Revolutionizing Education: A Comprehensive Review of Blockchain Technology's Impact and Potential in the Education Sector

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Keywords: Blockchain Technology, Digi Locker, Disrupt Education, Systematic Mapping, PRISMA.

Abstract: This cutting-edge study provides a comprehensive, PRISMA-based, systematic literature evaluation of the state of blockchain technology as it exists in the educational field. Because it lays the foundation for future efforts in this field, the study of Blockchain research is becoming more and more important. The use of blockchain technology in the field of education is examined, suggested, and analyzed throughout this essay. A final pool of 245 pertinent papers is produced by combining the 290 document pool with a set of inclusion and exclusion criteria. Examining the selected publications addressed research questions about the state of blockchain application in education, possible advantages for the area, and unresolved challenges; the results produced valuable insights. Numerous proof of concepts are being developed for Blockchain Technology because it has the potential to be beneficial in the educational setting. There are still some relevant technological, legal and intellectual issue that need to be addressed before this approach is extensively applied. In summary, the review concludes with a discussion of platforms, features and questionnaires as well as an overview of the literature on Blockchain applications in the education sector.

1 INTRODUCTION

Document verification is required for several important goals across various sectors and industries. Its primary goal is to assure the accuracy, legitimacy and authenticity of documents presented by individuals, organizations or entities. But here several problems have arisen, one of them is manual document verification. Manual document verification processes take a lot of time, are less trustworthy and resource intensive. That's why many organizations are moving towards more efficient and automated solutions to document verification for students and other processes. So here digital india initiative is to promote a paperless environment through the use of digital document verification methods(*Digital India*, n.d.).The government of india started the Digital India initiative to transform the nation into a society where people are empowered by technology. That's why the Government of India provided a digital platform which is known as digilocker. Digilocker is generally a time-saving process in document verification, especially in the context of India that allows citizens to store and access their official documents and certificates in digital form. It performs duties in a secure way to digitally store and manage various documents including educational certificates, identity proof, vehicle documents and more. Key properties of digilocker are centralized storage, secure access (authentication through aadhaar id, mobile number), instant verification, elimination of physical copies, data privacy, paperless transactions, government services and so more(*Digilocker*, n.d.).Overall, these properties of digilocker make ita valuable tool for document verification and enhancing user convenience in India. In 2017, digilocker, as a part of digital India integrated with NAD to provide a secure and user-friendly platform for individuals to store and access their academic documents digitally. NAD likely refers to the National Academic Depository in the context of india. It is designed for the process of issuing and verifying academic certificates and degrees. NAD focuses on centralizing academic document issuance and storage(*NAD*, n.d.). In summary NAD and digilocker are interconnected components of the Indian government. Digilocker don't provide a decentralized, reliable, immutability, tamper-resistant and cross-border solution for academic document verification(*Digilocker NAD (Students)*, n.d.). So, need for a decentralized mechanism which is accessible for international-level academic document verification. The decentralized mechanism is known as blockchain(Gururaj et al., 2020). In 2008, Satoshi

Suman, and Bhatia, A.
Revolutionizing Education: A Comprehensive Review of Blockchain Technology's Impact and Potential in the Education Sector.
DOI: 10.5220/0013256500004646

In *Proceedings of the 1st International Conference on Cognitive & Cloud Computing (IC3Com 2024)*, pages 144-153
ISBN: 978-989-758-739-9

