

Reimagining Educational Governance Through Blockchain: Decentralized Trust and Transparency in a Hybrid Analysis

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Abstract

With the acceleration of digital transformation in education, this paper examines how blockchain is being framed as a governance solution for trust, transparency, and decentralization. Using a hybrid bibliometric and thematic analysis of 93 Web of Science and Scopus publications, the study maps publication trends, leading outlets, author networks, and conceptual clusters. We analyze co-authorship networks, keyword co-occurrence patterns, and conceptual structures using VOSviewer version 1.6.19 and the R-based Bibliometrix package. Then, we apply qualitative coding to offer a more profound interpretation of governance stories. Findings show that blockchain in educational governance is predominantly positioned through techno-managerial lenses—focusing on secure credentials, tamper-proof records, and efficiency—while critical perspectives on power, equity, and participation remain limited. Global North institutions and computer science-oriented venues dominate the field, with little engagement from Global South contexts or educational leadership scholarship. The paper concludes by proposing a research agenda that reimagines blockchain not as a neutral tool, but as a socio-technical assemblage that must be interrogated through equity-, ethics-, and community-centered frameworks.

Keywords: blockchain and education; educational governance; decentralized trust; transparency; data integrity; distributed ledger technologies; bibliometric analysis; hybrid analysis

1. Introduction

The pace of digital transformation has significantly increased during the last 10 years. However, it can be seen that conventional models of educational governance are lacking in the creation of trust, transparency, and accountability. These models have methodically undermined this ability. The growing bulk of data used during decision-making, the growing multiplicity of involved parties, and the multiplication of the number of connections between accountability imply that interpersonal relationships are no longer the only foundation of trust. There is a growing need of process methodicity, verifiability and traceability (Mustafa et al., 2025). In this regard, blockchain technology should not be considered only as a technological breakthrough but as a decentralized registry that has the potential to alter the structure of corporate governance. In its initial stage, blockchain was developed by Nakamoto (2008) and functions on a decentralized model where all transactions are recorded on cryptographically secured, time-stamped blocks. These records are authenticated by a network of nodes, and not by a central authority. The architecture



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instills a distributed verification system that encourages transparency, traceability, and immutability of records, which lower the use of intermediaries in building confidence significantly. Further studies indicate that blockchain should be seen as a framework of governance that enables new forms of trust, accountability, and coordination among complex systems (Casino et al., 2019; Swan, 2015). Therefore, blockchain technology could be regarded as a stimulus behind radical managerial and ethical changes in educational management. This decentralized model, which is marked by distributed verification, immutability, and reduced dependence on intermediaries (Chen et al., 2023; Uddin et al., 2024), has the potential to provide a technical–ethical answer to the old problem of trust and accountability in the realm of educational governance. However, blockchain’s proposed role in complementing computational trust in records and transactions does not obscure the fact that educational governance has always relied on relational trust derived from human interaction, pedagogical judgment, and institutional equity standards.

Nevertheless, the metrics on the global level reveal significant gaps in online education data management. According to the reports released by the OECD Digital Education Outlook 2023, 65 percent of the OECD member states have national student or school information systems; however, most of them are not used as real-time, integrated decision-support systems (OECD, 2023). According to the report, the regulatory frameworks that cover the use of algorithms and automated decision-making in schools are either ineffective or nonexistent (Vincent-Lancrin & González-Sancho, 2023). According to UNICEF Innocenti, there exists no clear legal framework that defines the access of data gathered by commercial providers of EdTech, and there are no enforceable restrictions on algorithmic systems, which leave a significant gap in governance (UNICEF, 2025). Therefore, blockchain cannot be imagined as a silver bullet to the issues of educational governance. Instead, it can be regarded as a groundbreaking system of governance that can fulfill the needs of trust, transparency, and accountability. However, it still demands a careful assessment in the framework of the prevailing regulatory and institutional gaps.

Additionally, a survey of 40 countries conducted by a UNESCO Institute of Statistics revealed that in almost half (19) of them, students with disabilities are not collected in data, highlighting a lack of consistency between data-driven governance discourses and the objectives of inclusive and equitable education (UNESCO-UIS, 2018). Therefore, blockchain can be viewed as an alternative infrastructure that has the potential to institutionalize trust and restructure data governance in the field of education.

Initial studies of blockchain in education focused mainly on the verification of diplomas, student mobility, and the certification of micro-credentials (Alsobhi et al., 2023). Nonetheless, the subject of blockchain use in educational governance has witnessed a substantial increase in academic interest during the past five years. Web of science data indicates that there has been an increase from merely five publications in 2017 to 187 in 2024; 63.6 per year. An impressive number of such investigations are now published in high-impact Q1 journals, which points to a change in the focus of such studies, which are no longer focused on technical studies but rather directed at governance research (Zheng & Lu, 2022). Since the sphere is quickly developing, it becomes necessary to systematize the discourses of the new research.

Although the number of studies on blockchain in education continues to expand at a remarkable pace, there are still some major gaps. First, most of the current literature is still largely technology-centered, and limited in-depth studies exist that consider the implications of blockchain on education governance, decision-making, decentralized trust systems, and the related ethical and legal responsibilities in a holistic way (De Alwis et al., 2025; Liu et al., 2023). Second, there are limited bibliometric analyses to map the trends of publications and citation patterns and author–institution networks (Nuryahati et al.,

2025; Ocheja et al., 2022; Ortiz-Esparza et al., 2023; Reis-Marques et al., 2021), which means that the epistemic structure of the field has not been adequately studied. Third, despite the frequent statement of blockchain as a solution to improving transparency, trust, and institutional accountability, most of the literature ignores the influence of political, cultural, and socio-economic environments in the process of governance. Consequently, studies are still actively working to explore and discuss mainly technical feasibility instead of the administrative and structural consequences at large (Chen et al., 2023). Such constraints reveal the necessity of the redefinition of the role of blockchain in educational governance in relation to multi-layered, contextualized, and comparative analytical methods.

2. Research Foci, Directions and Guiding Questions

Despite the rapid growth of blockchain in the educational governance research area in recent years, the current literature is rather disjointed, mostly technical, and has a limited scope of application. The majority of research dwells upon credential verification (Delgado-von-Eitzen et al., 2021), acquiring diplomas and documents (Saja & Stecyk, 2023), and ensuring care of student documentation (Ocheja et al., 2022). Though these contributions illustrate the positives of blockchain to decrease fraud, improve transparency of data and increase institutional trust, they do not provide any systemic analysis of how blockchain could foster transparency, fairness, accountability and the production of trust in educational governance. The further extension of governance on blockchain to various levels within the education system, including the ministry-level policy-making process, district administration, school management, and the teacher placement process are insufficiently studied (Liu et al., 2023). Further, there are conflicting perspectives on the transformative or disruptive role of decentralized trust structure in the education sector as demonstrated by the literature. Addressing these gaps would need integrated research that encompasses both technical and managerial methodologies.

The current research centers mainly on the technical aspect of blockchain; therefore, this paper represents the first holistic exploration of the connection between blockchain and educational governance, especially regarding decentralized trust and transparency. To begin with, it charts the patterns of publications, citation, and author cluster, country, and institutional cluster, key words, and thematic emergence systematically by structural bibliometric study of research published in the period between 2017 and 2025, thus explaining the epistemic positioning of blockchain in education research. The time frame of the current study has been narrowed down to the period between 2017 and 2025, since empirical research of blockchain technologies beyond the sphere of the financial industry and within education settings has shown a significant increase after 2016. Despite the first introduction of the concept of blockchain by Nakamoto (2008), the emergent scholarly literature of the first few years focused mainly on cryptocurrency infrastructures, with little focus on governance-related applications. Beginning in 2017, a rapidly expanding literature explored the use of blockchain as a decentralized system enabling trust, transparency, and credentialing in the educational system (Casino et al., 2019). In turn, the area of focus in this ten-year interval represents the most fruitful period of the scholarly progress, during which the research on blockchain in the sphere of educational governance has gained momentum. Second, a content analysis examines the framing of blockchain as a technical resource, as well as an institutional instrument that is conducive to institutional trust, accurate data, transparent and traceable decision-making, fair access, accountability and participatory governance. Third, the paper evaluates the cultural, social, and political understandings of blockchain-based governance in the context of different countries, how the global and local contexts influence one another, and its strategic placement in educational systems. Leaving Euro-, technology-focused and mostly Euro-oriented views behind, this multidimensional

and cross-cultural analysis throws the multi-faceted character of blockchain in educational governance into a better perspective. In general, the article examines the association of blockchain with the governance process since 2017 and 2025 and conducts a comprehensive review of the abilities of blockchain to promote trust, transparency, and responsibility in education. The following questions will guide the study in this respect:

RQ1. What are the key publication trends, citation patterns, and leading actors shaping the academic discourse on blockchain technology in the field of education?

RQ2. What are the main themes and research focuses related to blockchain in the education system in terms of transparency, trust, and governance?

RQ3. How does the literature explain the ways in which blockchain transforms identity–document–assessment trust governance and learning ecosystem–data–policy governance in education through certain processes and governance mechanisms?

RQ4. How do current studies conceptualize blockchain’s multi-level operational architecture in education and reveal which governance processes are transformed at these levels?

RQ5. How do existing studies conceptualize blockchain’s purpose-driven governance logic in education and demonstrate how this logic shapes the goals of trust–transparency–automation and learner-centered portability and mobility?

3. Method

3.1. Methodological Framework and Research Design

The current research aims at outlining the current state, the evolutionary pattern, and the research agenda in scholarly articles published in 2017–2025 on the topic of decentralized trust, data integrity, and governance transparency in education using blockchain technology. In this respect, an integrative systematic review based on the mixed-methods design was performed, which merged bibliometric analysis with thematic content analysis (Aria & Cuccurullo, 2017).

