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The Potential of Blockchain Technology in Higher Education as Perceived by Students in Serbia, Romania, and Portugal

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Abstract: Lifelong learning approaches that include digital, transversal, and practical skills (i.e., critical thinking, communication, collaboration, information literacy, analytical, metacognitive, reflection, and other research skills) are required in order to be equitable and inclusive and stimulate personal development. Realtime interaction between teachers and students and the ability for students to choose courses from curricula are guaranteed by decentralized online learning. Moreover, through blockchain, it is possible to acquire skills regarding the structure and content while also implementing learning tools. Additionally, documentation validation should be equally crucial to speeding up the process and reducing costs and paperwork. Finally, blockchains are open and inclusive processes that include people and cultures from all walks of life. Learning in Higher Education Institutions (HEI) is facilitated by new technologies, connecting blockchain to sustainability, which helps understand the relationship between technologies and sustainability. Besides serving as a secure transaction system, blockchain technology can help decentralize, provide security and integrity, and offer anonymity and encryption, therefore, promoting a transaction rate increase. This study investigates an alternative in which HEI include a blockchain network to provide the best sustainable education system. Students' opinions were analyzed, and they considered that blockchain technology had a very positive influence on learning performance.

Keywords: educational platforms; higher education; online courses; artificial intelligence; blockchain; sustainable education

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1. Introduction

Blockchain is an underlying technology process that can perform digital verifications, such as cryptocurrencies [1]. More and more areas are emerging through innovative blockchain approaches. Blockchain technology is also used to improve Higher Education (HE), as well as for the development of an educational infrastructure to support learning. Innovative science learning relationships often involve sustained individual inquiry, intense social interaction with interest groups, and expert mentoring relationships. Blockchain technology allows students to interact with better-informed colleagues and mentors [2–4].

Today, blockchain technology has found wide application in numerous fields, as evidenced, among other things, by numerous studies and scientific research. Further-

more, blockchain-based applications are disruptive in their fields because of the infinite applications such as electronic cash [5].

Recent areas of application of blockchain often researched in a scientific setting are numerous: [6–10]; distributed electricity markets [11]; healthcare monitoring [12–15]; money laundering detection [16]; privacy preservation [17–19]; vehicular communication [20]; network knowledge transformation [21]; intellectual rights protection [22]; secure wideband spectrum sensing and security enhancements [23,24]; real estate transactions [25]; pharmaceutical industry [26]; and federated learning [27]. Unfortunately, there are few papers on the application of blockchain technology in HE in this and other reference journals, which this article seeks to amend. Understanding all the processes involved is necessary to use blockchain technology in HE.

The researchers seek to describe the current state of blockchain technology in higher education, examine the advantages and disadvantages of the technology, and present possible solutions that Higher Education Institutions (HEI) can implement, especially in low- and middle-income countries. This study addresses the following research questions:

- What significant opportunities do HEI gain if they implement blockchain technologies?
- What significant challenges do HEI face when they implement blockchain technologies?

Thus, the objective of this study is to investigate an alternative in which HEI are included in the blockchain network to provide the best possible sustainable education system. Toward this goal, the concept of the paper, along with its organization, used the IMRAD model, which is a common scientific writing structure as a document format and the most common structure for original research journal articles.

The research aimed to understand students' perspectives on blockchain and learning through a survey. This was complemented by a practical case of implementation. This study's researchers were motivated by their involvement in the educational development processes in their own countries for decades. For example, three authors are involved in formal and informal education in the Republic of Serbia. In addition, they have initiated the implementation of blockchain technologies in HEI and EdTech in which they are employed or which they own.

Another important motive for this research is the dearth of research in the field of blockchain usage on university students (in total), especially in the selected countries, so we are convinced that the results of this article will be of great importance for global application, especially for low- and middle-income countries.

Blockchain has been understood as creating agreement through reward systems for students, professors, universities, and smart contracts by avoiding waste, connecting people even if they are far away, and decreasing the bureaucratic and validation process.

The study collects qualitative data and knowledge via document analysis (literature review). Applying the model found in this document, the document analysis process utilizes the following steps: identifying relevant documents, organizing an organizational chart, authenticating documents, and locating document content.

2. Literature Review

Alzahrani et al. found that all employees must work together to realize quality gains and provide more services. Regarding any organization, improving communication among staff, faculty, and students is essential independently of the academic institution. The new technology that has been used in traditional forms of communication such as emails, text messages, social media applications, and blockchain has assisted with the development of joint projects in education and various other sectors [28].

