Cross-Currents: An International Peer-Reviewed Journal on Humanities & Social Sciences
Abbreviated Key Title: Cross Current Int Peer Reviewed J Human Soc Sci
ISSN: 2394-451X (Print) & Open Access
DOI: 10.36344/ccijhss.2024.v10i04.003

Volume-10 | Issue-4 | Jun-2024 |

Original Research Article

Blockchain Technology in Education: Applications and Challenges

Dr. Karamjeet Kaur[1*]
[1]Assistant Professor in Commerce & Business Management, ASSM College, Mukandpur, SBS Nagar, Punjab-144507
***Corresponding author:** Dr. Karamjeet Kaur

| Received: 06.05.2024 | **Accepted:** 13.06.2024 | **Published:** 15.06.2024 |

Abstract: Blockchain technology has emerged as a transformative tool with the potential to revolutionize various sectors, including education. This research paper explores the applications of blockchain technology in the education sector, highlighting its rationale, challenges, and prospects. By leveraging blockchain's inherent properties of decentralization, immutability, and transparency, educational institutions can enhance data security, streamline administrative processes, and ensure the authenticity of academic credentials. The benefits of blockchain are multifaceted and might be beneficial to educational institutions and students. However, the adoption of blockchain technology is presently in its incipient stage within the educational sector.

Keywords: Blockchain in Education, Decentralized Systems, Data Privacy and Security.

SECTION I

INTRODUCTION

Blockchain technology, introduced in 2008 as the underlying technology for Bitcoin, has since found applications beyond cryptocurrencies. Its decentralized, secure, and immutable ledger system offers numerous advantages for various sectors including finance, healthcare, supply chain management and education. In the education sector, blockchain can address several persistent challenges, such as verification of academic credentials, sharing of student records securely and creation of efficient, transparent educational platforms. The application of blockchain to education is still in its early stages. Only a small number of educational institutions have started to adopt blockchain technology. Mostly, these institutions are using it to authenticate and share academic certificates and learning outcomes that their students have achieved. However, researchers in the field are of the view that blockchain technology has much more to offer and can transform the field entirely. This paper examines how blockchain technology can be applied to education, focusing on its rationale, practical applications and associated challenges. Rest of the paper is organized as: Section II reviews the relevant literature, Section III discusses the rationale and some of the applications of blockchain technology in education, Section IV explains the challenges associated with its applications and Section V concludes.

SECTION II

LITERATURE REVIEW

International research is currently being conducted in both academia and industry applying blockchain in varied realms. Several studies have investigated the potential of blockchain in education. Alammary *et al.,* (2019) conducted a systematic review highlighting the benefits and challenges of blockchain-based educational applications, emphasizing credentialing and administrative processes. These applications can be classified into twelve categories: certificates management, competencies and learning outcomes management, evaluating students' professional ability, protecting learning objects, securing collaborative learning environment, fees and credits transfer, obtaining digital guardianship consent, competitions management, copyrights management, enhancing students' interactions in e-learning, examination review and supporting lifelong learning. Another study by Kassab *et al.,* (2019) identified blockchain's role in managing and sharing educational records, enhancing transparency and ensuring data integrity. Steiu (2020) discusses the opportunities and challenges of applying blockchain technologies in the education sector. The key blockchain-in-education applications discussed are the digitalization and decentralization of educational certifications and the enhancement and motivation for lifelong learning. The researcher emphasized that blockchain should not be perceived as a threat or replacement for educational institutions, but rather as an innovative technology that

Quick Response Code

Journal homepage:
https://saspublishers.com/

Citation: Karamjeet Kaur (2024). Blockchain Technology in Education: Applications and Challenges. *Cross Current Int Peer Reviewed J Human Soc Sci*, *10*(4), 128-133.

can provide value across a wide range of educational processes – making learning more engaging and effective, cutting down costs, improving trust, providing enhanced security and privacy, etc.