Nakamoto produced a paper titled "Bitcoin: A Peer to Peer Electronic Cash System," which introduced the concept of a Blockchain, the technology behind the majority of well-known cryptocurrencies, including bitcoin(Forsström, 2018). In the process of developing a system in which document timestamps could not be changed Stuart Haber and W. Scott Stornetta originally presented the idea of blockchain(Forsström, 2018). A chronological sequence of blocks comprising the data, hash and hash of the subsequent block make up the blockchain technology(X. Chen, 2018). Cryptographical links exist between each block. Each block is recorded in a distributed, decentralized ledger, making it reliable, unchanged able and simple to verify(G. Chen et al., 2018). Blockchain technology has gained a lot of attention in recent years across a number of industries, including banking, healthcare, government, and business operations. The unique security features that blockchain technology offers are the reason why industry, researchers, and programmers worldwide are interested in it. Blockchain technology uses distributed, decentralized ledgers to store its data(Ma & Fang, 2020). This technology's primary feature encourages dependability and confidence. It ensures that there will be no intervention from outside parties and offers all parties concerned a high degree of openness. It is essentially a peer-to-peer network with traceability and security features because each node is connected to all other nodes using a cryptographic hash function. Permissionless and permissioned are the two primary high-level classifications for blockchain approaches that have been identified(Gururaj et al., 2020). In a permissionless blockchain network, permission is not required for anyone to read or write to the blockchain. Finer-grained controls and restricted participation are possible with permissioned blockchain networks. The subset of blockchain technology that a firm needs to employ depends on its requirements and applications(Reis-Marques et al., 2021). Blockchains can be hybrid, private, public, or consortium-based, among other types. Owning a public blockchain is not possible. The decision-making process is accessible to anyone and anyone can participate as a node. Private blockchains are just private by nature(X. Chen, 2018). A consortium, or grouping of people or organizations who have agreed to share the ledger among themselves, is the only organization that has access. According to M. Swan's "Blueprint for a New Economy," there have been three generations in the development of blockchain technology. At present, there are three versions of blockchain: 1.0, 2.0, and 3.0."Blockchain 1.0 is associated with the creation of cryptocurrencies. Blockchain 2.0 now encompasses applications related to bonds, smart contacts, loans, and real estate. Blockchain 3.0 looks into the possibilities of applying blockchain technology to non-financial fields such as government, education, and healthcare"(Park, 2021).Furthermore, all operations are recorded in the blockchain and are impermeable. The educational landscape could be greatly enhanced by the many applications of blockchain technology(Steiu, 2020) . In-depth information about the benefits, challenges, and current and prospective applications of blockchain technology in the education sector is provided by the extensive literature review carried out for this study(Park, 2021).Thus, this study contributes to our understanding of the current and future applications of blockchain technology in the field of education(Steiu, 2020). Politicians, academics, managers, researchers, and universities are advised by the study's findings to take advantage of blockchain technology's potential advantages for the education sector(Ali et al., 2022). Objectives of the educational community was previously aware of the potential of blockchain technology. A growing body of literature is outlining the various ways that blockchain technology can be applied in education, and numerous attempts using different techniques are currently being developed(Ali et al., 2022). The objective of this publication is to provide professionals and academics with a new, relevant, and up-to-date perspective on the use of blockchain technology in education by carefully reviewing the most important papers published to date(Düdder et al., 2021). This article's final goal to present an overview of the state of art at the moment, which can be used as a starting point and a sourace of reference for further relevant projects in the future.A search protocol was created after the investigation's goal was established, and it is detailed in the sections that follow. i.e For the remainder of this work, it is structured as follows. Section 2 of this article outlines the methodology for the systematic literature review mapping approach, presents an alternative, the techniques employed with the body of research on blockchain technology in education is thoroughly reviewed and evaluated and synopsis of blockchain technology based systematic review for education. The implications for findings are covered in section 3. The summary, limitations, conclusions, challenges and future directions are all included in section 4-6.

2 SYSTEMATIC LITERATURE REVIEW MAPPING APPROACH

The mapping approach for the systematic literature is presented in this section. The most crucial starting point for any systematic mapping study must be the formulation of the research questions (RQs) and mapping questions (MQs). The prepared MQs and RQs listed below are covered in the section that follows:

MQ1: In what ways has the pool of pertinent research papers on Blockchain applications in Education been assembled using inclusion and exclusion criteria?

MQ2: Which significant publishers were taken into account for the study?

The aims of this review guided the formulation of the following research questions:

RQ1: What stage of development is the current framework for utilizing blockchain technology in education?