Ullah and associates found that schools have adopted blockchain technology for educational purposes in some institutions, and in others, it is being used to manage academic degrees and final grades. It requires a college degree, as well as grade-based assessments. Furthermore, various courses can be taken online along with group meetings, presentations, and research activities. The author states that one university uses Distributed Ledger Tech-

nology (DLT) to verify credentials received from Massive Online Open Courses (MOOCs). To incorporate blockchain into their overall business operations, Sony has decided to use blockchain to establish a transparent evaluation framework for providing information storage and management services. MIT developed a distributed ledger-based digital badge for online learning. DLT is being used to store degrees and educational information at Holberton School, the earliest educational institution to use DLT. A distributed ledger can accommodate various types of information, with a unique student identity (Id) for each record [29].

Immutability, decentralization, traceability, and currency properties were considered the main features of the blockchain, particularly suitable to the HE sector [30]. For Awaji and colleagues, in addition to decentralization, immutability, and traceability, the authors considered reliability, transparency of information, availability, and trust are important, too [31].

Considering a substantial potential scope for blockchain, a digital revolution, referred to as the fourth industrial revolution, is happening. This revolution consists of several technologies: artificial intelligence, machine learning, the Internet of Things, Big Data, blockchain, robotics, 3D technology, and more. In addition, recent technological advances have assisted societal concerns. For example, new technologies were of great importance for specific societal problems. They assisted in overcoming complex and unpredictable phases, such as providing the virtual integration of people in the complex situation of the COVID-19 pandemic [32].

According to Yli-Huumo et al., in this sense, the technology referred to as blockchain can be understood as a distributed, decentralized, and tamper-proof transaction and data management mechanism that offers several features such as security, anonymity, and data integrity [33]; most of the current studies on blockchain in HEI are looking into its applicability in various areas of HEI [28].

Tapscott and Tapscott investigated the possibility of using blockchain in HE [34]. According to this source, blockchain technology can be applied to a wide range of transaction categories [35], including certificates [36], data, money, student records and profiles [37], the data of workers and stakeholders, and online access to libraries and copyright issues. In the HE context, four recommendations for successful blockchain usage were outlined. These were: setting out the services and participants that handle and run the data [38], establishing the cryptocurrency principles, and conducting the code development and proof-of-work tracking. Smart contracts, for example, allow distribution of tasks and transfer value [39] and can be used for teaching and learning [30]. Blockchain and smart contracts together can be applied in different situations in HE, namely for learners and teachers [31].

Guo et al. presented a permissionless blockchain-based Ethereum network for the protection of online educational data such as MOOCs. The proposed system addresses insecure digital certificates and the limited openness of multimedia learning resources [40]. For example, Capece and associates found that current academic achievement certification systems are complex, time-consuming, expensive, and prone to forgery [41].

The current level of decentralization, while making educational achievements more accessible, does not include a computerized and standardized mechanism to document and manage said achievements. This infrastructure is expected to deliver various advantages due to its design [42] as a decentralized and secure digital certificate chain, based on blockchain technology. The students' first benefit would be the availability of a tamper-proof verified diploma. Moreover, regarding the universities, permanence, ease, and security for the student record can be assured with blockchain technology. They also bring good practice into the spotlight. They found that Blockcerts, a public education initiative started by MIT and Learning Machine in 2016, may be well-positioned to take on the role of a new standard for awarding educational certifications on the Blockchain platform. It helps students to obtain a verified tamper-proof diploma that is quick and

simple to produce. In addition, the infrastructure safeguards the certificate's authenticity by providing permanence, ease, and security according to the record's significance [41].

Blockchain will present options in colleges to choose from by utilizing this technology [43]. As we noticed in the example from the Technical University of Madrid, Spain, it is possible to achieve sustainability in the long term. HE platforms such as Tutellus, SGE, Edgecoin, distance learning management, student collaboration and interaction, student creativity, and increased motivation will be enhanced. Blockchain's widespread use will stem from its credibility, traceability, and security [17]. This makes it suitable for everything, including student fees, rewards, digital badges, and file storage, and as a platform for new online learning models. Blockchain facilities will be a sustainable solution for HE, as the physical distance will become a less significant factor in knowledge sharing and networking.

As a trusted platform for supplying auditable data, blockchain technology has evolved as a basic framework in the decentralized peer-to-peer network employing cryptographic techniques [44]. The software empowers the users to transact in trusted networks to facilitate the emerging Internet of Value (IoV) [45]. While this is still a relatively new notion, with new implications for citizens' next-generation protocols and applications, we feel it is only just starting to be applied. Bdiwi proposed a new blockchain-based architecture for ubiquitous learning that retains privacy [46]. In this way, the distributed ledger architecture opens new possibilities for collaborative learning. It offers decentralized data exchange with blockchain using trust methods. This disruptive technology-based framework delivers ubiquitous learning environment privacy [46], in which case some frameworks can be used: e.g., Ethereum, Hyperledger.