Dwivedi and Vig (2023) found 10 main challenges that were categorized under the three dimensions of the TOE framework. Challenges under the technological dimension include operational issues, security concerns, hardware-related issues and the cost of new technology. The organizational dimension includes attitudinal issues, human resource-related challenges and financial challenges. The third dimension, i.e. environmental dimension, covered the challenges relating to the regulatory environment, stakeholders and the competitive environment. The authors concluded that HEIs cannot be indifferent to this new technological development and must be ready for its adoption. HEIs also need to compare the challenges in adopting blockchain technology against the plentiful benefits it is offering. Shelke *et al.,* (2022) focus on how blockchain is playing a dominant role in the education industry and some real-world use examples from students and instructors. Mohammad and Vargas (2022) have discussed the challenges of adopting blockchain in the education sector. The review contained scientific papers published from 2017 to 2022 and from the screened records, 32 articles were analyzed in full-text form. In this review, 14 challenges were reported and classified, based on the technology-organization-environment (TOE) framework. In addition, this review showed that organizational and environmental barriers received little attention in the literature, compared to technological barriers.

SECTION III

Rationale and Applications of Blockchain in Education:

Before discussing various applications of blockchain in the education sector, it is worth addressing a fundamental question: What is the rationale for adopting blockchain in education? Tapscott and Kaplan (2018) claim that by using blockchain, the processes of teaching and learning can be improved across key dimensions.

- **Learners become self-empowered:** Through blockchain, data (credentials, skills learned, etc.) associated with students' identity is not owned by a central administrator such as a university, but by the student. Students can store their lifelong learning data (both from inside and outside of the classroom), fully own it and control its access to third parties (employers). This way, learners can attest that the credentials in their resumes are accurate and have more control over what can be accessed by their employers. Students not only benefit from blockchain "wallets" being complete owners of their identity-related data, but they still benefit from the support of their professors, thus not being alone in their learning voyages.
- **Security and efficiency enhancement:** Blockchain has the power to ensure the identity, privacy and security of students' data. It offers security and validity by ensuring immutability through its hash chain. For instance, students cannot alter past educational certifications stored on the blockchain, while they may easily do so with paper records. In addition, privacy is ensured through blockchain storing the data with a hash. Optionally, the data may also be encrypted before being stored on the blockchain. In terms of efficiency, Thayer (2018) highlights diverse blockchain-powered efficiency applications that include record-keeping uses such as digital credentials and intellectual property management, streamlining of diploma verification and fast and reliable student payments. These applications save time and cost for all stakeholders.
- **Integration of trust and transparency:** Blockchain ensures that students cannot change their grades, degrees and certification, thus offering employers the trust that the job seekers have the necessary skills to succeed in the workplace. In this way, blockchain becomes a "trust anchor of one truth for credentials" (Tapscott and Kaplan, 2018). Additionally, this anchor also provides for better matches between job seekers and employers. In other words, as distributed ledger technologies support learning and secure academic records, they improve the relationships among "colleges, universities, employers and society" through the integration of trust and transparency in the skills transactions and sharing processes.

Applications of Blockchain in Education:

1. Certificates Management: Blockchain can store and verify academic records securely, preventing fraud and ensuring legitimacy. Students and employers can easily access verified transcripts. Universities can issue digital diplomas on the blockchain, which are tamper-proof and instantly verifiable by employers and other educational institutions. Devine (2015) argues that through blockchain, students' academic records become public and can be easily shared with employers and universities for further personal development opportunities. This way, "the accredited educational timeline could be used to make projections of future potential based upon individual student learning histories". This application becomes an empowering tool for students to track and share their academic progress. It also helps employers, who can rely on accurate, true representations of students' potential based on their academic achievement (trusted verification). Top global universities have collaborated to build an international infrastructure for digital academic credentials known as the Digital Credentials Consortium. This platform can provide benefits to learners by holding a verified, lifelong record of learning accomplishments to share with employers, and obtaining credentials digitally in a secure way. They

need not ask or pay their universities for multiple copies of their transcripts and curating credentials received from multiple universities. On the other hand, educational institutions benefit by managing and sharing students' records in a price-efficient, secure way, removing the risks of identity fraud, and having access to a streamlined process to issue multiple credentials to one learner source. Companies would benefit by easily accessing the verified academic credentials of potential employees. In 2017, the MIT Media Lab piloted a program issuing digital diplomas using blockchain technology. The lab uses a blockchain-based system called Blockcerts to issue and verify academic certificates, ensuring their authenticity and reducing fraud. The University of Nicosia was one of the first universities to use blockchain technology to issue digital certificates for its online courses and degree programs. This initiative ensures that certificates are easily verifiable and tamper-proof. The university also offers a Master's program in Digital Currency, which covers blockchain technology and its applications.