This combination of quantitative and qualitative models, helps to reduce interpretive bias and provide a full picture of the rapidly developing, multidisciplinary landscape of the field (Cruz-Gonzalez et al., 2019; Tlili et al., 2022). The fragmented and fast-changing nature of blockchain–education–governance scholarship necessitates this mixed design for both broad mapping and conceptual depth (Braun & Clarke, 2006). This methodological combination boosts analytical validity through data triangulation (K. Arar et al., 2025); it enables concomitant analysis of publication and citation networks at the macro level, conceptual clusters at the meso level and governance-focused topics at the micro level. The methodology is an analytical foundation that provides a solid study of the intellectual perspectives and developmental trajectory of a research area (Donthu et al., 2021; Tlili et al., 2024) and a strong analytical foundation to examine the role of blockchain in educational practices (Samala et al., 2024). In selecting data, the PRISMA 2020 protocol was followed (Page et al., 2021). By means of bibliometric mapping and thematic analysis of the content, as well as the implementation of Biblioshiny, VOSviewer version 1.6.19, and WoS/Scopus databases, the current research provides a multidimensional evaluation of the role of blockchain in educational governance. This analytical approach offers a replicable framework to identify trends, gaps, and new theoretical directions (Nazzal et al., 2023).

3.2. Research Strategy

VOSviewer version 1.6.19 (van Eck & Waltman, 2010) and the R-based Bibliometrix program were used to map and visualize bibliometric networks. These software packages make it possible to construct co-citation networks and author collaboration maps, and keyword co-occurrence analyses capture research trends and key actors (Zupic & Čater, 2015).

Data preprocessing, classification and simple statistical analyses were performed using Microsoft Excel (Van Nunen et al., 2018). Excel helped to analyze the distribution according to publication year. More advanced analyses (e.g., co-word analysis, thematic maps, etc.) were done using R software. VOSviewer version 1.6.19 outputs were complemented by comprehensive science mapping analyses in the bibliometrix package (Aria & Cuccurullo, 2017). Therefore, the integrative application of various software enhanced the analytical robustness and systematic handling of the dataset (K. Arar et al., 2025; Hussain et al., 2025).

The following keywords were used in the search strategy:

“(blockchain AND education AND (governance OR transparency OR decentralization OR trust OR equity OR innovation))”.

Figure 1 indicates the procedures involved in the systematic definition of the study.

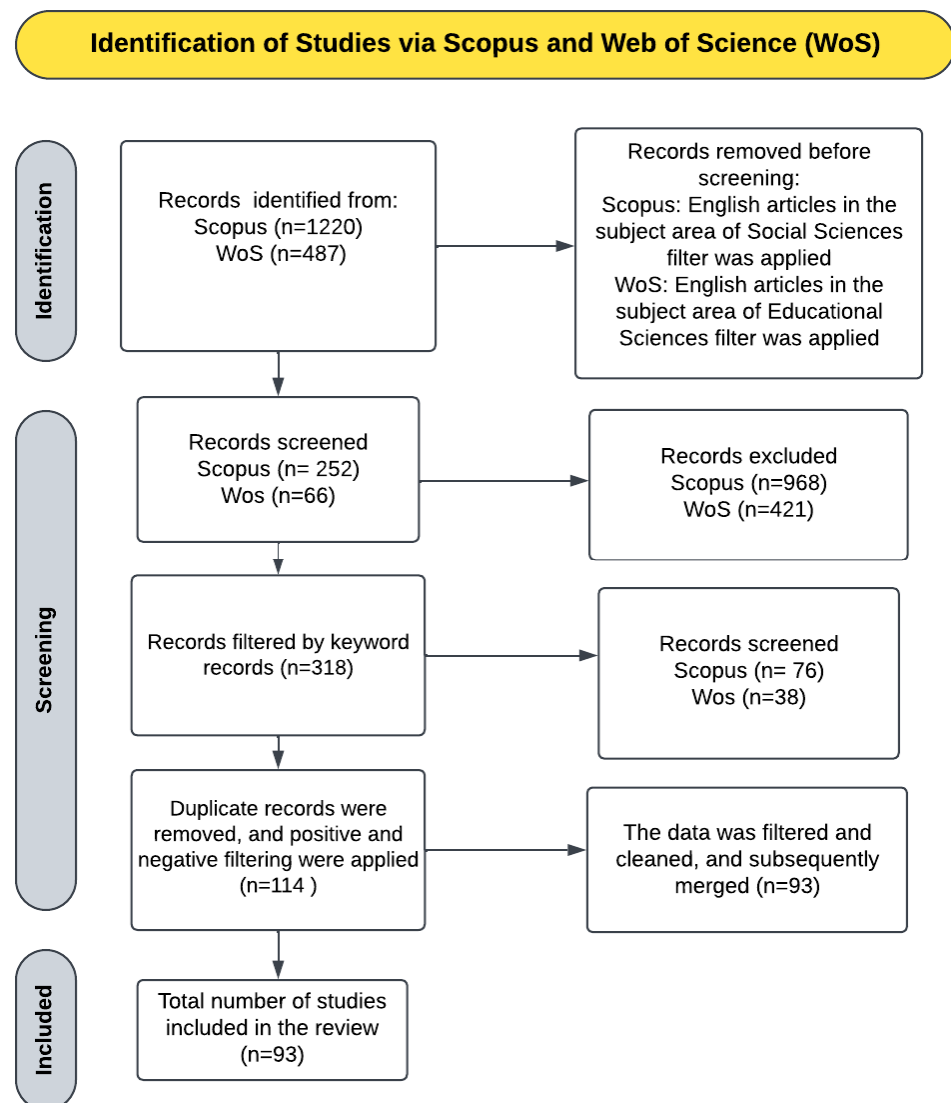


Figure 1. Summary of the PRISMA flow, including identification, screening, eligibility, and final inclusion steps. *Note:* This chart was adapted based on K. Arar et al. (2025, p. 8).

Figure 1 illustrates the screening in the Web of Science (WoS) and Scopus databases, where a set comprising blockchain, education, governance, transparency, trust, equity, and decentralization were used as keywords. The first, filter-free search retrieved 1707 records (487 in the WoS and 1220 in Scopus). Since the initial introduction of the blockchain into education literature occurred in 2017, the search time was limited to 2017–2025. At

the second level, filters were implemented to reduce the dataset to the area of education management and social sciences. Those publications were found under the category Education and Social Sciences, which in turn narrowed the sample to 318 records out of 1707. This finding supports the fact that most blockchain studies are still limited to the fields of technology, engineering and finance and validates the need for disciplinary sampling in the field of educational research (Snyder, 2019; Torraco, 2016; Van Nunen et al., 2018). Non-English editions were not considered to eliminate interpretative discrepancies and align with the foreign literature (Donthu et al., 2021). Then, duplicate entries were eliminated, resulting in the final PRISMA-based dataset.

The thematic phase aimed to deepen conceptual understanding through qualitative content analysis. The concepts associated with governance such as governance, transparency, trust, equity, and decentralization were determined and used to filter items thematically in the R-based Bibliometrix context. To minimize the number of studies that do not deal with the governance aspects of blockchain in education, these keywords were used on the mixed WoS–Scopus database. Since the concepts of governance are described with different technical terms (e.g., distributed trust, ledger-based transparency, digital credentialing, identity management, data governance), thematic filtering significantly reduced the dataset. The sample used was 93 articles selected out of the 318 disciplinary records.

The overall results of the final dataset ($n = 93$) compared to the initial pool of data ($n = 1707$) indicate that the retention rate of the final dataset is only 5.4% and, therefore, it can be inferred that disciplinary, linguistic, and peer-review criteria influence the determination of the scope of the analysis. These requirements, though restrictive, were necessary to maintain methodological integrity, conceptual relevance and compatibility to international scholarly standards. Based on this, the inclusion and exclusion strategies were developed in a systematic manner and are outlined in Table 1 in order to make the methods fully transparent.

Table 1. Inclusion and exclusion criteria.

Criterion Type	Inclusion Criteria	Exclusion Criteria
Publication Type	Peer-reviewed journal articles indexed in Web of Science (WoS) Core Collection or Scopus.	Non-peer-reviewed publications, including conference proceedings, book chapters, dissertations, editorials, reports, and gray literature.
Language	Articles published in English, ensuring conceptual consistency and comparability across the dataset.	Articles written in languages other than English.
Time Interval	Publications from 2017 to 29 May 2025.	Publications released before 2017 or after 29 May 2025.
Discipline	Studies categorized under education, educational research, social sciences, or governance-related interdisciplinary fields.	Publications from domains such as Computer Science, Engineering, Finance, Cryptography, or ICT, unless they explicitly connect blockchain to educational governance
Subject Suitability	Studies focusing on blockchain applications in education, specifically addressing governance, transparency, trust, decentralization, identity management, accountability, credentialing, or data integrity.	Studies discussing blockchain solely from a technical, engineering, cryptographic, financial, or industry-focused perspective without an educational or governance component.
Accessibility and Data Integrity	Publications with accessible full-texts and complete bibliographic metadata (authors, title, abstract, keywords, journal).	Publications lacking full-text access or containing incomplete bibliographic metadata.
Methodological Suitability	Studies that present theoretical, empirical, conceptual, or socio-technical insights relevant to blockchain-based educational governance.	Publications that do not establish a clear methodological, conceptual, or thematic link to educational governance, transparency, trust, or decision-making processes.