According to Abad-Segura and associate [47], the classic approach in education has some specific features:

- A fixed mindset: It is easy to eliminate students from the educational system because they do not meet the criteria. Nevertheless, a better approach will be developed to change the paradigm, mentoring, and guidance to determine necessary student behavior transformation.
- Results-only: The results are significant for sustainability, but we all learn from "trying and making mistakes". It is advisable to let students experiment in a controlled environment and see the consequences of their tests and behavior. Learning from mistakes sets a strong trace on the neural system and determines a long-time learning effect.
- Elitism: The teacher's talent might be proven when they can teach for gifted minds, destined for greatness, and for ordinary students, too.
- Self-righteousness: The rules assumed by this research are fundamental in everyday life/education, but there are exceptions when the student faces emotional problems, and the teacher must cope with them.
- Detachment: Detaching from things one fears losing helps to maintain an equilibrium. Some students exhibited desperate gestures when receiving negative feedback from the teacher. Nevertheless, at the same time, rewarding goals maintain student interest and engagement in their struggle to succeed. Detached teachers are mentors who call in each day because they no longer feel connected with their students.
- Lack of nuance: When spending years gaining wisdom, more nuances appear to reach high performance. Being wildly convinced by one idea means that there is a lack of knowledge or perspective.
- Lack of creativity: Prescriptive and rules-bound education ensures a coherent educational system, but sustainable innovation within this system stimulates critical thinking, creativity, communication, collaboration are essential issues.

Another perspective from [3] can be considered:

- Compassion: Students are not robots. They need to be encouraged to step over mental, psychological, emotional, and physical barriers in certain moments.
- Co-creation: The journey and the discovery do not lay out a systematic framework. The teacher may stimulate student interest through inquiry and experimental learning.

It does not insist on rigid lesson plans. Sometimes the student can discover their identity and grow in their wisdom.

- Character: The education target should be acquiring a skill set and focusing on the student's personality. In most educational systems, this mindset is often missing. Some examples of the education system that can make better people are Singapore, Japan, China, etc.
- Perseverance: The students give more significance to the results obtained with struggle than those gained without effort. The student's attitude must be of sticking with it until they get it right. When students are humble enough to admit they have made a mistake, they can grow.
- Just enough help: Great teachers know when to step out of the way and allow their students to thrive. In this approach, the teacher proved that being a facilitator or a "guide on the side" did not make them less influential but made the teaching more impactful.
- Potential: Teachers can see the potential in students that even the students do not yet believe; they know how to encourage them.
- Simplicity: The great discoveries show that sometimes wisdom is simple, for example, Einstein, who proved gravity. Likewise, proverbs are profound, simple, and reflect reality.
- Mindfulness: The teachers must encourage students to be action-oriented and help them manage their emotions and mind flow in agitated moments.
- Experiential learning: The teachers must create the experiences that allow students to thrive.

Different blockchain protocols provide other interactions [48]. Table 1 presents some of these methods.

Table 1. Examples of methods to differentiate through teaching and learning styles.

	Methods			
Conceptual framework	Virtual reality [VR] and augmented reality [AR] were considered scientific tools that help the learning process in different fields [49].	Massive online open courses [MOOCs] were seen to engage and motivate massive audiences, especially those related to dropping out of school [4]. There are strategies, such as social networking and digital storytelling, to ensure open education [50].	An application of game design, in non-game scenarios, to solve problems or change the behavior [51]. It was also considered as a critical pedagogical tool to improve student motivation [50] In addition, gamification design impacts users' development and learning performance of users [4]	Videoconferences
Simulation	X	X	X	
Experimenting	X	X	X	
Teaching by doing		X	X	

Platforms such as SGE, Edgecoin, and Tutellus offer most of these features and are appropriate in the educational system, as shown in Table 2.

Table 2. Examples of platform services.

Platform Services		Tutellus		SGE		Edgecoin
Content library	x	An excellent platform for online educational collaboration. Initially for Spanish-speaking countries, from 2019 available in other languages	X	Integrated platform to support the educational system	x	The world's first Educational Stable Coin offers an open payment system for educational institutions. Associated with the stable coin, the platform offers "Gradecoin", a fluctuating coin that allows students to "earn while they learn."
B2B paradigm	x		X		x	
Tokens	x				x	
Collaborative learning	x				x	
Job opportunities			X	Integrated platform to support an educational system		
E-Certificate			X		x	
Scoring system			X			
Store personal data			X		x	

In recent years, there has been a growth of students in MOOCs, especially after the outbreak of the COVID-19 pandemic [52]. According to the authors, learning can be enhanced using AR. Similarly, holographs and XR can aid the learning experience (e.g., surgeons). Blockchain technologies will also ensure high engagement in the courses and the resources for a sustainable platform.

