

# ISSUES, CHALLENGES AND OPPORTUNITIES IN BLOCKCHAIN-BASED EDUCATIONAL PARADIGMS: A SYSTEMATIC LITERATURE REVIEW PROTOCOL

<b>Rebwar Bakhtyar</b> <sup>1</sup>	<b>Twana Nasih Ahmed</b> <sup>2</sup>	<b>Ali Wahid Nwry</b> <sup>3</sup>	<b>Miran Hama Rahim Saeed</b> <sup>4</sup>	<b>Karzan Wakil</b> <sup>5</sup>
<sup>1</sup> <i>Database Technology Department</i>	<sup>2</sup> <i>Horticulture and landscape design Department</i>	<sup>3</sup> <i>Anesthesia department</i>	<sup>4</sup> <i>Information Technology Dept</i>	<sup>5</sup> <i>Department of Computer</i>
<i>Technical College of Informatics, Sulaimani Polytechnic University</i>	<i>Bakrajo Technical Institute, Sulaimani Polytechnic University,</i>	<i>College of Technical Health Sulaimani Polytechnic University</i>	<i>Computer Science Institute Sulaimani Polytechnic University</i>	<i>College of Science, University of Halabja</i>
<i>Sulaimani , Kurdistan Region, Iraq</i>	<i>Sulaimani , Kurdistan Region, Iraq</i>	<i>Sulaimani , Kurdistan Region, Iraq</i>	<i>Sulaimani , Kurdistan Region, Iraq</i>	<i>Halabja 46018, Kurdistan Region, Iraq</i>
<i>ribwar.ibrahim@spu.edu.iq</i>	<i>twana.nasih@spu.edu.iq</i>	<i>ali.wahid@spu.edu.iq</i>	<i>miran.saeed@spu.edu.iq</i>	<i>karzan.wakil@spu.edu.iq</i>

**Abstract** –Blockchain is a new technology that provides services of immutability, trust, disintermediation, collaboration, transparency. Nowadays, the use of this new technology is mostly used for Bitcoin and other cryptocurrencies, but apart from this, blockchain technology improved the performance level of other areas of life i.e. Higher Education Institution (HEI) and stakeholders, certificate verification and many other domains. Students and educational institutions' important data are mostly shared via different networks. The data integrity, privacy and security are the major issues for these in the blockchain technology which cannot be avoided. This paper is a documented plan for to conduct or a protocol based on which a systematic literature review would be conducted focusing the issues, challenges and major strengths of blockchain and its educational paradigms. The result of this review will be highly helpful for the new researchers to overcome the proposed issues and challenges, exploring educational paradigms in Blockchain, elaborate the major strengths helping the educational institutes in adapting process and increase the level of satisfaction. This study plans to explore some educational types with some issues and challenges such as scalability, immutability, and easy adaptation.

**Index Terms** - *Systematic Literature Review Protocol (SLRP), Higher Education Institution (HEI), Blockchain-Based Educational Paradigms (BCBEP).*

## I. INTRODUCTION

Blockchain is on Blockchain is on a list of fast-growing technologies. Due to its versatile features and advantages, it is extended from financial and other sectors to educational domain. Blockchain technology is a distributed and decentralized public ledger, which facilitates to keep immutable data securely and ensure that transaction can never be modified [9]. Blockchain is the new technology of distributed systems and is widely used in global finance, business and company services, and other areas, but in the

field of education and teaching there are few mature instances and research literature benefits. A few organizations that use the blockchain technology facility for educational purposes. Nowadays, universities and educational institutions are using blockchain technology for learning outcomes to improve the performance of the curriculum [1]. In Higher Education Institutions (HEI) Blockchain technology is mostly used for credits and grading system as well as to share the data securely efficiently and avoid the language barriers [2].“Blockchain in education is a Distributed Ledger Technology` which enabling protecting data integrity, prevent from tamper-proofing, disaster recovery of data, transparent and incorruptible transfer of data, protecting identities and protecting critical infrastructure, preventing fraud and data theft [3].

Blockchain technology provides some benefits, which can easily be easily adopted in the education system as shown in Figure 1.