The methodological filters strengthened the validity and reliability of the analysis by retaining only salient and methodologically sound studies (Fu & Weng, 2024). The criteria applied, including relevance in terms of discipline, topicality, and the type of publication, produced a coherent, analytically manageable corpus. Specifically, by focusing on peer-reviewed journal articles listed in high-impact databases like Web of Science and Scopus, the quality of the scholarly research was strengthened. Limiting the time frame to 2017–2025 ensured historical relevance. In addition, restricting studies to education, social sciences, and governance enabled a more focused discussion of blockchain's implications for educational governance. Accordingly, the resulting dataset is tightly aligned with the research questions and supports methodological rigor (Snyder, 2019; Van Nunen et al., 2018).

3.3. Analytical Approach and Data Processing Process

The data processing and analysis followed a multi-stage procedure to reveal both the bibliometric structure and the thematic focus of the field. In the first stage, the bibliographic dataset was examined through co-citation, author collaboration, keyword co-occurrence, and conceptual structure analyses using the Bibliometrix package in R (Aria & Cuccurullo, 2017). These techniques are widely recommended in bibliometric research to map intellectual foundations, collaboration networks, and thematic evolution (Donthu et al., 2021; Zupic & Čater, 2015).

Data cleaning, consistency checks, and descriptive analyses were carried out in Microsoft Excel, while visualizations of co-citation networks, keyword clusters, and conceptual relationships were generated with VOSviewer (Fu & Weng, 2024; van Eck & Waltman, 2010). The combined use of these tools supported analytical triangulation and improved the validity of the findings (K. Arar et al., 2025).

In the final phase, the conceptual clusters identified through bibliometric analysis were examined using integrative qualitative content analysis, enabling in-depth exploration of thematic patterns related to blockchain in educational governance. This systematic and multi-layered approach facilitated precise mapping of the research landscape and its core thematic orientations. Table 2 presents the twenty most cited articles that form the analytical foundation of the study.

To answer the third, fourth, and fifth research questions, the twenty articles that had the highest bibliometric performance (Table 1) were included in an integrative qualitative analysis. Such a choice is decisive because the works represent the existing theoretical orientations, methodological trends, and the most common debates about blockchain in the sphere of governance, transparency, trust, and accountability in education. Thematic analysis was performed during the qualitative review step, and narrative synthesis was performed according to the definition provided by Booth et al. (2021). The approach helped to identify common themes, discrepancies, and theoretical paths, as well as across literature through the combination of conceptual patterns of individual studies (as cited in K. H. Arar et al., 2025). Being the most frequently mentioned contributions, these papers not only depict the dynamic of the field development and its most significant scholars but also become a reference point for the development of the theory in blockchain-based educational governance. As a result, they were used as a framework of analysis to corroborate bibliometric results and to further develop the content analysis on a thematic level.

Table 2. Top 20 cited articles.

No.	Title	Author's Name	Total Citations (TC)	TC per Year	Normalized TC
1	Blockchain technology adoption in smart learning environments.	Ullah, Nazir; Al-Rahmi, Waleed Mugahed; Alzahrani, Ahmed Ibrahim; Alfarraj, Osama; Alblehai, Fahad Mohammed	140	28.0	3.0
2	The potential of blockchain in education and health care.	Skiba Diane J.	112	12.4	1.0
3	Blockchain-based approach to create a model of trust in open and ubiquitous higher education.	Lizcano, David; Lara, Juan A.; White, Bebo; Aljawarneh, Shadi	96	16.0	2.5
4	The evolution and future of retailing and retailing education.	Grewal, Dhruv; Motyka, Scott; Levy, Michael	86	10.7	1.3
5	Blockchain in education: Opportunities, applications, and challenges.	Steiu, Mara-Florina	86	14.3	2.2
6	Higher education's microcredentialing craze: A postdigital-Deweyan critique.	Ralston, Shane J.	83	16.6	1.8
7	Blockchain adoption in education: A systematic literature review.	Loukil, Faiza; Abed, Mourad; Boukadi, Khoulood	80	16.0	1.7
8	Blockchain technology enhances sustainable higher education.	Bucea-Manea-Țoniș, Rocsana; Martins, Oliva M. D.; Bucea-Manea-Țoniș, Radu; Gheorghită, Cătălin; Kuleto, Valentin; Ilić, Milena P.; Simion, Violeta-Elena	74	14.8	1.6
9	Blockchain technology: Redefining trust for digital certificates.	Capece, Guendalina; Levialdi Ghiron, Nathan; Pasquale, Francesco	59	9.83	1.5
10	Blockchain adoption in academia: Promises and challenges.	Kosmarski, Artyom	56	9.3	1.4
11	A blockchain-enabled e-learning platform.	Lam, Tsz Yiu; Dongol, Brijesh	47	11.7	3.8
12	Application of blockchain technology in online education.	Sun, Han; Wang, Xiaoyue; Wang, Xinge	47	5.8	0.7
13	Application of blockchain technology in higher education.	Fedorova, Elena P.; Skobleva, Ella I.	43	7.2	1.1
14	Towards utilising emerging technologies to address the challenges of using Open Educational Resources: a vision of the future.	Tlili, Ahmed; Zhang, Jingjing; Papamitsiou, Zacharoula; Manske, Sven; Huang, Ronghuai; Kinshuk; Hoppe, H. Ulrich	41	8.2	0.9
15	Revitalizing blockchain technology potentials for smooth academic records management and verification in low-income countries.	Alnafrah, Ibrahim; Mouselli, Suliman	40	8.0	0.8
16	Blockchain technology application: Authentication system in digital education.	Amitkumar; Sanni, M. Ifran; Apriliasari, Dwi	36	7.2	0.8
17	Maintaining trust in a technologized public sector.	Bodó, Balázs; Janssen, Heleen	29	7.2	2.3
18	Collaborative learning supported by Blockchain Technology as a model for improving the Educational process.	Bjelobaba, Goran; Savić, Ana; Tošić, Teodora; Stefanović, Ivana; Kocić, Bojan	22	7.3	2.2
19	Blockchain technology for sustainable education.	Savelyeva, Tamara; Park, Jae	21	5.2	1.7
20	Current status, issues, and challenges of blockchain applications in education.	Ma, Yan; Fang, Yiming	21	3.5	0.5

4. Findings

This part provides a micro-synthesis which briefly summarizes the results that are relevant to the five research questions that were discussed in the study. The table which lists the major thematic clusters related to each of the research questions outlines the minor focal points related to these clusters and also gives explanatory notes stating the contribution of each focal point to the specific research question. This well-organized introduction allows the reader to gain a quick and accurate glimpse of the broad picture, starting with the dynamics of publications in the sphere to the multi-level governance system and the rationality of the intent behind blockchain.

Table 3 lists the research questions of this study and their thematic clusters and subthemes, as well as their relationships. The table brings together the bibliometric and thematic analysis to explain the structure of blockchain discourse in higher education scholarship in terms of governance features.

Table 3. Micro-summaries of each RQ.

RQ	Thematic Cluster	Sub-Themes/Focus (Condensed)	Micro-Summary and Relation to RQ (Condensed)
RQ1	Publication Trends and Country/Actor Profile	Annual and cumulative outputs; country productivity; SCP/MCP; collaboration patterns	Shows a three-phase evolution (exploration–acceleration–maturation, 2017–2025) and identifies China, India, UK, USA as structural hubs shaping the blockchain-in-education discourse.
	Journals and Institutional Anchoring	Top 10 journals; edtech, sustainability, open-innovation outlets	Locates where the field is institutionally hosted and shows that discourse is mainly organized around edtech, transparency and credential/record-related themes.
RQ2	Trust, Identity Verification and Record Management	Digital ID, certificates, verification; micro-credentials; diploma/transcript systems	Positions blockchain as a core governance tool for transparency and verifiability, especially in higher education, where academic identity and record integrity are being redefined.
	Digital Pedagogies, Decentralization and New Ecosystems	E-learning, exam security, smart education; decentralization, DAO, metaverse; lifelong learning; sustainable/AI-enhanced education	Reveals a multi-layered landscape in which online learning, new incentive/ownership regimes and AI–blockchain synergies drive increasingly decentralized and data-intensive ecosystems.
RQ3	Identity–Document–Assessment Trust Governance	Digital credentials; immutable records; smart-contract grading/recognition	Explains how blockchain rebuilds trust by encoding authenticity and assessment into verifiable, tamper-proof protocols for identity, documents and evaluation.
	Ecosystem–Data–Policy Governance and Tensions	Learning histories; timestamped data; interoperability; policy automation; surveillance/market risks; token regimes	Shows that learner-centered, interoperable data architectures emerge alongside surveillance, profiling and marketization risks, with token and mobility frameworks reinforcing this logic.
RQ4	Micro- and Meso-Level Operational Architecture	Classroom assessment; token/badge motivation; institutional records; diploma/transcript; curriculum–competence frameworks; quality assurance	Clarifies that blockchain renders class-level processes transparent and traceable, while at the meso level it recentralizes quality assurance, archiving and performance monitoring on a single ledger.
	Macro-Level Ecosystem and Policy Governance	Credit transfer and mobility; national platforms; standards; open science; intellectual property	Shows that system-wide processes of mobility, recognition, QA and scholarly communication are being re-designed through blockchain-based infrastructures at national and transnational levels.
RQ5	Trust–Transparency–Automation and Administrative Rationalization	Credential verification; fraud prevention; smart-contract accreditation; error/cost reduction	Conceptualizes blockchain as a governance infrastructure for secure, transparent and automated management of credentials and assessment, promising standardization and rationalization.
	Learner-Centered Portability, Incentive Regimes and Critical Tensions	Self-sovereign ID; portable records; cross-border transfer; tokens/badges; surveillance/market logics	Shows that learner data sovereignty and mobility are strengthened, yet token/reputation systems tether participation and performance to market- and surveillance-driven governance, linking RQ3–RQ4 into a purpose-driven logic.