Technically speaking, the advantages brought by blockchain are: [53]

- Blockchain is a distributed network of computer systems. Therefore, data breaches are very difficult to carry out.
- Blockchain generates hash codes related to each block. Therefore, it is challenging to implement cyber-attacks.
- Each block's hash will be modified by manipulating data, and the blockchain becomes invalid.
- Stages of Blockchain implementation are:
- Identifying clear goals and setting priorities for achieving them;
- Making a prototype for implementation and setting a deadline for it;
- Creating an early application and testing it to obtain feedback to correct errors; and
- Launching the application for the public in general and cross-assessment of the results using the benchmark.

Table 3 presents some examples of institutions that are using these methods.

Table 3. Institutions of HE and respective methodologies implemented—examples.

HEI	Courses	Results
Technical University of Madrid, Spain [54]	Engineering education, Information and Communication Technologies	The incorporation of virtual methodologies improved the learning process and the motivation of students in engineering MOOCs
Universidade Aberta [50]	Aula aberta em 2013	Gamification, as well as other innovative strategies (e.g., digital storytelling), can help the sustainability of HE at institutions such as the Aberta University

Table 3. *Cont.*

HEI	Courses	Results
Open University e EADTU (Holanda), Universidade Aberta (Portugal), Universidad de Oviedo (Spain), Universidade de Zaragoza (Spain) [55]	Integrated into the ECO European project	ECO MOOCs, massive, open, and online courses
Science Museum, AgriTech Centre of Excellence, University of Adelaide, The Holy Quran Academy [56]	VR/AR	The use of technology in schools, in the field of education, provides the students with unlimited learning and development opportunities
Online Course Platforms—MOOCs [57];	Canvas Network, Coursera, FutureLearn, Cognitive Class	Provides predominantly free and self-paced online classes; users can pursue coursework at their own pace with no time restrictions for completion; addresses information from different fields; low-cost online academic programs

Two main groups have been identified for the use of blockchain in HE: the beneficiaries (HEI) and providers (start-ups, organizations) of such solutions [58]. In addition, certification initiatives, identity management (Digital Credentials Consortium, Open-Source University, BCDiploma), and applications that motivate lifelong learning were considered relevant factors. In addition, General Data Protection Regulation (GDPR), scalability, market adoption, innovation, and data privacy and security, were considered challenges to overcome. Blockchain technology applications in HE led to productivity gains and cost reduction [59]. In addition, blockchain improves the quality of universities [60].

3. Materials and Methods

This study investigates an alternative in which HEI are included in the blockchain network to provide the best possible sustainable education system. Thus, the research was developed according to the perspective of the survey research itself and the explanation about the implementation.

An instrument was developed. Questions related to the profile, demographic, and personal variables were answered by HE students, as well as questions about blockchain and learning performance. The questionnaire was implemented online.

The questionnaire was oriented towards HE students from courses related to new technologies and, therefore, with understanding about blockchains. In this sense, one can consider the students' opinions acceptable, even if they do not have extensive experience.

The results were analyzed using the statistical technique of structural equation modelling by Partial Least Square (PLS), which analyzes latent variables, formative or reflective, with simultaneous interactions, even for smaller samples.

The researchers employed a methodology that included participant observation, case study model, and observation to gather their information. Document analysis was additionally used. In addition, a survey was conducted with 150 college students from Serbia, Romania, and Portugal and aimed to evaluate students' opinions regarding the influence of blockchain on learning performances.

As university professors involved in learning processes and daily interaction with students, we used observation with the participation method. The study of literature or a document may also serve the needs of the social sciences and assist in gathering data within secondary research. Surveys are the right tool for collecting quantitative information and applying analysis. In its digital (online) form, it is a low-cost tool. However, for its impact on identifying people who use technological tools efficiently, it is an invaluable resource.

We have managed to maintain objectivity and avoid bias by using multiple coders to code our data: allowing participants to view our results enables us to maintain objectivity.

In addition, to be sure of the results, we used multiple statistical analyses. Finally, using an excellent literature review, we were able to find more data sources and to seek out possible explanations for our findings.

A new analysis of the blockchain literature reveals that most studies are interested in describing the benefits and challenges of applying blockchain technology across various business sectors. On the other hand, a lack of interest in adopting blockchain technology in HEI has been observed.

This research aims to learn more about blockchain in education and develop a preliminary study through several other countries. The overall goal of this research is to enhance the understanding of the current state of blockchain applications. In the first phase of the research, aiming to understand the relationship between student learning performance and blockchain, a questionnaire was implemented on students from these three countries: Serbia, Romania, and Portugal. The results presented different decision-making factors that impact the intention of students to utilize blockchain in postsecondary education.