2. Competencies and Learning Outcomes Management: To improve the learning objectives and enhance the attainment of proficiencies within the educational scope, greater attention was paid to building some blockchain applications. This would help improve the learning process and enrich the education domain in a broad spectrum. Due to the high efficiency of blockchain, several applications could measure and evaluate the student's performance based on qualitative and quantitative parameters. For instance, Farah *et al.* (2018) built a system to trace the performance of students for their multiple learning activities. It adds up all traces for each given activity into a block. Thus, this learning block can be considered self-describing since it includes all metadata about many activities. Such an application leads to achieving a high level of self-efficiency. Another application by Williams (2018) proposed a learning environment for students. The system provides prompt support and useful feedback. It was supposed to improve the learning process by applying a wide set of skills and inspire critical thinking and problem-solving with better alliance and communication.

3. Collaborative Learning: Since the blockchain provides a decentralized network that can be accessible easily with high security and integrity, it builds a collaborative atmosphere for all stakeholders including students, faculty members, and authorities. Bdiwi *et al.*, (2018) introduced the Ubiquitous learning (U-learning) system, which uses blockchain technology to provide students with a highly secure anytime/anywhere collaborative learning environment. Thus, U-learning has an interactive multimedia system to boost efficient communication system among faculty and students.

4. Fees and Credits Transfer: This application has similar features for transferring testimonial records or fees among institutions, organizations and universities due to the high security and trust of blockchain. Usually, educational institutions rely on an intermediary to handle and approve the transfer of credits or fees. Fortunately, the blockchain can be used efficiently to exchange information and eliminate the need for such an intermediary party due to its high security level. For instance, the EduCTX system enabled the transfer process using tokens. These tokens can be in terms of any digital form for learning units such as certificates, courses, and diplomas. Each educational institution has its own EduCTX address to handle the secured transfer process.

5. Obtaining Digital Guardianship Consent: Blockchain helped replace the traditional way of gathering parents' consent to be collected electronically instead. This is possible due to the trust that blockchain technology can provide. The decentralized nature of blockchain helps in speeding up the process of collecting consent without compromising its privacy. This has made the collection and exchange process easy among a large number of students, parents, and educational institutions.

6. Competition Management: Blockchain technology is used to facilitate competition operations and to enhance its efficiency and transparency. Wu and Li (2018) introduced a competition model based on the e-commerce operation sandbox, which is a decision-making system for examining students' professional knowledge and expertise. They developed this system to build up an evaluation system, which measures and manages students' operational proficiencies.

7. Evaluating Students' Professional Ability: A study by Liu *et al.,* (2018) applied blockchain technology to link educational institutions and employers to share all necessary information regarding recruitment and industry requirements. Similarly, Zhao *et al.,* (2019) illustrated an application program that was developed using blockchain to evaluate students' professional skills based on their academic achievements and performances. This evaluation system has been intended to assess and analyze students' abilities based on the clustering algorithm within the blockchain.

8. Copyrights Management: It preserves the ownership rights when using the blockchain. Hori *et al.,* (2018) discussed the implementation of a decentralized learning system "CHiLO" for protecting e-books' copyrights and ownerships. Moreover, protecting learning objects is another category that emphasizes the importance of utilizing the blockchain application to protect any innovation or learning objects acquired from students or faculty members. Sychov and Chirtsov (2018) developed a unified bank of learning objects, which consists of the Electronic Educational Environment (EEE). Due to the numerous resources available, a protection technique for these resources was required. Therefore, they used a

permitted blockchain algorithm to save fundamental scientific resources.

9. Learning Engagement: Engaging students in e-learning systems is listed as another application of blockchain technology to solve some issues related to students' interactivity in the e-learning environment. Zhong *et al.* (2018) proposed a potential application to improve learning engagement based on the blockchain technique. It gives rewards in the form of virtual currencies to the top-ranked learners based on predefined policies arranged on the blockchain network.