RQ2: What aspects of blockchain technology have the potential to improve education?

2.1 Methodologies Used

A methodical approach is usually taken to compile and evaluate pertinent literature in review papers regarding the state of blockchain technology in the field of education. A summary of common approaches is shown below: PRISMA tool, database searches, inclusion and exclusion criteria, and the systematic literature review (SLR) mapping approach.

1. In order to address MQ 1, we used the scientific mapping methodology with the PRISMA tool, which is a helpful tool for comprehending the evolution of a research topic across disciplines and explains the inclusion and exclusion criteria objectively.
2. The approach of Database Searches will be employed to address MQ2. A number of scientific databases, including IEEE Xplore, Springer, Hindawi, MDPI, and Wiley, were searched. Using the search phrases "blockchain," "technology," and "education," a large and pertinent collection of materials was obtained.
3. Utilizing the Systematic Literature Review (SLR) Mapping Approach with Literature Search and Review, to respond to Research Questions(RQ) 1 and 2. An exhaustive search of academic databases, journals, conference proceedings, and other pertinent sources is done at the beginning of the paper to gather relevant literature.
4. A search for pertinent studies, such as case studies, theoretical frameworks, conceptual papers, and empirical research, is conducted using keywords associated with blockchain technology in education.

Review papers on blockchain technology in education, as a whole, use strict procedures to methodically compile, examine, and summarize pertinent literature, providing insightful information to scholars, practitioners, and decision-makers in the subject.

2.2 Mapping Report for the Literature Review

The Systematic mapping of research papers is presented in this section. Above discussed Mapping Questions are answered in this section to show the step-by-step selection of research articles for the systematic literature review.

2.2.1 MQ1: In What Ways Has the Pool Pertinent Research Papers on Blockchain Application in Education Been Assembled Using Inclusion and Exclusion Criteria?

A comprehensive summary of the systematic literature studies on blockchain in education was created using the PRISMA(Preferred Reporting Items for systematic reviews and meta analyses) tool(Selcuk, 2019). 290 publications on the application of blockchain technology in education had to be searched in order to find relevant studies that were published between 2018 and 2023 were taken into consideration. For this literature review, a total of 22 research publications and 4 web pages were eventually selected. There were only 245 were left for screening after duplicate records(N = 45)were eliminated from the total number of papers (N = 290). There were just 26 records remaining after the papers were sorted by title and abstract. The flow diagram for the PRISMA style of representation used in this systematic study's paper selection is displayed in Figure 1.

Using the academic database search. The published studies that matched the study objectives were found by searching the SCOPUS database, which was accessible through the university liberary system of the authors. There were no restrictions on the year of publication and result were restricted to English exclusively.The initial search was conducted with the terms. "blockchain" "technology" and "education". A total of 290 documents including books, book chapters, editorial, conference papers, review paper, articles and web pages were recovered. It was noted how many documents had the specified keywords. The number of documents types that were obtained from the database is displayed in Table l.

B. Eligibility criteria Based on eligibility criteria, only 22 papers and 4 websites meet the eligibility requirements, demonstrating a high level of adherence to the methodology. Table 2 contains a list of the inclusion and exclusion criteria

