blockchain technology in the field of education are proposed below:

A smart contract running on the Ethereum blockchain network is essentially a computer protocol that simulates a real contract (such as economic transactions, employment, etc.) (Vujičić, et al,. 2018,). It can facilitate contract negotiation, simplify contract terms, implement contract execution, and verify the status of contract performance. It marks the unique and precise identity of the parties to a transaction (contract subjects) through a digital form and stipulates the rights and obligations of both parties (contract terms) by code. The smart contract not only reduces the "third party costs" in traditional transactions, but also drastically guarantees the security and reliability of the transaction. For example, in the context of a car installation, the buyer negotiates directly with the seller instead of the bank loans, saving any additional processing fees. If the buyer violates the rules, the code will be executed and the smart contract will be terminated. The smart contract greatly improves the executive power and fairness than the traditional contract. Therefore, if professors and students conduct instruction and learning activities based on smart contract, some of the educational problems would be solved.

From the students' point of view, some subjective or objective negative factors, such as lack of motivation and financial pressure, still cause poor learning outcomes. Because of the monetary property, blockchain can be used to motivate students by implementing the principle of "learning is earning" (Pina,& al, 2017). The smart contract between professors and students can be applied to the educational scenario. Professors can award prizes in real time to students with a few clicks. Students will receive a certain amount of digital currency as a reward, according to the smart contract. This type of money can be stored in the educational wallet, used as tuition fees or even exchanged with real currencies.

Assessment is also a problematic issue in the higher education system. Formative assessment has been advocated for a long time, but it has not yet matured because it is not easy to track every detail of teaching and learning. The application of blockchain and smart contracts can address this challenge. In particular, the immutability, traceability and reliability of blockchain means that data stored in blockchain is more specific, authentic and anti-theft. Take the example of 'collaborative learning', which is seen as an excellent way to implement constructive teaching and cultivate students' ability to work with others. However, it is often accompanied by a free rider problem that hinders the fairness of assessment. Blockchain technology can mitigate this.

Each student submits their work to the learning platform through their unique account, the smart contract that runs contract that runs will review the student's performance and the results will be recorded in blocks. All behaviours during the collaboration will also be saved in blocks as evidence for evaluation. In addition, the public blockchain has the feature of decentralisation. It means that the ledger distributed ensures the consistency of most of the nodes. Therefore, as nodes in the blockchain network, students' opinions would be taken into account when assessing them. In this context, blockchain ensures fairness of assessment.

From the professor’s perspective, instruction is sophisticated and artistic, making it difficult to evaluate. The traditional method based on student feedback tends to be one-sided, lacking in subjectivity and hardly useful for teacher improvement. A new evaluation system can be built based on blockchain network and smart contract. First, professors should present pre-planned educational activities as a smart contract to schools. During the teaching process, all teaching activities will be recorded in the blockchain network. The smart contract will verify the consistency of teaching design and practice, which will be an important indicator of instructional evaluation. In addition, a smart contract can verify and complement each other between professors and schools as well as between professors and students. Professors who meet the standards will get a digital currency as a reward.

It serves as an appreciation and a stimulus for professors' teaching skills.

In general, blockchain can be used to build a balance to measure the learning process and outcomes. It is a reliable proof of equal value for all. Theoretically, blockchain can solve the problems of information asymmetry and trust between outsiders due to its decentralisation and outsiders due to its decentralisation and immutability. It ensures authenticity because information and value are collectively are published and maintained collectively. It provides a trusted form of talent investment. The most educated user of digital currencies has a high chance of gaining chances of gaining recognition and investment. investment. The Blockchain ledger tracks everything you've learned. you have learned. Employers can use this information to offer you a job that matches your skills. your skills. On the other hand, the user who wants an excellent employee can also turn to the blockchain ledger. blockchain ledger. It will greatly reduce the risk of risk of investment bias and failure. In a word, blockchain maximises the interests of both parties.

One of the best advantages for Moroccan higher education is that, blockchain technology can transform the ways people build trust from the creation of an external institution to the creation of technology. The behaviours of teachers and students are recorded and monitored when the smart contract and blockchain are applied. Trust between subjects is based on the technology itself, not the third party, In addition, it would favor the development of an active and an autonomous learning, but always verifiable and accessible.

III. CONCLUSION

Education is considered one of the most traditional fields, and in this regard, it is unlikely that a large-scale transition to new technological platforms and the associated radical restructuring of educational and administrative processes will be widespread, especially in the near future. Certainly, some universities might pilot blockchain or issue their own cryptocurrency, but it is unlikely that all universities will actively pursue this kind of innovation without also having the support of government. It seems that the use of blockchain technology in universities in the near future will be limited to certain areas, such as the organization of the storage of large amounts of data (this problem is particularly acute in connection with the transition to distance learning due to the pandemic of the COVID-19 coronavirus and the transfer of classes online). At the same time, a number of researchers note that, in the future, blockchain may significantly simplify the organizational and technical side of the learning process. Blockchain is a technology that after several years being used in cryptocurrencies, has begun to be used in various very different sectors, including Higher Education for the facilities it provides in academic, administrative and organizational management in universities. It is notorious the potential that has the disruptive Blockchain technology, which is in development, reason why, higher education institutions observe its applicability and feasibility in that educational sector, because it can manage high volumes of high volumes of information and content in real time, which allows you to make a change in the management of educational programs. Based on the documentary review presented in this article, it is evident that it can be used in the management of certificates, academic credentials, grades, professional licenses, among other official documents, acquisition of competencies, payments, as well as in the monitoring and control of the personalized learning process of each student. Blockchain becomes an interesting alternative to provide university management with mechanisms to improve planning, streamline processes, increase the monitoring of actions and the evaluation of results, so that it is carried out in a secure, transparent, agile and efficient way. Some institutions have developed pilot studies with the use of Blockchain, only to manage the accreditation process of certificates and other organizations are using it to accept payment in cryptocurrency. Based on everything presented in this research essay, it can be concluded that in this digital era this technology in universities offers the opportunity for the development of an ideal system for the monitoring and verification of the learning goals of each student, a digital portfolio so that the participant could have organized and compiled all their results, acquisition of skills and credentials before any administrative or formative need, coupled with this, it would allow to create mechanisms for the accreditation of learning. It would facilitate university exchange, mobility between institutions in this educational field, accreditation and recognition of credits, as well as sharing knowledge, all this in a more secure and transparent way, endorsed by the educational systems. In this same sense, with the use of this technology in universities, it is possible to implement the construction of personalized learning itineraries with the support of a network of instructors and educational facilitators locally or located anywhere in the world, the accreditation of learning and experience, and everything that involves the academic-administrative management in these institutions and with other entities.

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