4. Results

The results were analyzed in two stages: the survey research itself and the explanation about the implementation.

4.1. Survey Research: Data and Variables

This survey was applied to 150 students from Serbia, Romania, and Portugal and aimed to evaluate students' opinions regarding the influence of blockchain on learning performance. Two variables were extracted from the survey: Blockchain (V1Blockchain) and Student Learning Performance (V2LernPerform). The Blockchain variable evaluated how extensive the use of blockchain was in HE for a large audience when courses were taught through instruments such as MOOCs, AR, VR, gamification, or videoconferences. The Student Learning Performance variable evaluated the students' opinion regarding how much the learning performance is influenced by collaborative work, motivation, engagement, MOOCs, AR, VR, gamification, or online classes (Table 4).

Table 4. Variables and respective indicators.

Variable Name	Code of Indicator	Indicator Name
Student Learning Performance	V2 Collaborative	V2 Collaborative work enhances learning performance
	V2 Motivation	V2 Motivation enhances learning performance
	V2 Engagement	V2 Engagement enhances learning performance
	V2 MOOCs	V2 MOOCs enhances learning performance
	V2 AR	V2 AR enhances learning performance
	V2 VR	V2 VR enhances learning performance
	V2 Gamification	V2 Gamification enhances learning performance
	V2 Online class	V2 Online classes enhance learning performance

Table 4. *Cont.*

Variable Name	Code of Indicator	Indicator Name
Blockchain	V1 MOOCs	V1—Blockchain is used in HE for the massive audience [MOOCs]
	V1 AR	V1—Blockchain is used in HE for the massive audience [AR]
	V1 VR	V1—Blockchain is used in HE for the massive audience [VR]
	V1 Gamification	V1—Blockchain is used in HE for the massive audience [Gamification]
	V1Videoconferences	V1—Blockchain is used in HE for the massive audience. [Videoconferences]

The questionnaire used these two variables, blockchain and learning performance, and their respective indicators to assess the influence of blockchain on learning performance. Collaborative work, motivation, and engagement would be indicators of learning performance and the use of MOOCs, AR, VR, gamification, and online class. Moreover, blockchain application to HE, such as MOOCs, AR, VR, gamification, and videoconferences, was evaluated.

4.2. Research Process

Considering hypothesis H1: Blockchain used in HE for the massive audience has strong positive influences on Student Learning Performance, the research used SmartPls [61] to evaluate the consistency through composite reliability as presented in Figure 1. One may observe that MOOCs containing AR/VR applications, Gamification and Videoconferences unified by blockchain technology had a very positive influence (path coefficient = 0.742) on learning performance. They also increased in a specific extension of students' engagement, collaborative work, and motivation.

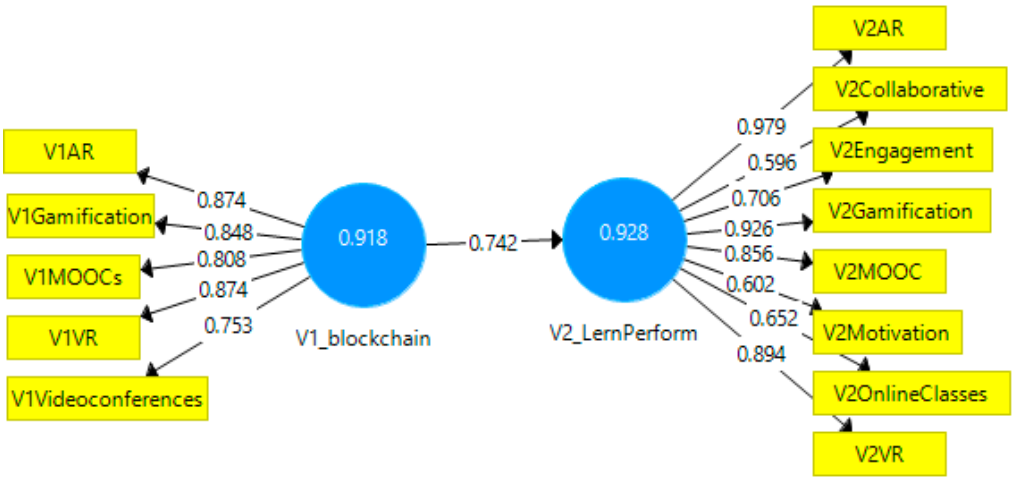

Figure 1. Composite reliability.

The composite reliability showed a robust model that confirmed this hypothesis considering the high values (>0.9). Next, investigators evaluated the Cronbach Alpha to determine if the survey was correctly designed and has the same coefficients as Composite reliability.