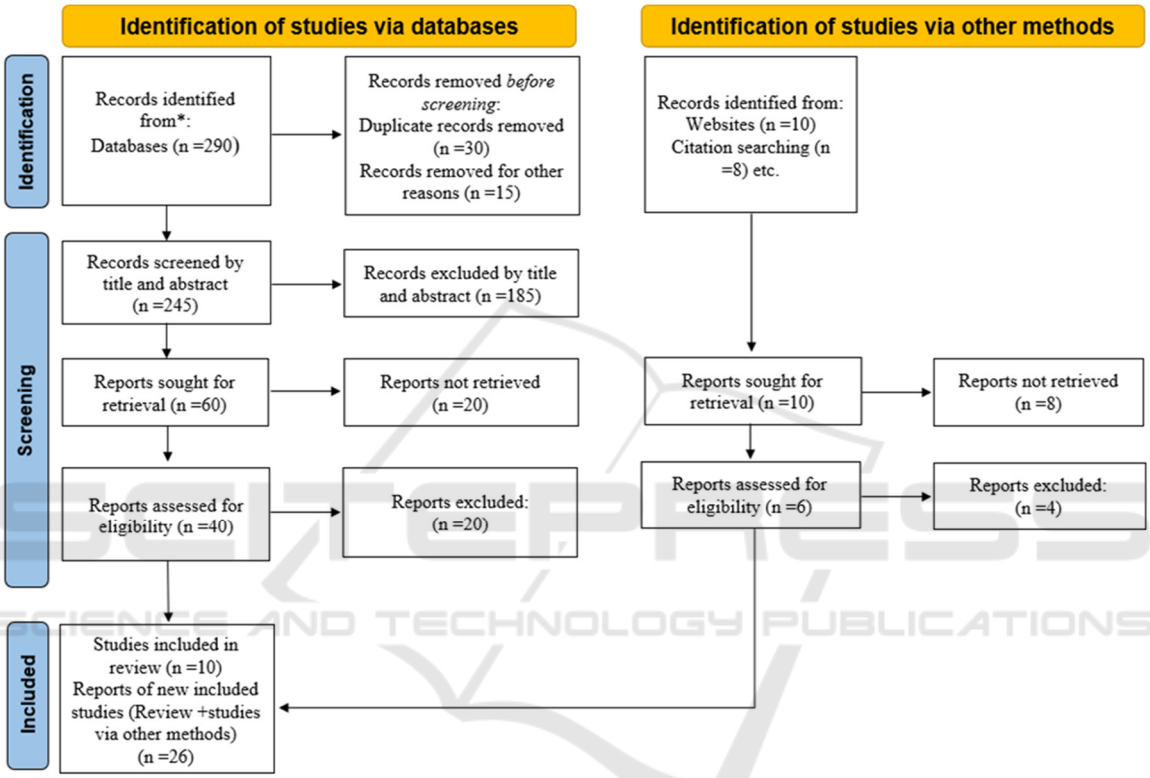

Figure 1: An Illustration of The Screening and Selection Process Flows.

Table 1: The number of document types obtained from the database.

Article	Book Chapter	Conferencepaper	ConferenceReview	Note	Review	Web Pages
67	13	168	29	1	12	4

Table 2: Inclusion and Exclusion Criteria.

	Inclusion	Exclusion
Timelines	Published from 2018 to 2023	Published before 2018
Availability of Access	The entire text is accessible	There is no full-text available
Language	Composed in the EnglishLanguage	Composed in tongues other than English
Relevance	The main goal is to use the blockchain Technology	The main goal are not use the Blockchain technology
Document Type	Articles, Conferences, Book Chapters, Reviews and Conferences	Letters, Notes, Books, and Editorials

Table 3: Documents Being Distributed According to Various Publications.

	Publication sources	No. of documents	Databases
1	IEEE Journal	7	IEEE Xplore
2	Springer	3	Springer
3	Others (MDPI, Wiley etc. and webpages)	12	MDPI,Wiley,Google Scholar, Hindawi,etc.
Total		22	

Table 4: Evaluation Purpose and Findings of Some of the Selected Research Articles.