10. Examination Review: Blockchain technique can improve the security of auditing exam papers by using trusted ledgers. Mitchell, Hara and Sheriff (2019) developed a decentralized application for an examination review called "dAppER." This system was designed by considering the quality assurance standards when distributing exam papers among external examiners. Based on their findings, dAppER helped manage the quality assurance systems.

11. Lifelong Learning: Blockchain technology has played an imperative role in enhancing lifelong learning aspects such as improving skills, knowledge, and efficiency. Mikroyannidis, *et al.,* (2018) discussed how blockchain technology has improved real-life learning and they presented an ecosystem that puts the learner at the middle of the learning process and its related data. Researchers identified how accreditation, tutoring, and ePortfolios can be developed within this lifelong learning ecosystem using blockchain technology. The proposed model can enable learners to draft an efficient plan for their educational journey, which relayed their desired professional trajectory, by offering them complete dominance and ownership during their learning processes. There are numerous universities, large enterprises, and start-ups that aim to facilitate the process of providing learners with lifelong digital credentials to recognize and ensure the authenticity of achievements both inside the classroom (academic degrees) and outside MOOCs (Massive Open Online Courses), other online courses etc., through blockchain technologies.

SECTION IV

Challenges of Applying Blockchain in Education:

Even though blockchain has shown its potential in an education context, multiple challenges need to be considered when employing blockchain technology in the education field. Given below are some of the challenges being faced by blockchain in education.

Security and Privacy: While security is the main feature of blockchain technology, the risk of malicious attacks cannot be ruled out. It is very difficult to provide security and keep privacy at the same time and this issue becomes more crucial when a person's career is at risk (online authorization of educational credentials and certificates). The interconnectivity and complexity of blockchain may elevate a range of security concerns such as hacking, cyber-attacks, and unauthorized acquisition of sensitive data. Without proper implementation, it entails the risk of unauthorized access to the students' and staff's personal information, which could be utilized for illegal purposes. Private or consortia blockchain technology may be utilized here. Here, confidential information would remain secure. While there are a lot of efforts to create new privacy protocols, such as proof of zero knowledge, we are still far away from a new identity structure.

Scalability: The main difficulty with blockchain implementation is scalability. In their study, Alammary *et al.*, (2019) define the scalability challenge as the "slow speed blockchain transactions" challenge. Educational systems have large amounts of data collected on many students, which leads the block sizes to increase. As the number of blocks becomes larger, transactions on the blockchain become time-consuming given that each transaction requires peer-to-peer verification. Thus, scalability may be a significant impediment when blockchain-in-education solutions are explored and potentially adopted on a wide scale. For widespread adoption to take place, blockchain must improve its speed. The inability to serve many users is one of the most significant limitations of blockchain technology. Organizations that can scale blockchain platforms successfully will profit successfully due to the rising demand for enterprise blockchain and associated applications.

Heavy cost of blockchain implementation: Huge investment is required to hire skilled software engineers who specialize in blockchain development, licensing fees to switch to a paid version of the software, overall administration and more. It is one of the most important blockchain implementation challenges. For the adoption of blockchain technology the educational institutions will have to incur significant additional costs in the setup of additional infrastructure and upgrading of the existing IT infrastructure. Moreover, there is limited availability of knowledge and information about the uses of blockchain in this sector. Considering this cost burden, the educational institutions may be less interested in adopting this technology.

Lack of Skilled Workforce: Implementing and maintaining the blockchain solution would require a team of skilled blockchain developers, cybersecurity experts, and IT professionals who can handle ongoing maintenance, updates, and security measures. Multiple educational institutions remain reluctant to adopt blockchain technologies. Some of the reasons behind this lack of trust may consist of the lack of necessary knowledge and skills on how to manage students' data on a blockchain platform. According to recent data, demand for blockchain talent has increased by over 300% among both established businesses and startups as they look for top-tier personnel. The lack of experienced

developers in the blockchain industry has worsened due to high competition between firms offering highly competitive pay packages to attract and retain the talent. Businesses are calling coders to fill the blockchain talent gap.