The Cronbach's Alpha Analysis shows that the survey questions were very well chosen—the factors that influenced V1 and V2 represented the analysis because they all

had very high values (more excellent than 0.7). The validation process was based on the criteria/steps presented in Table 5.

Table 5. Validation Steps/tests.

Reflexive Construct	Composite Reliability	Cronbach's Alpha	AVE	R Square
	(>0.7)	(>0.7)	(>0.5)	(>0.5)
V1Blockchain	0.918	0.934	0.624	
V2LernPerform	0.928	0.918	0.703	0.551

The mean extracted variance (AVE) of each latent variable: (a) V1Blockchain (0.624); (b) V2LernPerform (0.703) was higher than the acceptable threshold of 0.5, so the convergent validity was confirmed. Moreover, the correlation coefficient R square was higher than the minimum accepted 0.5. The inner model was statistically significant because its standardized track coefficient (0.742) had a high value. The Collinearity Statistics (VIF) shows that there is no multicollinearity between our independent variables (Figure 2). If between independent variables manifests multicollinearity then the statistical inferences will be less accuracy, due to higher standard errors. VIF value 1 means that variables are not correlated VIF values between 1 and 5 means that variables are moderately correlated and VIF values greater than 5 means that variables are highly correlated.

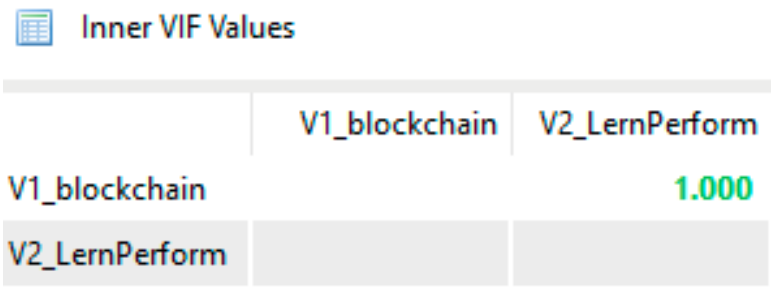

Figure 2. Collinearity Statistics (VIF).

All the validation steps presented in Table 5 allow us to consider that the indicators of the constructs, V1 and V2, were highly correlated, and the H1 hypothesis was not rejected. To evaluate the significance of variables, the Variance Inflation Factor (VIF) of each construct was performed with 5000 samples, and a reliability of 95% through the bootstrapping procedure was achieved with the help of SmartPLs software. The results are summarized in Figures 3 and 4.

The two-tailed *t*-test in bootstrapping values was all higher than 1.96. In other words, the values were higher at the critical level, which means they were significant [62]. *p* Values were smaller than 0.01. Even the path coefficient (8.813) had a very high value. All these criteria allow us to assume that our hypothesis was accepted. Thus, we may assume that blockchain technology facilitates learning performance in a very high proportion (Figure 5).

Keeping in mind the importance of blockchain implementation in HEI, we have data to prove from the point of view of students (our future generation—very important for sustainable economy) that blockchain influences learning performance.

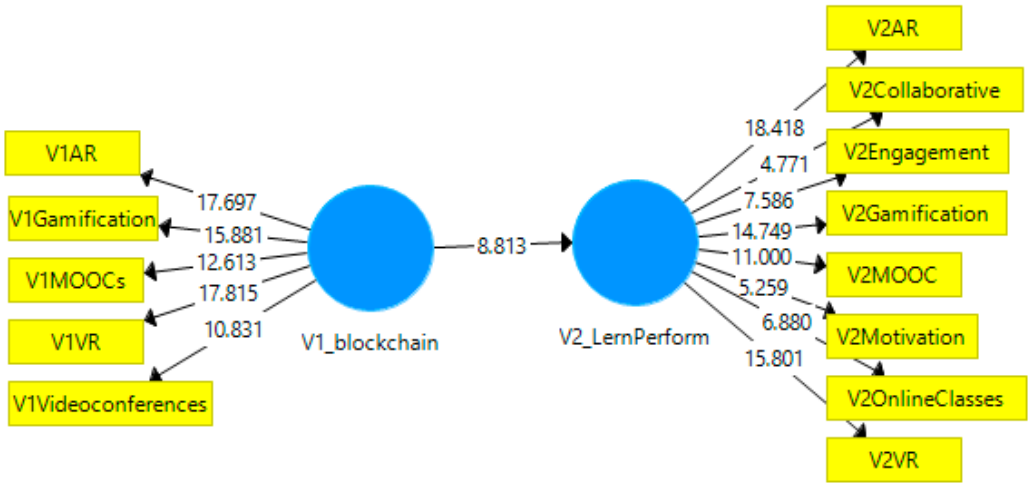

Figure 3. Bootstrapping data.

Mean, STDEV, T-Values, P-Val...