- Decentralization: A P2P distributed architecture over a centralized improves the fault tolerance but there exists no connection for central point's which is the main reason for its failures.
- High scalability: Easily manage a large number transactions and processing information.
- Reliability: Immutable information and easy verification of the data.
- Security: Blockchain enables to keep the institutional records more secure.
- Cost: Adaptation of blockchain in education reduces the academic institutions' administrative cost [4]

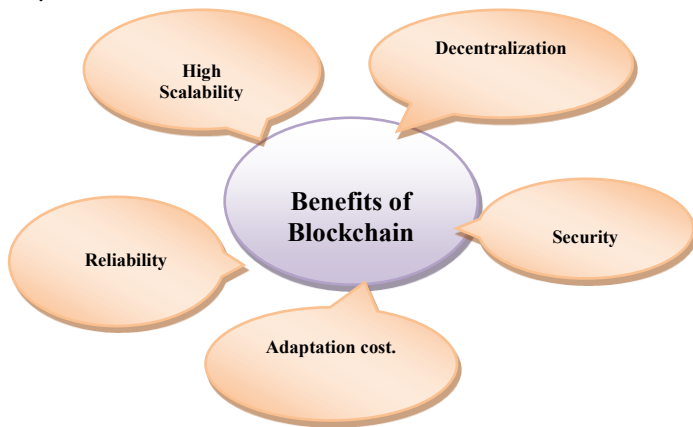


Fig. 1 Benefits of Blockchain.

Prominent strengths of blockchain are verification of documents, improving data quality; integrity and immutability, etc, and helps in most areas of life. Recently, blockchain is mostly used for Bitcoin and cryptocurrencies in academia and non-academic sectors. Blockchain was firstly proposed in 2008 for Bitcoin and then later on after one year in 2009 launched and implemented. Additionally, Blockchain technology has a great potential to improve the quality of the internet. Scalability is one of the main challenges to work with Blockchain [15]. Blockchain is a useful technology which improves the efficiency of the business community, internet of thing and e-voting system, medicines as well as in pharmaceuticals field. There are some advantages of SLRs, the main purpose is to identify the gap in the current research. In the complete SLR study, we will try to find out the main issues in Blockchain-based educational paradigms and exploring the educational paradigms used in the Blockchain. This study presents a protocol or a documented plan, on how the SLR would be conducted.

## II. BACKGROUND

This section mainly discussed the background and related work of Blockchain-based Educational paradigms.

### A. Education Paradigms based Blockchain

Blockchain technology provides the facility of distributed record of a digital event in a decentralized platform where data and educational transactions has no influence of the third party. The primary objectives of BCBEP are exploring BC types in the education sector, issues, and challenges, key strengths of BCBEP. The Higher Education Institutions adopts this technology for sharing of educational certificates/degree via a secure platform. The use of this new technology is still in the initial phase, only a few number of educational institutes are using Blockchain technology across the globe. Their lack of interest is due to the lack of knowledge in the relevant field. Some educational institutes are using for learning outcomes and certificate verification [4]. As per the report of the University of Cincinnati, “the use of Blockchain technology is

much more helpful in the classroom environment which improved our students positively in the learning process by 92%”[17]. Furthermore, there are many uses of blockchain technology due to its application they are used in in the field of healthcare, the internet of things, and banking [5]. In Higher education institutes continuous learning outcome evolution of curriculum is efficiently possible with the benefit of trustworthy awarding degree/certificates, improvement in the curriculum, and facing the issues of filtering and standardization of data [1]. Through blockchain technology, in large scale system recording and collecting the school data in an efficient manner which help in decision making prevent from the fraud activities [6]. Applications of blockchain technology deal with many issues like insufficient users, system interoperability (dependence on a system) in the e-learning system, and related information security, adopting this new technology in the existing system will overcome these issues to a certain level [7]. Exploring the new paradigms in the field of blockchain improves the overall efficiency of the academic and non-academic environments. In blockchain-based computer science education brings down the cost per transaction, integrity, and immutability of data is guaranteed [5, 8].