RQ1—Publication Trends, Citation Patterns, and Leading Actors in Blockchain Education Literature

In the framework of this research question, publication trends, citation patterns and key actors influencing the field were investigated in a systematic way in order to identify the level of scientific visibility of blockchain in the education field. Based on this, the rates of growth in publications per year, productivity of the journals, contributions based on country, and citation dynamics that defined the intellectual structure of the discipline were

examined through the use of bibliometric performance indicators. These indicators are essential for interpreting institutional maturity, thematic establishment, and disciplinary dispersion (Donthu et al., 2021; Hood & Wilson, 2001). The data displayed in this frame were the annual publication distribution, country cooperation network, and the journal productivity frameworks obtained through the R-based bibliometrix package, which was utilized to visualize the dynamic of the blockchain in education literature development, the thematic focus of the literature, and the knowledge production hubs that are fueling the sphere. The analyses exhaustively demonstrate the quantitative imprints of the academic emergence of blockchain in the learning environment and the communities of intellectuals that determine the emergence.

The annual and cumulative distribution of the publications that are incorporated in this study is presented in Figure 2 and discusses the application of blockchain technology to the sphere of education during 2017–2025, in terms of governance and transparency. The graph indicates the number of publications per year and the cumulative (total) amount of publications per year individually. In the next paragraph, the trend analysis will occur according to annual and cumulative publication graphs in Figure 2.

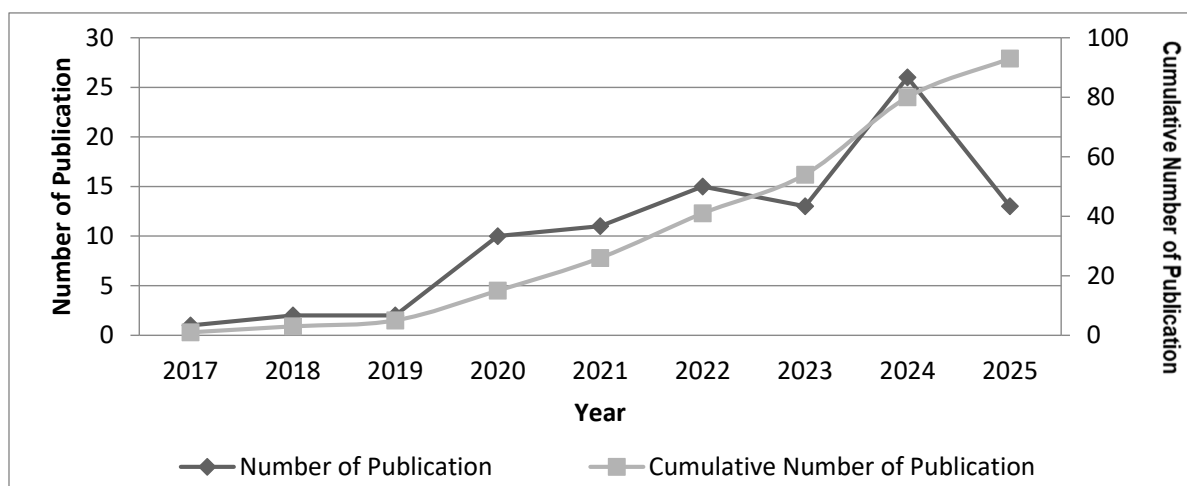


Figure 2. Annual and cumulative number of publications on blockchain-based educational governance.

When examining the annual and cumulative publication distribution for the 2017–2025 period shown in Figure 2, it developed in three phases: (i) early discovery (2017–2019), (ii) acceleration (2020–2022), and (iii) maturation (2023–2024) (Choudhary et al., 2025). The increase reflects the overall dynamics of academic evolution in this area. There is evidence of blockchain technology being mostly linked with education in the field of identity verification, certificate management, data integrity, and security, and these discourses have grown more active since 2020 (Nuryahati et al., 2025; Wang et al., 2024). According to the work of Samala et al. (2024), this state of affairs is a natural upshot of the maturation process of the technology sphere, which is consistent with the increase in our study. Consequently, it is explained by the fact that the number of publications on our topic in the early years was low because of the implementation of blockchain to an incredibly niche and specialized sub-field of educational governance. Equally, the current acceleration of 2023 and 2024 can be linked to the advent of blockchain in the literature to govern issues through the following reliabilities, transparency, and accountability within a learning establishment.

Figure 3 demonstrates the distribution of academic publications created in 2017–2025 on the applications of blockchain technology in the educational industry by country and the

intensity of collaboration with the world. The graph separates single-country publications (SCPs) and multi-country publications (MCPs). This differentiation is a very important pointer in bibliometric studies, as it reveals the level to which nations have developed the discipline on their own and the status of their participation in the global research networks (Aria & Cuccurullo, 2017; Donthu et al., 2021).

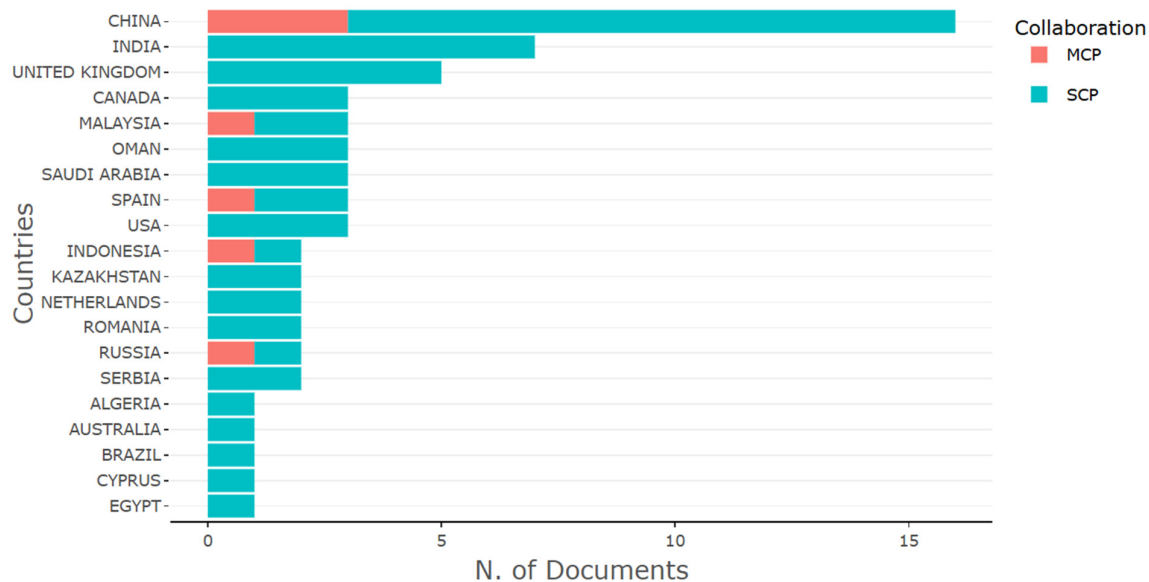


Figure 3. Academic production and collaboration profile of on blockchain-based educational governance publications by country.

As Figure 3 reveals, China has taken a leading role in the publication in the blockchain literature on education. The visibility of China is high regarding single-country production (SCPs) and multinational collaboration (MCPs). This finding is aligned with the performances of other blockchain bibliometric studies in the past (Kyun et al., 2025). China is one of the first states to introduce the blockchain ecosystem into the technical, managerial, and institutional strategies of the country. This strategic vision is also related to the early development of the study on blockchain application in education in China (Samala et al., 2024). The productivity of India, standing in the second position, refers to the high level of technology culture and the increased interest in digital identity management, certificate validation, and solutions of digital governance in the educational sphere and over the last several years (Kyun et al., 2025). The dominance of local research teams in the production of most of the literature is signaled by India, which has a high rate of SCP production. The UK is also one of the countries with the highest rates of MCPs in blockchain-oriented studies in the education sector. This means that the nation has been a bridge in the area of blockchain-in-education, especially in multinational research projects with European, Canadian, and Asian nations (Nuryahati et al., 2025).

Those countries with moderate publication volume and low rates of MCPs, like Canada, Malaysia, Saudi Arabia, Spain, and the United States, suggest that much research on blockchain-in-education is carried out at the national scale by large teams. Thus, it could be claimed that the sphere has not yet transformed into a global collaborative network (Choudhary et al., 2025). In those countries with a smaller volume of production, like Kazakhstan, Romania, Serbia, Indonesia and Algeria, the fact that studies are mostly domestic cooperations indicate that research in these countries is at its infancy and that applications of blockchain are in fields of limited application such as data security and identity checks. The overall poor degree of multinational cooperation indicates a disjointed, country-based expansion cycle, since applications of blockchain technology are a technology

that is susceptible to the digital infrastructure, regulatory and governance capabilities of countries (Samala et al., 2024).

The networks of collaboration between countries in the scholarly literature on blockchain applications in education are depicted in Figure 4. The visualization indicates the research relationships among countries and the severity of international academic relationships. The bigger the node, the more central the role of particular countries in the field, whereas the bigger and tighter the relationships among them, the more powerful the research partnerships (Galeano-Barrera et al., 2022).