Integration with legacy systems: There is the problem of integrating blockchain with a legacy system. Most organizations must completely rebuild their old system or develop a strategy to integrate the two technologies successfully if they decide to adopt blockchain. Organizations lacking blockchain developers may be restrained from participating in the process. This problem can be intensified by reliance on outsourcing. However, most solutions in the market need the company to invest a significant amount of time and resources to complete the shift.

Innovation Challenge: In her study, Thayer (2018) claims that blockchain technology is immature and rapidly changing, which often causes blockchain projects to be "prone to failure and abandonment with upward of 90 percent never coming to fruition". One of the implications of this aspect is that "the realization of these benefits and disruptions is likely to take a longer time than the current hype would suggest". Because of that, researchers often claim all the parties involved in the blockchain education process should carry out careful risk analysis on a continuous basis.

Hardware-related challenges: Limited availability and incompatibility of hardware and digital infrastructure may act as a challenge to the successful adoption of blockchain technology by educational institutions. Complementary digital infrastructure constitutes a crucial requirement for integrating blockchain into business processes. However, educational institutions may not always have convenient access to the same. The utilization of DLT-based solutions necessitates a prior availability of broadband connection, either fixed or mobile (Gray & Gray, 2021). Additionally, the adoption of complementary technologies may also prove to be essential. The scarcity of digital infrastructure, particularly in terms of high-speed broadband connection, both mobile and fixed, may pose a significant barrier in this context.

Regulatory environment: External factors that might influence blockchain adoption in higher education in India include government regulations related to data privacy and security, availability of funds and support for technology upgrades and the overall technological maturity of the education sector. To fully utilize the benefits of blockchain for emerging market economies like India, it is essential to establish a regulatory environment that will foster competition and investment while also promoting innovation. However, at present, there are no specific laws to regulate blockchain technology in India.

Future Prospects: It is impossible to predict whether blockchain will have a significant and sustainable impact on education. The concept of lifelong learning and updating old knowledge will create the need for a trusted, immutable record of learning certifications. Thus, given that lifelong education is becoming increasingly essential in a world led by fast-paced technological progress, the need for blockchain-backed credentialing may increase. On the other hand, suppliers of blockchain-in-education solutions such as the Digital Credentials Partnership aim to build eco-systems of educational institutions that use the standards they define. However, they are also aware of the necessity of building sustainable business models and market adoption strategies to ensure that their vision becomes a reality. During the last few years, the perception of the world has changed from perceiving blockchain as the key technology for cryptocurrencies to a technology that has immense potential in new industries such as healthcare and education. While the technology has seen some successes in fields such as supply chain (Tribis *et al.,* 2018), it is still in an incipient, "prototyping" phase in the education industry (Alammary *et al.,* 2019). For blockchain-in-education solutions to generate beneficial impact at a large scale, the private sector and the public must unite and coordinate their efforts to test, research, develop, implement, and fund such innovations. It is worth noticing that blockchain should not be perceived as a threat to educational institutions, but rather as an innovative technology that can add value across a wide range of educational processes – making learning more engaging and effective, cutting down costs, improving trust and providing enhanced security and privacy.

SECTION V
CONCLUSION

The adoption of blockchain technology in the education sector is still at the incipient stage. Blockchain technology is mostly used to issue and verify academic certificates, share students' competencies and learning achievements and evaluate their professional ability. However, a multitude of applications are emerging rapidly. Blockchain could bring significant benefits to education including providing a secure platform to share students' data, lowering costs, and enhancing trust and transparency. However, it is to be noted that the use of blockchain technology is not free from challenges. Managers and policymakers should consider challenges related to security, privacy, cost, scalability and availability before adopting the technology. Lastly, it shows that the educational areas in which blockchain technology was applied are still limited. Therefore, the potential for blockchain is still untapped.

REFERENCES

- Alammary, A., Alhazmi, S., Almasri, M., & Gillani, S. (2019). Blockchain-based applications in education: A systematic review. *Applied Sciences*, *9*(12), 2400.