### B. Related Works

This review will be about how Blockchain helps to improve the quality of education in academic and non-academic organizations as well as show its worth and importance. Every educational paradigm has its issues and it can be overcome to some level by Blockchain features. Blockchain in Peace Engineering process millions transaction efficiently, which is not an easy task. In most cases, not every person shares their private information [10]. Blockchain learning is possible through design tools and models, which increase the chance of adaptation level in the academic environment, text-based blockchain mostly tough for new learners [11]. In an Academic and non-academic environment, data authenticity, privacy cannot be compromised, due to unique features of this technology improved the quality of education. In some cases blockchain does not provide a complete solution, scalability is one issue; scalability is sometimes inversely proportional to high level of security. Improvement of throughput is essential to increase the level of the transaction [3, 4]. Online quiz-based blockchain paradigm improves the quality of education with a powerful feature that record cannot be changed and the injustice in marking is prevented [16].

### C. Existing systematic reviews of Blockchain-based educational paradigms:

For searching the existing systematic reviews, we have searched different electronic database as mentioned in Table 1. The following searching string strategies for existing reviews were formulated to look for existing reviews studies on the topic domain:

1. (Educational paradigms in blockchain”) AND Review

2. (Educational learning types, academic, teaching”) AND Review
3. (Educational Models using Blockchain technology”) AND Review

Several SLRs have been published for Blockchain technology in the area of education. According to the best of our knowledge, no SLR was present which is specifically based on Blockchain Education Paradigms. The first Blockchain Systematic review presented in the EDUTECH, Revista Electrónica de Tecnología Educativa in Nov 2017, by Antonio Ramon Bartolome, Carles Beller with a title of Blockchain in Education: introduction and critical review of the state of the art to find the issues and uses in the educational field. The second review was presently published in applied science journal by Ali Alammery, Samah Alhazmi, Marwah Almasri, and Saira Gillani in 2019; they worked on issues of blockchain in education, verification of educational certificates, and benefits of using blockchain in the education sector. The third SLR published in Springer journal in 2019 by Hafiza Yumna, Muhammad Murad Khan, Maria Ikram, and Sabahat Ilyas, paper title “Use of Blockchain in Education: A Systematic Literature Review”, the author explores some issues which are related to blockchain in education and features.

### III. RESEARCH METHOD

The research method is a process used to conduct the research, applying some important steps to get the entire information and enable it for making the right decision. That research methodology is concerned with a specific research question or area of concern and identifying gaps in the current research. However; for an efficient Systematic Literature Review, we will follow the complete procedure and guideline proposed by Kichenham [05]. The following steps are the important guidelines.

#### A. Systematic literature review protocol

Systematic literature review protocols utilized to specify the method that performs a documented plan completion before starting the systematic review. Systematic reviews are a type of literature review that uses systematic methods to collect secondary data, critically appraise research studies, and synthesize findings qualitatively or quantitatively. However, a good quality protocol offers a successful systematic review and can be frequently updated during any time to consist newer publications.

#### B. Research questions

To explore the importance of current research issues and challenges, explored types, major strengths/benefits, improvement areas for further research; the research questions are set to focus on the main target. Hence, in this study following are the research questions:

- (RQ1) What are the education types explored by blockchain [4]?
- (RQ2) What are the issues and challenges regarding Blockchain-based educational paradigms [3, 13]?

(RQ3) What are the major strengths/benefits through which educational organizations trust Blockchain technology [18]?

#### C. Research objectives

There are some objectives of this study. The benefits are clearly defining the objective of research questions helps in the right platform and findings. Following are the objectives:

- To identify what types of educational paradigms are used by researchers in Blockchain.
- To know about what are the common issues and challenges proposed by researchers in Blockchain Educational Paradigms.
- To know about what are the common issues and challenges proposed by researchers in Blockchain-Based educational paradigms.

#### D. Data sources

Data sources are the key repositories for performing any sort of review, where the primary source can be easily searched for further work. Every database searched out different results expects the Google scholar because it finds the same literature as the other data sources. To use the facility of Google scholar to increase the searching research materials within the efficient manner, purpose to access maximum relevant literature. Mostly some key papers can be quickly imported via Google scholar except other electronic databases. (Table1).