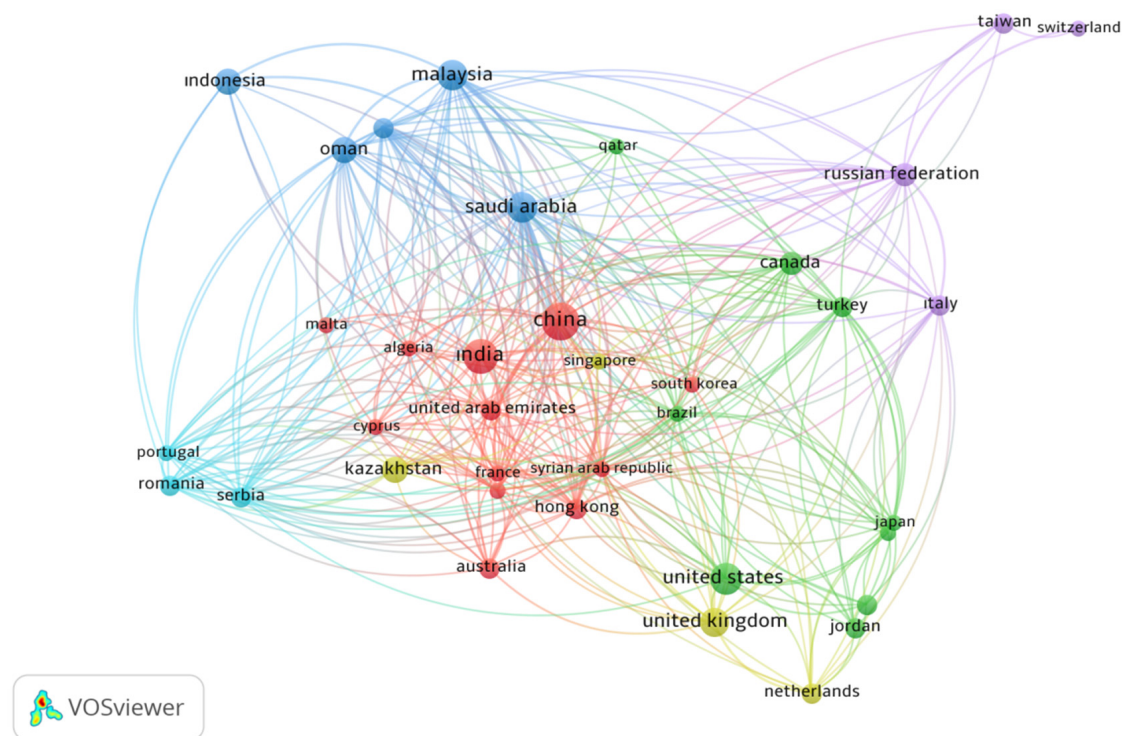


Figure 4. Cooperation network between countries and territories in on blockchain-based educational governance.

Figure 4 demonstrates the collaboration network based on the co-authorship relationship between the countries based on the publications that make up the sample of the research. The nodes of the network are presented as the size of the country, based on the number of publications. Connection intensity is highlighted by the thickness of the connections between countries in terms of joint publications. The colors imply the communities of collaboration that are based on the clustering algorithm. Bibliometric studies also make extensive use of such network visualizations to indicate how countries are located in knowledge production and the level of scientific interaction.

China and India have been found to be at the center of the network, with heavy network connections in the network structure. This scenario shows that the two nations are in multifaceted collaboration with other nations, including the United Arab Emirates, France, Australia, and Kazakhstan. The United Kingdom and the United States, concentrated in the lower-right of the figure, serve transitory roles between the Asia, Europe and Middle East sub-clusters since they are strongly linked to the Netherlands, Japan, Türkiye, Brazil and Canada. This trend suggests that the United States, China, India, and the United Kingdom are some of the nations with the most scientific productivity in the blockchain-in-education literature. The supporting findings in the existing bibliometric research indicate that the research in these countries is mostly related to the types of areas of application, including the use of digital identity verification, certification/authentication,

and the use of trust-based data management (Nuryahati et al., 2025; Samala et al., 2024). Countries in other clusters such as Malaysia, Saudi Arabia and Oman constitute a scattered regional net around Southeast Asia and the Gulf region, whereas the Russian Federation, Italy, Switzerland and Taiwan establish another, comparatively narrower and yet more compact collaboration community. This image indicates that research into the application of blockchain in education is slowly being done more via international collaborations, yet that most collaborations are still organized around regional clusters, owing to the disparity in infrastructure, regulations, and governance frameworks. These results indicate that the US, China, India, and the UK have taken decisive leadership in blockchain-in-education, not only in the number of publications but also in the range of topics, and that the areas of education, which may be critically important in blockchain use, e.g., trust, identity verification, and management of certificates, are dominated by the countries on the global scale.

The 10 journals with the highest number of articles published on the application of blockchain in the education field are presented in Figure 5. Such data show where the literature on this topic is concentrated in journals, and tries to identify the profile of publications of the field and possible knowledge centers. This will enable the scholars and the professionals to assess the interdisciplinary broadness of the topic, its free accessibility, and efficient sources of publication in a more transparent context. They are also able to have knowledge on the potential gaps and new areas of concentrated work in future.

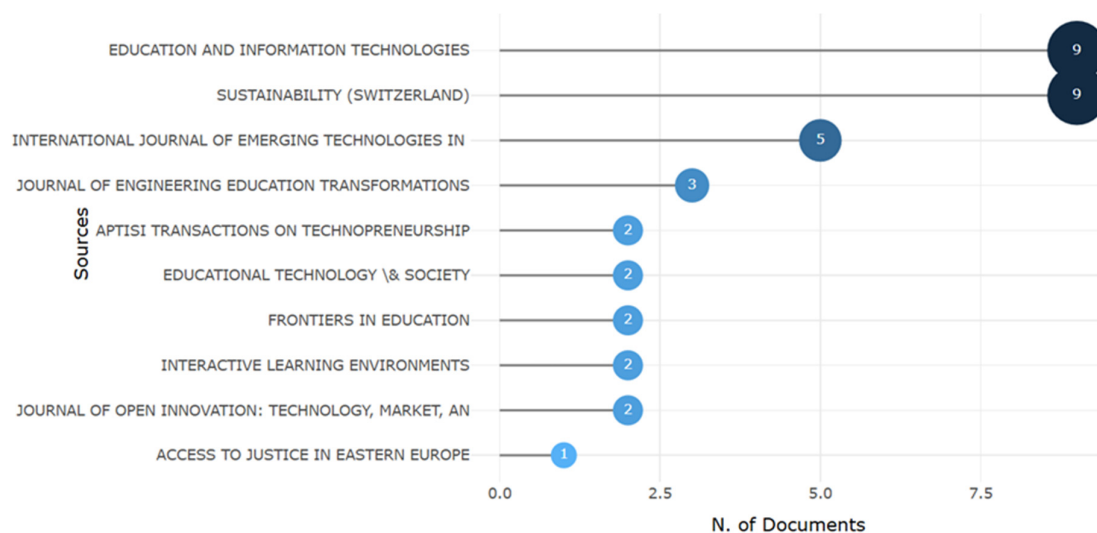


Figure 5. Top 10 sources for publications on blockchain-based educational governance.

According to Figure 5, the highest production is concentrated in the journals *Education and Information Technologies* and *Sustainability* (Switzerland) ($n = 9$). These two journals are followed by the *International Journal of Emerging Technologies in Learning* (iJET) ($n = 5$) and the *Journal of Engineering Education Transformations* ($n = 3$). Other education technology-focused journals (*Educational Technology & Society*; *Frontiers in Education*; *Interactive Learning Environments*) offer low-volume but thematically complementary contributions. This distribution shows that the blockchain-in-education literature has developed primarily around the axes of educational technologies, online learning, digital certification, and institutional transparency (Ocheja et al., 2022; Reis-Marques et al., 2021). Certain research suggests that much of the work on blockchain is dedicated to its use in identity verification, micro-certificates, verifying academic records, and trust-based processing of data (Chen et al., 2023; Ocheja et al., 2022; Raimundo & Rosário, 2021).

Moreover, the *Sustainability* journal is one of the most fruitful sources, which suggests that sustainable governance, data integrity, and accountability also represent the different views of the blockchain studies. The same idea is shared by Zhao et al. (2023), who state the opportunities of blockchain to increase transparency and verifiability and build stable digital learning ecosystems.

Also, the fact that sources like the *Journal of Open Innovation: Technology, Market, and Complexity* and *APTISI Transactions on Technopreneurship* are included in the graph proves that blockchain is studied not only in the context of the functions of open innovation and technological entrepreneurship but also the data economy (Choudhary et al., 2025). This tendency, which is in line with the results of many bibliometric analyses, demonstrates that the area is quickly becoming hybrid in the sense of its structure, incorporating technical, pedagogic, and governance aspects (Chen et al., 2023; Shuhaimi et al., 2024).

RQ 2. Thematic Focus Areas of Blockchain in Education in the Context of Transparency, Trust, and Governance

Answering this research question, we examine how blockchain is positioned in the educational system regarding transparency, trust, and governance, and how these themes evolve over time. To this extent, the thematic analysis was performed in two stages using author keywords of publications in the sample of studies. These analyses were decided upon as (i) co-occurrence analysis to determine conceptual clusters and areas of focus, and (ii) thematic map analysis, which categorizes themes under driving, core, niche and emerging themes. These techniques are widely used to establish thematic focus (Aria & Cuccurullo, 2017; Donthu et al., 2021). The combination of analyses provides a comprehensive conceptual map of the connection between blockchain and the themes of trust, transparency, identity verification, digital certification, decentralization, and governance as applied to the area of education.