Authors	Purpose	Methodology	Findings
(Nargis et al., 2023)	To discuss the blockchain technology trials being conducted ineducational systems	Exploratory study, Systematic Literature Review	The blockchain ledger can be connected to many activities such as administrative checkouts and educational record. Technology can also be used to stop alterations or tampering with documents records
(Siddiqui et al., 2022)	This document verification will address the benefits and challenges of using blockchain technology in education.	Exploratory & qualitative study,Revie-w of studies	An Internet of Things (IoT) framework built on the blockchain.The safe creation and verification of certificates is made possible by this system.
(Reis-Marques et al., 2021)	Examine how cutting edge technologies like artificial intelligence and blockchain are combining could need significant adjustments to the way education is delivered	Exploratory study, Systematic Literature Review	Because of blockchain technology powerful advantages, colleges need to adjust to this technology in order to support outcome-based learning
(Gaikwad et al., 2021)	To look into how blockchain can be used in outcome-based higher education and assess how successfully marketing education is now integrating new technologies	Review of studies	Technologies like OCR and blockchain must be incorporated into martingale education. Tranasparency is brought to student, instructor, institution and regulatory body detail via blockchain including UGC, AICTE
(Kutty, 2021)	To address the issue of admissions processing at academic institutions and look into the possible uses of blockchain technology in the sector of education.	Review of studies	To examine research utilizing blockchain technology or suggest its application to enhance educational sector procedures and offerings
(Delgado-Von-eitzen et al., 2021)	To examine research utilizing blockchain technology or suggest its application to enhance educational sector procedures and offerings	Systematic Literature Review	Acedemic certificate issuance and verification are the primary uses of blockchain technology. Technology can improve data sharing openness, save costs and foster confidence. The field's technological potential is still Untapped
(Serranito et al., 2020)	To examine research utilizing blockchain technology or suggest its application to enhance educational procedures and services	Exploratory study,Review paper	Blockchain technology such as Ethereum and Hyperledger fabric are widely utilized in the education sector. In addition to handling credentials, these technologies help colleges cut down on administrative Expenses
(Bhaskar et al., 2020)	To study blockchain technology's advantages, disadvantages, current uses and prospects in the field of education.	Review paper	The review focused on how blockchain technology might help with student activity management, teaching and learning in educational Environments.

2.2.2 MQ2: Which Significant Publishers Taken into Account for the Study?

For the study, Considered from 2018 to 2023 a total of 22 papers and 4 websites were filtered out from electronic searches were performed on various scientific databases: IEEE Xplore,Springer, Hindawi, MDPI,Wiley. Table 3 displays the distribution of papers by publishers.

2.3 Education's Blockchain-Based Systematic Review

The goals of this review served as a guide for the development of the following research questions.

2.3.1 RQ1: What Stage of Development Is the Current Framework for Utilizing Blockchain Technology in Education?

Blockchain technology is uniquely positioned to benefit from the fourth industrial revolution. The adoption of cryptocurrencies as a digital payment method in numerous significant worldwide economies, together with the establishment of cryptocurrency exchanges in 2016, sparked interest in the topic among academics. Education, the Internet of Things, banking, supply chains, healthcare, defence, and governance are among the main research industries that heavily rely on technology(Min & Bin, 2022).However, studies have also revealed that public awareness of blockchain technology is still quite low and its use is still relatively new, which makes it difficult to create a strategy that fully utilizes the promise of the platform. Users' adoption, smart contract security, and scalability are now experiencing issues (Jirgensons & Kapenieks, 2018). Blockchain technology is believed to have a substantial impact on the relationships that schools, colleges, and institutions have with society(Min & Bin, 2022).Table 4 presents a few noteworthy contributions from the current research to better illustrate. The extensive reviws of the literature indicate that blockchain technology is a rapidly developing field in research with many educational applications. The applications include managing student information and credentials, administrative tasks and teaching and learning at higher education institution utilizing both online and offline platforms(Jirgensons & Kapenieks, 2018).

2.3.2 RQ2: What Aspects of Blockchain Technology Have the Potential to Improve Education?

In this section, the author discusses eight aspects of blockchain technology and examines how other can enhance education via the lens of the evaluated publications. According (Table5) Through blockchain offers many intriguing features, it isn't necessarily the ideal option in every situation. Author provides a methodical approach to identify the best technical solution to address a particular application.

Table 5: Aspects of Blockchain.