- Bdiwi, R., De Runz, C., Faiz, S., & Cherif, A. A. (2018, July). A blockchain based decentralized platform for ubiquitous learning environment. In *2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT)* (pp. 90-92). IEEE.
- Dwivedi, S., & Vig, S. (2024). Blockchain adoption in higher-education institutions in India: Identifying the main challenges. *Cogent Education*, *11*(1), 2292887.
- Farah, J. C., Vozniuk, A., Rodríguez-Triana, M. J., & Gillet, D. (2018, July). A blueprint for a blockchain-based architecture to power a distributed network of tamper-evident learning trace repositories. In *2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT)* (pp. 218-222). IEEE.
- Gray, G. R. (2021). *Blockchain technology for managers* (pp. 3-184). Springer.
- Hori, M., Ono, S., Miyashita, K., Kobayashi, S., Miyahara, H., Kita, T., ... & Yamaji, K. (2018, March). Learning System based on Decentralized Learning Model using Blockchain and SNS. In *CSEDU (1)* (pp. 183-190).
- Kassab, M., DeFranco, J., Malas, T., Laplante, P., Destefanis, G., & Neto, V. V. G. (2019). Exploring research in blockchain for healthcare and a roadmap for the future. *IEEE Transactions on Emerging Topics in Computing*, *9*(4), 1835-1852.
- Liu, Q., Guan, Q., Yang, X., Zhu, H., Green, G., & Yin, S. (2018, August). Education-industry cooperative system based on blockchain. In *2018 1st IEEE international conference on hot information-centric networking (HotICN)* (pp. 207-211). IEEE.
- Mikroyannidis, A., Domingue, J., Bachler, M., & Quick, K. (2018, June). A learner-centred approach for lifelong learning powered by the blockchain. In *EdMedia+ innovate learning* (pp. 1388-1393). Association for the Advancement of Computing in Education (AACE).
- Mitchell, I., Hara, S., & Sheriff, M. (2019, January). dAppER: decentralised application for examination review. In *2019 IEEE 12th International Conference on Global Security, Safety and Sustainability (ICGS3)* (pp. 1-14). IEEE.
- Mohammad, A., & Vargas, S. (2022). Challenges of using blockchain in the education sector: A literature review. *Applied Sciences*, *12*(13), 6380.
- Shelke, Priya., Patil, Sourav., Patil, Minal., Gaikwad, Tejas. & Borane, Nikhil. (2022). Blockchain In Education, *Journal of Emerging Technologies and Innovative Research (JETIR)* www.jetir.org f588-592.
- Steiu, M. F. (2020). Blockchain in education: Opportunities, applications, and challenges. *First Monday*.
- Sychov, S., & Chirtsov, A. (2018, September). Towards developing the unified bank of learning objects for electronic educational environment and its protection. In *Proceedings of the 2018 workshop on PhD software engineering education: challenges, trends, and programs, St. Petersburg, Russia* (Vol. 17, p. 1e6).
- Tapscott, D., & Kaplan, A. (2019). Blockchain revolution in education and lifelong learning. *Blockchain Research Institute-IBM Institute for Business Value*.
- Thayer, T. L. (2018). Promising and ambitious blockchain initiatives for higher education. *Gartner Research*, *20*.
- Tribis, Y., El Bouchti, A., & Bouayad, H. (2018). Supply chain management based on blockchain: A systematic mapping study. In *MATEC Web of Conferences* (Vol. 200, p. 00020). EDP Sciences.
- Williams, P. (2019). Does competency-based education with blockchain signal a new mission for universities?. *Journal of higher education policy and management*, *41*(1), 104-117.
- Wu, B., & Li, Y. (2018, October). Design of evaluation system for digital education operational skill competition based on blockchain. In *2018 IEEE 15th international conference on e-business engineering (ICEBE)* (pp. 102-109). IEEE.
- Zhao, W., Liu, K., & Ma, K. (2019, February). Design of student capability evaluation system merging blockchain technology. In *Journal of Physics: Conference Series* (Vol. 1168, No. 3, p. 032123). IOP Publishing.
- Zhong, J., Xie, H., Zou, D., & Chui, D. K. (2018, November). A blockchain model for word-learning systems. In *2018 5th international conference on Behavioral, Economic, and Socio-Cultural Computing (BESC)* (pp. 130-131). IEEE.