The results below outline the priority areas, which were determined by the means of bibliometric analysis and in-depth content reviews, along with the important ideas that will help shape the course of future research. The co-occurrence analysis of published works on blockchain applications in education provided in Figure 5 demonstrates the specifics and complementary nature of thematic focuses of published works on the topic.

Figure 6 is the co-occurrence relationships of the author keywords employed in the literature on education blockchain applications. By doing so, thematic clusters as per the strength of the co-occurrence of the concepts can be observed. The conceptual core of this area has been made up of the concepts of blockchain, education, blockchain technology, and higher education, which fall at the center of the network. Around this hub, there are governance-oriented ideas which include trust, digital certification (digital certificate, credentials), data verification, and decentralization. This framework demonstrates that the functions of transparency, reliability, and verifiable record management are the main areas in which blockchain is used in education (Chen et al., 2023; Ocheja et al., 2022; Raimundo & Rosário, 2021).

The first thematic cluster of the network is the trust-authentication-oriented governance cluster consisting of the tags of “trust”, “credentials”, “digital certificate”, and “digitalization”. The presented cluster indicates the fact that blockchain is already taking center-stage in the educational sector and its system has become important in areas like the systematic verification of digital identities to attain authenticity, trustworthy recording of learning results, and record integrity. The literature underlines that blockchain is becoming one of the technologies that are rapidly being adopted in the field of education governance because of its capability in improving data integrity, transparency, and accountability (Bhaskar et al., 2021; Reis-Marques et al., 2021).

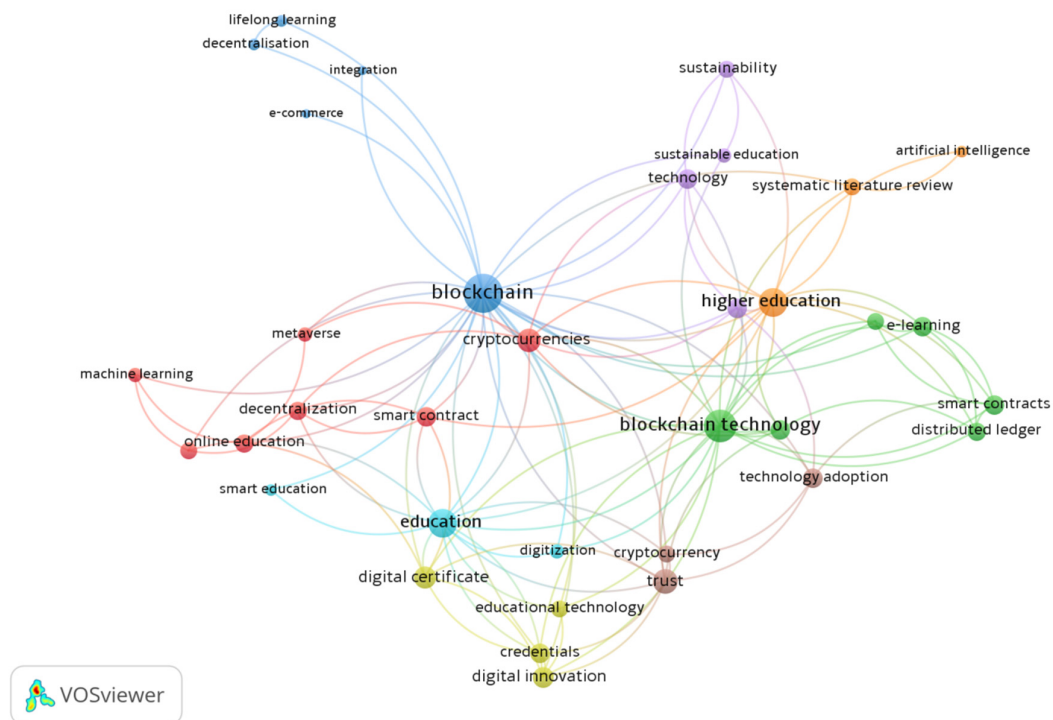


Figure 6. Co-occurrence network analysis of research on blockchain-based educational governance.

The second cluster is the cluster of the higher education and academic record management that is formed based on the tags of “higher education”, “technology adoption” and “distributed ledger”. This framework shows that diploma verification, micro-certification, management of digital transcripts, and academic identity integrity are some of the primary applications of blockchain in higher education (Choudhary et al., 2025; Shuhaimi et al., 2024).

The third cluster is the online learning and digital pedagogies cluster that comprises such tags as “online education”, “e-learning”, “machine learning”, and “smart education”. This thematic organization demonstrates that blockchain can be viewed as a complementary technology in the fields of online exam security, checks of learning analytics, protection of the integrity of the content, and the protection of individual learning processes (Chen et al., 2023; Zhao et al., 2023).

The fourth cluster consists of a collection of emerging technological themes consisting of the tags of “decentralization”, “smart contract”, and “metaverse”. In this respect, the works published after 2022 also justify the swift development of the ideas of decentralized identity, assessment driven by smart contracts, and learning environments based on immersion and blockchains (Alonso-Muñoz et al., 2025; Choudhary et al., 2025). Furthermore, the peripheral presence of concepts such as “cryptocurrencies” in the network is a terminological echo stemming from blockchain’s technical origins and is not directly related to the thematic core clusters in the educational context. In the bibliometric literature, such concepts are generally considered peripheral labels that reflect the technical background of the field but are not part of the thematic core (Zhaisanova & Mansurova, 2024).

As the thematic map in Figure 7 indicates, in the area of education, blockchain is clustered around these concept groups and themes and how they are grouped by their degree of centrality (relevance) and concentration of development in the area. Thematic map analyses have high levels of analytic value with respect to identifying the fundamental themes of a research area, niche clusters that have high but low levels of impact, emerging topics and driving themes (Aria & Cuccurullo, 2017; Donthu et al., 2021).

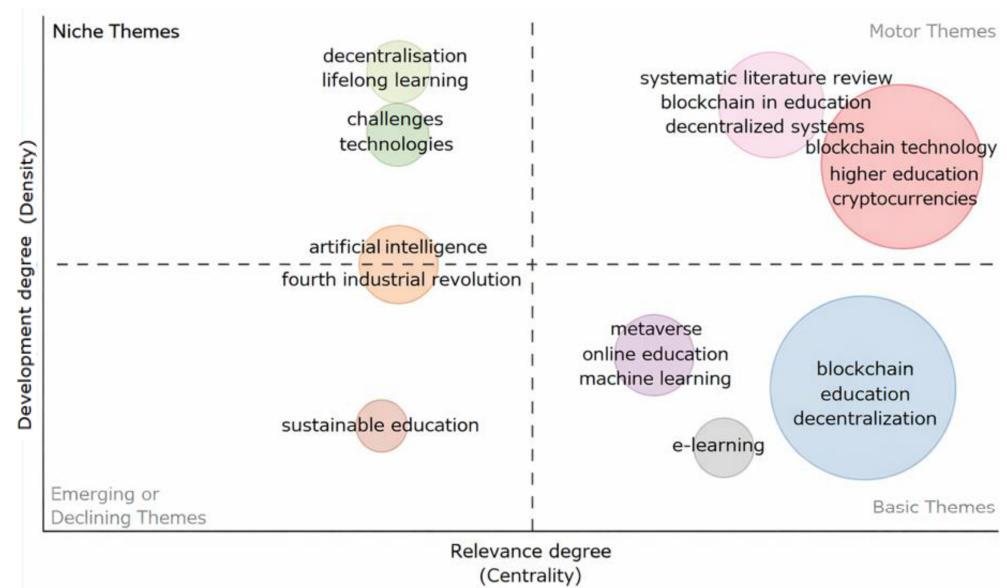


Figure 7. Thematic map of keyword clusters on blockchain-based educational governance.

The findings of Figure 7 show that blockchain-in-education literature is in a hybrid format that consists of both technical and pedagogical aspects.

Motor Themes (High Centrality—High Density): The motor themes placed in the upper right part of the map indicate that the ideas of blockchain technology, higher education, and cryptocurrencies are the conceptual basis of the field. These themes verify the fact that blockchain is actively used in the field of education, especially in the processes concerning identity verification, certificate management, diploma verification, data integrity, and security. Past bibliometric analyses also suggest that the most advanced and ubiquitous domain of application of this technology is education at an advanced level (Chen et al., 2023; Ocheja et al., 2022; Reis-Marques et al., 2021).

Core Themes (High Centrality—Low Density): The concepts of the blockchain, education, and decentralization on the lower right quadrant reflect the most common yet-to-be-developed thematic parts of the field. The findings indicate that blockchain is anchored by the fact that it has the potential to increase transparency, traceability, and accountability in the education governance sector (Shuhaimi et al., 2024).

Niche Themes (Low Centrality—High Density): The topics of decentralization, lifelong learning, challenges and technologies that are in the upper left quadrant suggest that the topics are studied intensively by a limited number of research groups but have very little spreading throughout the entire field. The fact that the lifelong learning and ownership of knowledge themes are present here suggests that blockchain is starting to be linked with innovative models including micro-certification and the ability to transfer a personal learning history. Essentially, the studies by Zhao et al. (2023) and Choudhary et al. (2025) support this trend in the research.

Emerging or Declining Themes (Low Centrality—Low Density): The ideas of sustainable education, e-learning, metaverse, and machine learning, which are in the bottom left quadrant, show the themes that are either at the stage of development or which are losing their strongholds in the literature. The applications of blockchains with the metaverse and artificial intelligence are specifically at the discovery level, which implies a wide range of research in the years to come.