	Original Sampl...	Sample Mean (...	Standard Devia...	T Statistics (|O/...	P Values
V1_blockchain ...	0.742	0.746	0.084	8.813	0.000

Figure 4. Bootstrapping significance.

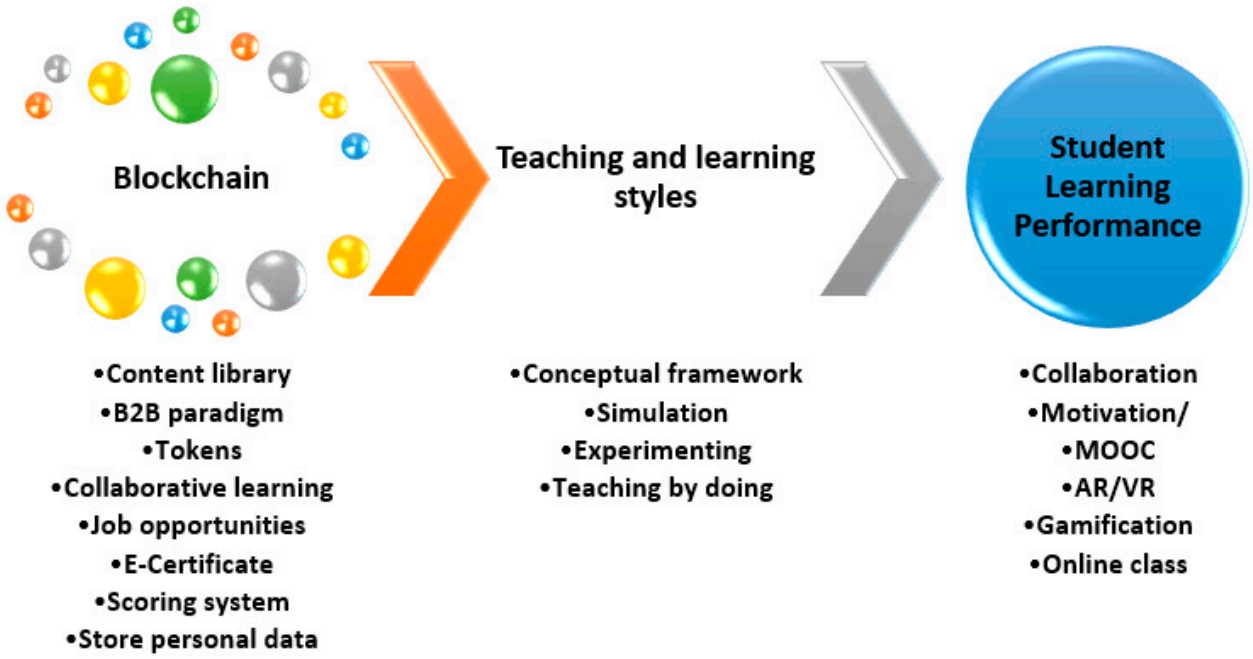

Figure 5. Blockchain facilities for HEIs.

5. Discussion

We analyzed the opinions of 150 students from Serbia, Romania, and Portugal regarding the influence of blockchain on learning performance. HE students were asked questions on their personal and demographic characteristics, blockchain, and learning performance. The survey was administered online. Students in technology-related courses at HEI were targeted with the questionnaire. The students' comments were considered, even if they lacked a lot of expertise.

We implemented a blockchain school history to emphasize the advantages of converting school documents (transcripts) into blockchain data [29]. In addition, students can extract their study results into blockchain (UMS/ID number), validating each added new block [33]. Furthermore, that can be enabled after each exam, making the platform more interactive as the teacher or eLearning platform associates a note with the student by default.

The students can spend earned bitcoins to purchase books, pay the tax, buy food at the school coffee bar, etc. [34]. Thus, the benefits are duplicated: on the one hand, there is a very accurate record in the data source; and, on the other hand, it increases the students' interest to interact with the E-learning platform aiming to gain bitcoins. Moreover, the HE Cloud can be stored in many blockchains on different activities [29].

Decentralizing [44] online learning will ensure realtime online interaction [28] between teachers and students. The student may have the opportunity to choose between courses from curricula. In addition, blockchain allows us to implement improvements in terms of structure and content or to add learning tools. The importance of document validation must also be associated, accelerating the process, and reducing costs and paperwork [41].

Finally, beyond the classical approach [47], blockchain is a fully inclusive process [3], allowing the integration of the most diverse cultures and people at the most diverse learning levels. In this way, one can connect blockchain to the concept of sustainability, especially when learning in HEI can be favored by new technologies.