Publication	Distributed consensus	Smart Property	Immutability	Transaction verification	Smart contracts	Platforms for smart contracts	Uniqueness	Security provision
(Gururaj et al., 2020)	✓	✓	✓	✓	✓	✓		✓
(Zheng et al., 2017)	✓	✓	✓	✓	✓	✓		✓
(Forsström, 2018)	✓	✓	✓	✓	✓	✓		✓
(X. Chen, 2018)	✓	✓	✓	✓	✓	✓		✓
(G. Chen et al., 2018)	✓	✓	✓	✓	✓	✓		✓
(Steiu, 2020)	✓	✓		✓	✓	✓	✓	✓
(Reis-Marques et al., 2021)	✓	✓	✓	✓	✓	✓		✓
(Ma & Fang, 2020)	✓	✓	✓	✓	✓	✓		✓
(Düdder et al., 2021)	✓	✓	✓	✓	✓	✓		✓
(Ali et al., 2022)	✓		✓	✓	✓	✓		✓
(Capetillo et al., 2022)	✓	✓	✓	✓	✓	✓		✓
(Park, 2021)	✓	✓	✓	✓	✓	✓		✓
(Min & Bin, 2022)	✓	✓	✓	✓	✓	✓	✓	✓
(Jirgenson et al., 2018)	✓		✓	✓	✓	✓		✓
(Nargis et al., 2023)	✓	✓	✓	✓	✓	✓		✓
(Siddiqui et al., 2022)	✓	✓	✓	✓	✓	✓		✓
(Gaikwad et al., 2021)	✓	✓		✓	✓	✓		✓
(Kutty, 2021)	✓	✓	✓	✓	✓			✓
(Delgado-Von-eitzen et al.,	✓	✓	✓	✓	✓	✓		✓
(Serranito et al., 2020)	✓	✓	✓	✓	✓		✓	✓
(Bhaskar et al., 2020)	✓	✓	✓	✓	✓			✓

Table 6: The Publication's Platforms.

Platform	Publication
Blockchain ARK(Serranito et al., 2020)	(Jirgensons & Kapenieks, 2018) , (Serranito et al., 2020)
Bitcoin(Gururaj et al., 2020)	(Gururaj et al., 2020), (Zheng et al., 2017) , (X. Chen, 2018) , (Steiu, 2020)
Ethereum(Nargis et al., 2023)	(Min & Bin, 2022) , (Nargis et al., 2023)
Bitcoin and Ethereum(G. Chen et al., 2018)	(G. Chen et al., 2018)
Hyperledger Fabric(Ali et al., 2022)	(Ali et al., 2022) ,(Siddiqui et al., 2022)

1.Distributed consensus: By allowing a blockchain-based system with tens or even thousands of participants to agree upon a single version of the data maintained throughout the network, this feature eliminates the need for a central authority. Currently, educational institutions retain grades, competences, portfolios, certificates, and general student data, and they share some of this data with official educational bodies(Delgado-Von-eitzen et al., 2021). Making these documents available to other parties or stakeholders is difficult. Through distributed consensus, businesses might collaborate and share knowledge on a single platform, making it easily available to others.

2. Smart property: This feature make it possible to permanently, reliably and temperproofly link tangible or digital assets to the blockchain preventing them from ever belonging to anyone else until there are transferred (Delgado-Von-eitzen et al., 2021).The asset can never be double or double spent power over it remains with its owner alone. According to this analysis, the most often maintained property in the educational sector is the certificates and grades that are awarded to students, graduates or professionals by an institution. There are several methods used in the studied works in relation to this kind of data. Data can be used for instance to register competencies, analyze data to reward badges for specific accomplishments and acknowledge volunteers for events(Kutty, 2021). It can also be tamperproof saved and shared with recruiters. Educational factors can also be used to obejectively rank academic institutions.

3. Immutability: Due to the extremely high computational effort required, which varies based on the kind of platform and quantity of users transactions saved in a blockchain are nearly difficult to change. Within the realm of education, leaving data on credentials, grades, competencies and other details that is temper-proof, accessible, validated and secured against repudiation is essential(Zheng et al., 2017).