TABLE I  
DATABASE SOURCES

Data Source	URL
IEEE Xplore	<a href="http://ieeexplore.ieee.org">http://ieeexplore.ieee.org</a>
ACM	<a href="http://portal.acm.org">http://portal.acm.org</a>
Springer	<a href="http://www.springerlink.com">http://www.springerlink.com</a>
Google Scholar	<a href="http://scholar.google.com">http://scholar.google.com</a>
Science Direct	<a href="http://www.sciencedirect.com">http://www.sciencedirect.com</a>

#### E. Search Strategy

Keeping in view the primary research questions, systematic literature searched in September 2019 without any time condition. Furthermore, searched through Google scholar, IEEE database automatically ignoring the date and quality of the paper. Published papers in the database from the start date to up to date were searched, downloaded, and collected efficiently. We searched the papers through many strings and refinement features and the following combination of strings returned the number of related papers:

Following are the different searching strings.

“Educational paradigms based Blockchain” or “Education paradigms in Blockchain” i or “Educational SLR” AND “Blockchain” AND “paradigms” or “Use & issues of educational paradigms” AND “Blockchain” or “Blockchain impact teaching” or “Blockchain Higher institutes” AND “Types, Strengths & issues”.

The above strings helped and searched the maximum number of papers easily instead of others like Springer. Mostly, we use the filter option for refining and searching the requisite materials. As a result & the best of our knowledge, we explored different types of the article published in quality journals and conferences.

F. Study selection

Obtaining the relevant primary literature is easily possible based on selected inclusion and exclusion criteria (shown in Table 2). Defined basic inclusion criteria help to overcome the study of extra irrelevant literature. Initially, the abstract and introductory areas of the paper were accessed for the purpose to know the actual theme of the paper. Mostly, the title reflects the actual meaning of the research work but sometimes these selection criteria are not helpful. We read the complete paper to achieve the maximum information.

We filtered and reduced the number of papers through three major stages. To cover the maximum number of requisite publications for Systematic Literature Review in different databases, we retrieved 178 papers from electronic databases (Table 1). Firstly, we read the titles, abstracts and applying inclusion and exclusion criteria, majority of papers were excluded and the number of papers reduced to 66, relevant papers are exported to the Endnote database shown in Figure 2 for refining toward the final primary study selection In the second stage, we searched and removed 12 numbers duplicated papers using the Endnote tool.

Finally, in the third stage, we carefully read the complete text of 66 papers and due to irrelevant article materials, we discarded 34 papers. According to the best of our knowledge, we achieved our more relevant papers and selected these as these 32 papers as the primary studies specifically on Blockchain-based Educational Paradigms.

TABLE I I DATABASE SOURCES

Inclusion criteria	Exclusion criteria
Papers only based on Blockchain-based Educational.	If, the paper is not based on the Blockchain-based educational paradigms.
A scientific papers	If, the paper in another language, not completely English.
Papers reviewed by electronic Databases	If, the Papers were not in full text.
Papers that describe Blockchain-based Educational paradigms. Issues, paradigms, tools, and strengths.	Duplication of titles.

G. Data extraction

Data extraction is one of the important phases of a Systematic Literature Review. Key information is extracted from each paper. The related information is (title of the paper, author, published in journal or conference, name of the database, year, types of research, objective, research environment, Research proposed issues and challenges, education types explored by BC, major strengths of BC in the educational sector) to endnote database. The benefits of using the Endnote database

are to register all information related to selected studies and easy to maintain and manage this information in the Endnote. Table 3 shows the data items that were used in every study including descriptions and research questions related to our systematic review conducted. The first research question (RQ1) indicates the issues and challenges in BC-based educational paradigms that need analysis for all data extraction items. Our SLR second research question is (RQ2) to educational types explored by Blockchain technology. The third and final research question (RQ3) is major strengths, which enable an organization for adaptation Blockchain in existing or new education system.