According to co-occurrence network and thematic map outputs, the blockchain-in-education literature has a multi-layered conceptual design structured around the transparency, trust, and governance axes. The fact that the core themes of identity verification,

data integrity, and institutional trust production have been centralized in higher education means that blockchain is now an institutional means of creating epistemic reliability and verifiability instead of a tech-focused innovation. The range of core and niche topics represented in the fields of decentralized data ownership, lifelong learning ecosystems, and micro-certification demonstrates that the technology is touching upon more fundamental governance issues in the education sector, which include subjectification, autonomy, and digital citizenship. The use of blockchain applications is not just restricted to being one of the tools that governs the operational processes within education systems. This thematic trend can be conceived as a paradigmatic change, which allows for a new paradigm of governance that is based on transparency, accountability and the ethics of trust.

RQ3. Process-Based Governance Areas of Blockchain in Education

The reviewed studies show that blockchain has been incorporated into the sphere of educational governance not as an exclusive technological solution but as a mechanism for restructuring existing governance practices at various levels. The findings indicate that the related practices can be analytically divided into two major dimensions.

An Examination of Identity Document Assessment Trust Governance

The first dimension shows that the sphere in which blockchain is mainly implemented is processes related to the generation of trust. According to the findings, academic identity and credential management, i.e., the production, verification, transfer, and revocation of diplomas, transcripts, and certificates, have been redesigned into blockchain-based management (Ullah et al., 2021; Skiba, 2017; Steiu, 2020). This change is associated with algorithmic and protocol-driven trust that is executed on the basis of distributed and immutable record formats. This particular initiative is aimed at combating diploma and certificate fraud (Capece et al., 2020). Grading rules are specified by smart contracts and automatically implemented. The records of online exams are stored as unalterable block entries, and competency approvals are registered according to expert consensus (Lizcano et al., 2020; Lam & Dongol, 2022; Loukil et al., 2021; Sun et al., 2018). The structure can reshape the grading and competency recognition procedures and push them beyond the jurisdiction of individual teachers or schools and create a shared assessment regime based on network agreement (Lizcano et al., 2020; Lam & Dongol, 2022). In turn, blockchain technology allows for rebuilding trust, authenticity, and accountability in the practices of credential governance and assessment.

Learning Ecosystems, Data, And Policy Governance

The second dimension is evidenced by the fact that the applications of blockchain go beyond the limits of individual organizations, including the processes that no longer are confined to documentation and assessment. This phenomenon has the potential to change the flow of learning on the ecosystem scale and impact such areas as data governance and macro-policy architecture. A growing body of literature testifies to the effectiveness of blockchain in creating an integrated system of learning data-governance infrastructure, which logs the learning history of learners in a time-stamped fashion and, thus, facilitates the integrity and security of the data. Moreover, it enables the sharing, access, and permission policy of data to be managed using smart contracts. As the authors of the studies by Ullah et al. (2021), Sun et al. (2018), and Loukil et al. (2021) have shown, such an approach is a promising solution to the problem of data management in academic institutions. The self-sovereign identity model in this case attempts to empower the learners by providing them with more control in terms of their identity and data. Student-centered record designs form the basis of concepts of data portability and cross-institutional interoperability (Steiu, 2020; Loukil et al., 2021). However, the fact that the discourse of data sovereignty could be integrated into the process of market surveillance and platform capitalism can be seen as one of the crucial tensions identified in the current literature (Fedorova & Skobleva,

2020; Lam & Dongol, 2022; Ralston, 2021). According to empirical evidence, in reality, blockchain-driven redistribution of data ownership in favor of the learner might also create the risks of surveillance and profiling, as well as commodification (Ralston, 2021). This dimension includes inter-institutional recognition, credit transfer, mobility, token- and badge-based regimes of motivation and reputation, curriculum management in an international marketplace, macro-policy, standards and quality assurance, open science, and intellectual property governance (Bucea-Manea-Țoniș et al., 2021; Grewal et al., 2018; Lizcano et al., 2020; Loukil et al., 2021; Kosmarski, 2020; Sharples & Domingue, 2016). The ensuing growth implies that the educational ecosystem is undergoing a restructuring that is enabled by blockchain-based protocol architectures. This reorganization goes beyond the conventional teaching processes and to data infrastructure, mobility, incentive systems and the scientific production cycle.

RQ 4. Blockchain's Multi-Level Operational Architecture in Education

The fourth research question focuses on the scales at which blockchain operates in education. The studies examined reveal that applications cluster at three governance levels: micro, meso, and macro. Though the levels are analyzed separately to help better understand their functioning, the results indicate that blockchain-based educational governance functions dynamically at various levels, which is enabled through the mutual exchange of data, verification procedures, standardization, and the influence of regulation.

Micro Level: Learning-Activity Governance

At the micro level, blockchain is changing the systems of recording and rewards of learning activities conducted at the classroom and course levels. Studies have shown that the output of online exams and the processes done by the learners are stored in time-stamped and non-modifiable record blocks. As a result, the performance of students and in-process processes can be reliably traced (Sun et al., 2018; Loukil et al., 2021). Simultaneously, participation incentives in the form of tokens and badges develop a correlation between learning behaviors and the blockchain-based reputation and rewards systems. The records on the chain are consequently connected to student participation, collaboration, and performance in the course (Bucea-Manea-Țoniș et al., 2021; Sharples & Domingue, 2016). These results highlight the instrumental functionality of blockchain in two major dimensions, namely, the lack of veil of pedagogical processes and the restoration of motivational processes at the micro level. At the same time, the verifiability of the accounts of the pedagogical interaction and the performance created at the individual level can not only contribute to the increased transparency within the instructional settings, but directly contribute to the institutional-level discourse as a provider of a sound database to be used to produce a comprehensive assessment, competencies recognition, and quality assurance protocol calibration.

Meso Level: Institutional-Program Governance

At the meso level, blockchain is incorporated in the governance processes that run on institutional and programmatic levels. Empirical research shows that the systems of diploma and transcript verification are currently in the process of a profound reorganization, which is made possible by blockchain-based credential management systems. This reorganization will reduce the use of institutional archives, third-party authorization systems, and manual verification processes (Lizcano et al., 2020; Skiba, 2017). At the same time, integrating institutional competency assessments systems, program outcomes, and curriculum modules into a blockchain platform represents the pinnacle of developing a meso level in the form of curriculum infrastructure and performance governance (Lam & Dongol, 2022). This assimilation collimates disparate education measures through a tamper-evident unified ledger. The application of blockchain technology brings a significantly higher level of auditing and traceability into the quality assurance procedures of the internal

scope. Blockchain enhances the transparency and accountability of accreditation indicators and performance measurements by documenting them on an unchanging ledger (Capece et al., 2020). Thus, blockchain is absorbed in a governance logic that predetermines administrative efficacy and responsibility on the university and program level. Institutional control is practiced at the meso level, at the same time, playing the role of mediating between the records created at the micro level and the mechanisms of recognition, accreditation, and mobility at the macro level.

Macro Level: National/Transnational Ecosystem Governance

On the macro level, blockchain penetrates the size of ecosystem rules in the whole educational system. The results point to the fact that the networks of credit transfers and mobility, such as EduCTX and Erasmus-like student exchange programs, are currently assessed to be administered by blockchain-based registration systems (Loukil et al., 2021). The regulatory frameworks that are created by the national education blockchain platforms and associated projects (that create regulatory standards) indicate that the data infrastructure, recognition and quality-assurance regimes are being redesigned at the system level (Fedorova & Skobleva, 2020; Steiu, 2020). At the same time, the fields of open science and intellectual-property management are being reconfigured, driven by the convergence of the research data, preprints, peer review, and citation (Kosmarski, 2020; Ralston, 2021). On the other hand, macro-level regulatory frameworks, data standards, and accreditation systems provide a retro-post fashion of how many micro-level activities should be recorded and which meso-level verification procedures should be treated as authentic.

RQ5. The Purposeful Governance Logic of Blockchain in Education

The fifth research question aims to understand blockchain's purposes in education. The literature reveals that these purposes fall into two main categories.

Trust–Transparency and Administrative Automation Purposes

The first category of purposes dwells on the rationalization of education administration with reliability, transparency and automation. According to empirical research, blockchain-based credential verification systems aim at preventing diploma and certificate fraud, maintaining the integrity of documents, and enhancing the transparency of accreditation (Loukil et al., 2021; Skiba, 2017; Steiu, 2020; Ullah et al., 2021). Introducing learning and assessment procedures that have invariable and traceable records is believed to be a relevant approach towards increasing accountability (Lizcano et al., 2020; Sun et al., 2018). At the same time, smart contracts are automatically used to perform actions, including verification, cancellation, grading, and credit recognition according to pre-programmed rules, thus creating massive expectations with regard to the efficiency and standardization of administrative procedures (Lam & Dongol, 2022). Within this paradigm, blockchain is presented as the infrastructure that will help decrease the governance expenditures in educational organizations, minimize the instances of procedural mistakes and delays, and make administrative processes more predictable.

Learner-Centered Portability, Mobility, and Incentive Objectives

Second, the system of objectives indicates that the educational ecosystem is based on the fact that learner-centric information is a prerequisite, and the independence of identity, inter-institutional mobility, and re-invented incentive systems. Portable learning records and self-sovereign identity will enable learners to take charge of their data and move it beyond institutional and national boundaries (Loukil et al., 2021; Steiu, 2020). The solution envisaged will enable and expedite credit transfer and qualification recognition on a transnational basis (Loukil et al., 2021; Skiba, 2017). Additionally, tokens, badges, and reputation systems are allegedly connected to emergent blockchain-based learning economies and motivation, as well as engagement (Sharples & Domingue, 2016; Bucea-Manea-Țoniș et al., 2021). However, the literature on critical analysis also emphasizes the possibility of

these economies to overshadow a pedagogical agenda by getting hooked to market logics and surveillance (Ralston, 2021). Therefore, despite the claim that blockchain technology strengthens the mobility of learners and the sovereignty of their data, it also leads to the establishment of a two-level, conflictual regime of governance, relating motivation and participation to an economic, protocol-based system of incentives. Together, these patterns link RQ3 to RQ4 by illustrating how conceptual clusters mirror authorship and institutional networks. Similarly, RQ5 builds on these structures to examine governance implications.