4. Transaction verification: Before a proposed transaction is added to a block on a blockchain, it is first validated by the network's active participants in accordance with established guidelines. The data has been warehoused can therefore be regareded as reliable. In order to prevent forgeries, organizations in educational sector Issue, maintain, and withdraw information that must be trustworthy, tempered, and verifiable (Capetillo et al., 2022). That's why this features is considered in some capacity in every proposal that is reviewed.

5. Smart Contracts: Certain blockchain systems facilitate the operation of smart contract which, in accordance with their pre- programmed instructions, utilize oracles to read, analyze, and store data from the blockchain as well as other sources and locations (Ali et al., 2022).

6. Platforms for Smart Contracts: Smart contracts are not supported by every blockchain, when this capability is present, nevertheless, it facilitates the potential of carrying out tasks on behalf of users by carrying out specific procedures honesty and by keeping track of all associated transactions in way that is accountable and tamperproof(Forsström, 2018). It is evident that this feature is helpful for education because all of the examined publications employ smart contracts that are executed on different platforms to automate processes and start operations (Table 6). The recommended platforms are Ethereum, Bitcoin, ARK Blockchain, and Hyperledger Fabric.

7. Uniqueness: Within a blockchain, each transaction is distinct and able to be tracked back. Multiple spending or multiple ownership of a token or asset is prohibited by this feature. The uniqueness of academic information for these purposes is irrelevant because it reflects reputation, knowledge and abilities that are personal, professional or institutional and cannot be purchased or transferred.

8. Security Provision: Blockchain's technology and design guarantee security characteristics for the

stored transactions, including nonrepudiation, availability, integrity and authentication. Nevertheless, confidentiality and privacy can not always be ensured because openness and verifiability frequently require that all parties have access to the content. To remedy this,certain blockchains are specifically designed with methos of delivering them. Because the blockchain's peer-to-peer structure makes it possible to provide reliable information even in unsafe circumstances, it reduces the security issues related to education(Jirgensons & Kapenieks, 2018). Due to its peer-to-peer dissemination, temper-proof storage, authentication, and resistance to repudiation because it is signed by the signers, information is also extremely available. Along with regulating access to and consumption of multimedia resources and test questions, Additionally, these blockchain elements are used in concert with other technologies to confirm the legitimacy and integrity of the educational resources offered to teachers and students in MOOCs (*Digilocker NAD (Students)*, n.d.).

3 IMPLICATIONS OF THE FINDINGS

We address the ramifications of the work's findings in this part, as well as future directions for blockchain research in education. Blockchain technology offers prospects for improved, security, transparency, and efficiency and has the ability to completely transform a number of facets of education. Some conclusions for future research and practical applications of blockchain education are provided below. A brief overview of the ways blockchain technology is being used in education, from credential verification to support for continuing education, is provided in Table 7.

4 LIMITATIONS OF THIS SYSTEMATIC STUDY

There are three limitations of this systematic review that need to be taken into account. The limited quantity of internet databases that were accessible is the first drawback. There's always a chance that an item published in another source will be left out and many more could have been consulted. Blockchain technology are very new and there are an increasing number of publications on the subject. Still the topic's most pertinent databases were chosen.The keywords and queries used in the databases represent the second limitation. However, prior to beginning the investigation, the search terms were merged using

Table 7: Implications of Findings in Blockchain Technology Applications in Education.