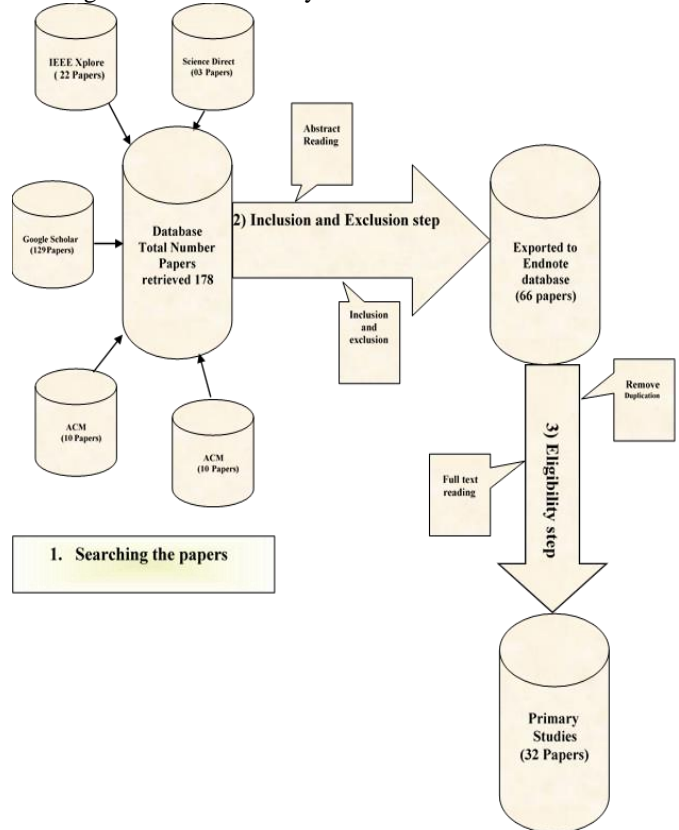


Fig. 1 Primary Studies

TABLE III DATA EXTRACTION DESCRIPTION

Data item	Description	Study research Questions
Title	Title name	RQ1
Authors	Study authors name	RQ1
Reference type	Such as a journal paper, conference paper, etc.	RQ1
Name of Database	Google scholar, IEEE, etc	RQ1, RQ2, RQ3.
Year	Publication year	RQ1,RQ2, RQ3
Contribution type / Research type	Such as a survey, model, framework, etc.	RQ1
Study objective/aim	The aim/objective of application stated by the author	RQ1, RQ2, RQ3
Research environment	The research help / implemented in academia or nonacademic	RQ1, RQ3
Research issue &	Describe the research issue propose	RQ2



challenges	or challenge proposes or study	
Types explored by BC	Educational paradigms topics described in the studies	RQ1
Strengths for adaptation of Educational paradigms	Major advantages, benefits, strengths described the study	RQ3
Future work & further improvement	Future suggestions are described in the study.	RQ1, RQ2, RQ3

#### IV CONCLUSION AND FUTURE WORK

There are several Blockchain applications in the field of education. As per the best of our knowledge via different databases, this is the first SLRP study specifically on Blockchain-Based Educational Paradigms (BCBEP). Therefore, this SLRP will be more helpful for a new researcher to get useful information for further research. In this review, we worked on the Systematic Literature Review Protocol of Blockchain-Based Educational Paradigm. After certain steps, we selected 32 primary articles. This review will cover three major areas: paradigms of education using Blockchain technology, issues & challenges using blockchain technology, and key strengths of Blockchain educational paradigms. Blockchain improves the quality of education & learning process in different areas i.e. verification of certificates, learning outcomes, digital education, online quiz, etc. Secondly, Blockchain is not a complete solution to everything there are still some proposed issues and challenges, which are privacy, trust, data security, insufficient user interactivity, facing a language barrier and high access time, etc are main issues. Thirdly, this technology is new and in the experimenting stage so adopting this needs some satisfactions for educational institutes. Adaptation is only possible when it has some strength through which they can easily trust like protecting data integrity, tamper-proofing, disaster recovery, protecting critical infrastructure, and distributed nature.

In future, after the completion of complete SLR, it would be useful for new researchers of the same domain. They would be able to identify the strengths and challenges in a single research article. After the complete SLR, the researchers might get benefit from this study by saving time and effort to conduct relevant research in mentioned domains of education paradigms of blockchains.