Blockchain will also offer alternatives in HEI through this technology [28]. As we saw in Technical University of Madrid, Spain, Universidade Aberta, Open University EADTU (Netherlands), Universidade Aberta (Portugal), Universidad de Oviedo (Spain), and Universidade de Zaragoza (Spain), blockchain can promote sustainability in the long term.

HE platforms such as Tutellus, SGE, and Edgecoin will enhance the distance learning management process, student collaboration and interaction, student creativity [40], and higher motivation in obtaining transferable skills and international recognition through badges.

Because of its credibility, traceability, and security, blockchain [17] will be increasingly used in all areas: record-keeping (for students, professors, educational institutions, and file storage), create a new market for digital assets (students' fees, rewards, digital badges, publishing fees), and create a disruptive business model, decentralizing online learning and creating better learning platforms.

In the future, physical distance will matter relatively little for knowledge sharing and networking, diminishing the importance of distances, meaning that blockchain facilities will be a sustainable solution for HE.

More recent research on artificial intelligence and machine learning found that students have more accessibility to personalized learning environments today. Computers are helpful for both problems, which both involve them. Assisted by data and supported by individualized learning, students will have access to individualized learning experiences powered by artificial intelligence. Professors can discover new teaching methods that meet students' learning needs, while also providing advice on tailoring teaching to fit students' unique needs. Other educational institutions and EdTech companies will significantly benefit from these new approaches [63].

6. Conclusions

The changes that emerged in the younger generations could not be avoided, and as a result, learning itself was redefined. Teaching methods are being re-engineered to keep pace with the evolution of learning and to help train both working-class and career-oriented future professionals. This interaction and sharing of knowledge make it possible to include people and bring different cultures closer together.

Mechanisms such as blockchain could increase the efficiency and effectiveness of blockchain in learning performance. Nevertheless, blockchain must evolve a great deal in terms of technical challenges. Moreover, keeping up with this evolution comes at a high cost.

However, acquiring knowledge is a cognitive and social process that necessitates interaction. Moreover, existing barriers that may obstruct this interaction need to be overcome.

The main objective of this study was to investigate an alternative in which HEI are included in the blockchain network to provide the best possible sustainable education system. As a result, blockchain is a technology with advantages such as process and resource optimization and disadvantages such as update costs.

Education must be a sustainable process over time, from a broader perspective. Therefore, a holistic model that strives to promote employability and ensure continuous, inclusive, and equitable learning by leveraging new teaching methods and technologies and digital, transversal, and practical skills is a critical element of sustainable education [SE]. Moreover, SE may include all stakeholders, including customers, partners, and investors (e.g., students, professors, universities, communities, etc.). Furthermore, the students know that what they are doing is linked to blockchain technology.

This study adds to the literature by referencing publications on the implementation of blockchain technology in HE and assessing the importance of blockchain for learning performance. In terms of practical implications in HE, blockchain can be applied to MOOCs, AR, VR, Gamification, and Videoconferences can be used in HE for a massive audience and the entire process related to the management of teaching and learning. In other words, the practical implications in terms of intervention, blockchain can be used to facilitate access, and at the same time the beneficial impact in terms of prevention, blockchain can improve trust, transparency, and security of this access. Moreover, it influences learning performance.

Students' learning performance depends on collaborative work, student motivation, engagement, and blockchain tools such as MOOCs, AR, VR, online courses, and gamification. In summary, blockchain can support learning performance by bringing people together and promoting knowledge sharing, increasing it.

Regarding the study's limitations, the HE Cloud can be stored in many blockchains. Due to space constraints, our case study only covers student transcripts, but other features can be implemented. We will continue to research the ways to implement these facilities. Moreover, even the pioneering HEI that adopted blockchain did not cover all facilities. This is a limitation for now, given digital literacy, the newness of blockchain technology, and its complexity. Mining bitcoin is also harmful to the environment and the climate, and it goes against the EU's Green Deal.

Furthermore, students' socioemotional and cognitive development is a significant issue that lacks a digital solution. So, we keep looking for solutions, mainly with psychological support. So, we still await the psychologists' answers.

The literature review shows that resolving the challenge of HEI-blockchain implementation is not formulated well for low- and middle-income countries. There are inadequate recommendations in the literature, which represents the research gap.

This research is due to social desirability, generalizability, imprecise measurements, and unasked questions. Referencing past research in the reference list is limited because this is not a review paper. Future research must involve finding suitable blockchain application proposals and projects for HEI in low- and middle-income countries and spreading awareness about solutions and practices that can aid HEI the most when adopted.

In terms of limitations, this research was focused on HE and assessed only the two variables: blockchain and learning performance. Furthermore, the sample size does not allow generalized inferences. Nevertheless, as a possible way to apply blockchain technology in HE institutions, this research suggested using all possible support from technologies to promote more reliable learning in different areas of education.

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