Implications	Explanation
1. Credential verification	Preserve and verify academic credentials safely, including as degrees, certificates, and diplomas, while preventing fraud and providing a decentralized verification procedure (Ali et al., 2022).
2. Transcript management	To expedite the processing of academic transcripts, establish a transparent and secure system for exchanging and storing student data(Nargis et al., 2023). This will improve the accuracy of the data and make inter-institutional transfers easier.
3. Micro credentialing	Acquire and maintain micro credentials or badges for specific skills or achievements using a decentralized credentialing model, recognizing a range of learning experiences outside of traditional degrees(Capetillo et al., 2022).
4. Protection of intellectual property and copyright	Make sure that research papers, creative works, and instructional materials are safeguarded by an unalterable, transparent record of ownership and rights(Siddiqui et al., 2022).
5.Peer-to-peer online learning environments	By avoiding middlemen and utilizing smart contracts to automate payments and guarantee contributors receive fair recompense, you can enable peer-to-peer learning (Jirgensons & Kapenieks, 2018).
6.Cooperation and funding for research	Facilitate transparent and traceable transactions for research funding and collaboration agreements using smart contracts to automate fund disbursement and ensure accountability(Gaikwad et al., 2021).
7. Acquiring knowledge of analytics and personalisation	In order to tailor learning experiences and give students the help they need, transparently gather and evaluate data on student performance and engagement(Nargis et al., 2023).

Boolean operators and picked with alternatives based on a set approach appropriate for the educational profession. Before launching the questions, the terms appropriateness was confirmed twice. A potential source of bias in the publications chosen is the third limitation. A set of predetermined conditions were established and adhered to in order to prevent it from happening. Documents pertaining to blockchain technology and education have proliferated in the past few years. This was one of the strictest filters because the papers that are published in peer-reviewed journals are the most rigorous ones. After carefully examining every included work that was screened and the final selection, the authors came to a consensus where it was unclear if they should be included in the review or not.

5 CONCLUSION

In order to fully exploit the potential benefits of blockchain technology in education, it highlights the need for additional study and development. In conclusion, a thorough and methodical methodology is used in the research to assess the state of blockchain technology in the education sector, offering insightful information and highlighting important topics for further study and use. This systematic review examines 22 publications and 4 webpages discusses the state of blockchain applications in education today, as well as the possible advantages they may have for the industry and the many issues that need to be resolved before they are widely adopted. In reality, the numerous initiatives that have recently been researched and published show how much blockchain may offer the education industry .Due to its features, there are now more opportunities to strengthen academic information security, trust, efficiency. Furthermore, it is possible to create new use cases and safely issue, exchange, exploit, and verify them. Even Nevertheless, the underlying technology and applications are still in their infancy and are developing rapidly. To properly model processes using smart contracts, one must take into account the normative, intellectual, and technological viewpoints on concerns (e.g., security, privacy, performance, scalability, etc.). Blockchain initiatives in education are now restricted to prototypes, proof of concept, and models rather than wide-scale deployment. Still, progress is being made, and initiatives like this keep people interested because they demonstrate how blockchain will be a big part of learning environments in the future.

6 CHALLENGES AND FUTURE DIRECTIONS

Blockchain technology is being explored for a wide range of applications in education, including improving administrative duties, assisting teaching and learning processes, and storing student information and credentials. The technology promises gains in data security, efficiency, and transparency, especially in the issue and verification of academic certificates.The research enumerates challenges related to user acceptance, smart contract security, and scalability. In order to completely reap the rewards of blockchain technology in education, it highlights the necessity for additional study and development. The study ends with an assessment of the current of blockchain technology in the education sector, offering insightful analysis and highlighting, all while adhering to a strict and disciplined methodology.

ACKNOWLEDGMENTS

We would like to extend our sincere gratitude to the people and organizations that helped us throughout the preparation of this document.

First and foremost, we would like to express our gratitude to Chaudhary Ranbir Singh University in Jind, Haryana, India, for offering a friendly atmosphere and the tools we needed for our study. We especially appreciate the Department of Computer Science and Applications' ongoing encouragement and assistance.

We also thank Chaudhary Ranbir Singh University's library personnel for helping us access a variety of databases and research materials that were crucial to our investigation. Their assistance was quite helpful in carrying out a comprehensive literature review. Finally, we express our gratitude for the invaluable insights provided by the education professionals interviewed for this study, as well as for the continuous help and guidance provided by Mr. Manoj Rathee, research scholar (MDU), during the drafting of this paper.

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