#### REFERENCES

- [1] Duan, Bin, Ying Zhong, and Dayu Liu. "Education application of blockchain technology: Learning outcome and meta-diploma." 2017 IEEE 23rd International Conference on Parallel and Distributed Systems (ICPADS). IEEE, 2017.
- [2] Turkanović, Muhamed, et al. "EduCTX: A blockchain-based higher education credit platform." IEEE access 6 (2018): 5112-5127.
- [3] Kamboj, Divya, and T. Andrew Yang. "An exploratory analysis of blockchain: applications, security, and related issues." Proceedings of the International Conference on Scientific Computing (CSC). The Steering Committee of The World Congress in Computer Science, Computer Engineering and Applied Computing (WorldComp), 2018.
- [4] Turcu, Cristina, Cornel Turcu, and Iuliana Chiuchisan. "Blockchain and its Potential in Education." arXiv preprint arXiv:1903.09300 (2019).
- [5] Yumna, Hafiza, et al. "Use of blockchain in education: a systematic literature review." Asian Conference on Intelligent Information and Database Systems. Springer, Cham, 2019.
- [6] Bore, Nelson, et al. "Towards blockchain-enabled school information hub." Proceedings of the Ninth International Conference on Information and Communication Technologies and Development. 2017.
- [7] Zhong, Jiemin, et al. "A blockchain model for word-learning systems." 2018 5th International Conference on Behavioral, Economic, and Socio-Cultural Computing (BESC). IEEE, 2018.
- [8] Purdon, Ian, and Emre Erturk. "To the cloud and its potential role in computer science education." Engineering, Technology & Applied Science Research 7.6 (2017): 2340-2344.
- [9] Sahonero-Alvarez, Guillermo. "Blockchain and peace engineering and its relationship to engineering education." 2018 World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC). IEEE, 2018.
- [10] Liu, Xing. "A small java application for learning blockchain." 2018 IEEE 9th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON). IEEE, 2018.
- [11] Farah, Juan Carlos, et al. "A blueprint for a blockchain-based architecture to power a distributed network of tamper-evident learning trace repositories." 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT). IEEE, 2018.
- [12] Srivastava, Abhishek, et al. "A distributed credit transfer educational framework based on blockchain." 2018 Second International Conference on Advances in Computing, Control and Communication Technology (IAC3T). IEEE, 2018.
- [13] Zhao, Wengqing, and Zhuoying Ma. "The Application of Blockchain in Higher Education Field." Proceedings of 3rd International Conference on Politics, Economics and Law (ICPEL 2018)—Advances in Social Science, Education and Humanities Research. Atlantis Press. Vol. 246. 2018.
- [14] Zheng, Zibin, et al. "Blockchain challenges and opportunities: A survey." International Journal of Web and Grid Services 14.4 (2018): 352-375.
- [15] Guustaaf, Edward, et al. "Blockchain-based Education Project." Aptisi Transactions on Management (ATM) 5.1 (2021): 46-61.
- [16] Alammary, Ali, et al. "Blockchain-based applications in education: A systematic review." Applied Sciences 9.12 (2019): 2400.
- [17] Ahmed, Sheraz, Muhammad Arif Shah, and Karzan Wakil. "Blockchain as a trust builder in the smart city domain: a systematic literature review." IEEE Access 8 (2020): 92977-92985.
- [18] Ahmed, Sheraz, et al. "A SYSTEMATIC LITERATURE REVIEW PROTOCOL FOR BLOCKCHAIN REVOLUTIONIZING ARENAS OF SMART CITY."
- [19] Cheriguene, Anissa, et al. "NOTA: a novel online teaching and assessment scheme using Blockchain for emergency cases." Education and Information Technologies (2021): 1-18.
- [20] Al Harthy, Khoula, Fatma Al Shuhaimi, and Khalid Khalifa Juma Al Ismaily. "The upcoming Blockchain adoption in Higher-education: requirements and process." 2019 4th MEC international conference on big data and smart city (ICBDSC). IEEE, 2019.
- [21] Ghazali, Osman, and Omar S. Saleh. "A graduation certificate verification model via utilization of the blockchain technology." Journal of Telecommunication, Electronic and Computer Engineering (JTEC) 10.3-2 (2018): 29-34.