5. Discussion

The results revealed in this research indicate that blockchain is not a technological invention in education; it is a multi-layered framework that alters the reasoning of educational governance. There is an integrated analysis of the shared governance logic that lies behind such applications that have historically been studied individually in the literature based on three main themes: the process-based areas of governance, multi-level operational architecture and purpose-driven governance logic (Bucea-Manea-Toniş et al., 2021; Lizcano et al., 2020; Loukil et al., 2021). In line with this, this study offers an integrative and descriptive framework that adds value and consolidation to the existing scholarship.

To begin with, there is evidence concerning the areas of process-based governance, according to which blockchain is oriented on the axis of trust production in the identity, document, and evaluation processes. The migration of credential management to distributed and immutable records reduces the potential of fraud, and the evidence is consistent with previous systematic reviews (Lizcano et al., 2020; Capece et al., 2020; Steiu, 2020). However, this paper shows that this trust regime goes beyond diplomas and certificates to include grading, exam documentation, and competency checking (Lam & Dongol, 2022; Sun et al., 2018). As a result, assessment practices are changing from being not only the preserve of individual teachers but to a collective assessment regime based on network consensus. The resulting change contributes to the creation of trust as a protocol- and algorithms-based norm and is no longer an issue that is constructed in pedagogical relationships, thus creating new opportunities of theoretical discussion on the provenance of educational power. The original contribution of the study is the conceptualization of this transformation, which so far has mostly been only referred to at the technical or administrative levels, into an overall process, called trust governance.

Second, the results regarding multi-level operational architecture show that blockchain applications are concentrated at the micro level (learning-activity), meso level (institutional-program), and macro level (national/transnational ecosystems). Although Loukil et al. (2021) and Fedorova and Skobleva (2020) mention the use of blockchain in higher-education situations at various levels, they fail to logically present those levels in the framework of analytical scope called the three-level governance architecture. The current paper indicates that at the micro level, time-stamped histories of learning processes and token- or badge-based motivation systems link classroom pedagogy and an emergent learning economy. On the chain, institutional credential management, such as curriculum modules, quality assurance processes, and indicators of accreditation are also represented, thus re-establishing the performance and accountability regimes at the institutional level. On the macro level, it has been found that there is a shift towards the reorganization of ecosystems in areas like credit transfer, transnational mobility networks (such as EduCTX-type models), national education blockchain, and open-science intellectual-property governance (Sharples & Domingue, 2016; Grewal et al., 2018; Kosmarski, 2020; Ralston, 2021). In this respect, the research fills a major theoretical gap, by combining classroom activities, institutional organizational governance and national/transnational policy measures, which have previously been analyzed separately in the literature, into a multi-level model.

Third, the existing body of empirical research on the logic of intentional governance offers suggestions that blockchain systems deployed in the context of education seem to converge around two main sets of dimensions: (i) trust, transparency and administrative automation; and (ii) learner-centered portability, mobility and incentive structures. The former dimension aligns with the goals of the previous research on reducing fraud, document integrity, and automation of bureaucratic processes (Skiba, 2017; Ullah et al., 2021; Sun et al., 2018; Lam & Dongol, 2022). However, despite the fact that this governance reason supports the anticipations of expenditure decrease, standardization, and fast verification in educational organizations, it also presupposes that a significant share of pedagogical judgments is assigned to algorithmic procedures. Such delegation can lead to controversial pedagogical results. The latter dimension indicates the establishment of new learning economies based on learner-centered learning through self-sovereign identity, portable learning records and motivational and reputational systems based on tokens or badges (Bucea-Manea-Toniş et al., 2021; Loukil et al., 2021; Sharples & Domingue, 2016; Steiu, 2020). In agreement with the critical scholarship of Ralston (2021) and Kosmarski (2020), the current research demonstrates the risk that these economies may become integrated with market logic and surveillance practices and platform capitalism. Thus, on the one hand, the rhetoric of blockchain holds the potential of emancipating learners through the discourses of data sovereignty and mobility; on the other, it runs the risk of creating new dependency relations connecting motivation and participation to the regimes of incentives, which are based on protocols. From this perspective, the theoretical contribution of the given research is in the conceptualization of blockchain as not a tool of trust-enhancement or efficiency-enhancement, but rather as a normatively contested infrastructure that represents dual, contradictory, purpose-oriented governance logic. Considering these themes, this paper conceptualizes blockchain in education in the following axes: process-based trust and data regulation; multilevel operation on micro, meso and macro-levels; and automation of trust and learner-centered mobility and incentives. In line with this, this paper provides an integrative conceptual framework of what is currently scattered in the literature (Lizcano et al., 2020; Loukil et al., 2021; Capece et al., 2020; Fedorova & Skobleva, 2020). By suggesting that the educational value of blockchain should be viewed alongside the reasoning regarding data sovereignty, platform capitalism, and learning economies, the research partly fills the gap in the understanding of technical discourse and critical, post-digital, and decolonial frameworks (Ralston, 2021; Kosmarski, 2020).

6. Conclusions and Recommendations

The results of the present study indicate that the potential of blockchain in educational practice is two-fold—both transformative and dangerous at the same time. Through smart contracts and distributed ledger systems, trust, authenticity, and accountability are safeguarded. Nevertheless, protocols are in place, together with economic incentive regimes linked to the measurement, monitoring and incentivizing of learning processes. This bi-polar organization requires prudent consideration both on theoretical and practical considerations. As a researcher in the field of education, first, qualitative and mixed-methods research is needed to investigate the implications of blockchain's technical feasibility, teacher agency, student identity, and inequality dynamics. These studies investigate the effects of blockchain-based systems on classroom engagement, assessment equity and subjective experiences of students. Second, an empirical study in the Global South, as well as exploring education environments that are understudied and governance practices across the micro-, meso-, and macro-levels, will help to redress the qualitative geographical and epistemic imbalance in the literature (Loukil et al., 2021; Fedorova & Skobleva, 2020).

The findings imply that pedagogical goals, and principles of justice, privacy, security, and efficiency, must be explicitly stated in blockchain-based credential and data management tools to the policymakers and institutional managers (Capece et al., 2020; Ullah et al., 2021). Projects founded on blockchain developed at the national and institutional levels are to be considered as tools of governance that have the ability to reproduce or minimize inequalities, as opposed to administrative automation tools. As a result, the structural level of these projects should incorporate ethical control systems, stakeholder involvement, and open processes (Ralston, 2021; Kosmarski, 2020). In the process of introducing micro-level token/badge-based systems, the design principles should be developed in a way that the motivation of students is not entirely determined using extrinsic motivators. Instead, the interpretation of learning, sense of belonging, and autonomy are to be maintained and strengthened (Bucea-Manea-Toniş et al., 2021; Sharples & Domingue, 2016).

Lastly, blockchain seems to be a disruptive sector that offers possibilities and threats according to teachers and learners. Clear documentation and authorization checking may be able to offer a more justifiable and trackable teacher evaluation procedure. The constant recording and traceability, however, can lead to the development of high-performance pressure and a sense of being spied on by both teachers and students. Hence, teachers need to achieve the necessary critical digital literacy in such a way that their pedagogic independence and ethics remain intact in a situation where they apply this type of system (K. H. Arar et al., 2025). This paper shows that blockchain is to be perceived as a system that digitalizes education and restructures its logic of governance. It consequently offers a fruitful theoretical and empirical basis to research in the future. However, the intersection of the right to be forgotten and the immutable nature of blockchain is a topic that is seldom discussed in academia. Although tamper-proof records are being billed as a plus for governance, educational records are also used to capture the developmental trends of learners, their errors, their weaknesses, and prospects for growth. Storing the data about students in the long term may cause both educational and legal issues, particularly when one needs to rewrite, delete or reinterpret the data. Therefore, blockchain-based educational law must be considered with trust and transparency, as well as the security of the data, the rights of students, and the possibility for second chances.

7. Limitations and Future Research Agenda

This review demonstrates that the literature on blockchain and educational governance is dominated by techno-managerial framings, and there is little information regarding how such systems can reallocate power, authority, and control. Despite its description as a non-centralized and trust-inducing system of governance, decentralization does not necessarily involve democratization. Therefore, further studies must address more than technical functionality and governance efficiency to understand who is benefiting from transparency, who has control over educational data, who shapes and determines algorithmic rules, and whether blockchain-based systems provide more agency to their users or become built-in governance in less visible technical systems. This analysis should look critically at the technological–managerial orientation in the literature.

The choice of database creates one more limitation; international coverage, full citation metadata and the ability to perform bibliometric mapping make Web of Science and Scopus especially appealing to scholars, despite the fact that both services are biased towards publications in English and other languages that are indexed worldwide. As a result, non-Western research, regional indices, and languages can be neglected in the process of evaluation. The current study, consequently, runs a risk of an unrepresentative sample of the Global South, not due to a lack of scholarship, but, as a consequence of the orientation of indexing regimes to English-language literature. As has been exhibited in such research

choices, there are perpetuated epistemic differences. To reduce those constraints, the current studies need to be complemented by means of multilingual and regional data to attain a complex perspective of blockchain in the context of educational governance, geographically and epistemologically.

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