

DEVELOPMENT AND EVALUATION OF BLOCKCHAIN-BASED E-LEARNING PLATFORMS TO IMPROVE DATA SECURITY

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Abstract

In the industrial era 4.0 with advances in technology and information, e-Learning refers more to distance learning-based learning involving internet networks. E-learning allows flexibility and effectiveness in the learning process. Even while the internet has made it possible to rapidly and readily find knowledge, there are still some things that could be harmful, such security flaws in e-learning platforms. Blockchain is a computer database that electronically saves data in an electronic manner. Blockchain technology has a big impact on data security and industry. Blockchain technology is a mechanism that makes it possible to validate digital transactions securely and decentralized. The literature study approach was used to conduct the research. The idea of e-learning and how it developed, data security issues in e-learning, the fundamentals of blockchain technology, the use of blockchain-based e-learning platforms, and an assessment of the effect of employing blockchain on data security are all covered in this study.

Keywords: E-learning, blockchain, data security.

INTRODUCTION

Education has undergone massive changes over the past few decades, especially with the advent of information technology and the internet (Sitopu et al., 2024; Guna et al., 2024; Hairiyanto et al., 2024). One of the most significant evolutions is the introduction of e-learning, which has changed the way we learn and teach. E-learning, or electronic learning, refers to the use of digital technology to deliver learning material. These can be online courses, webinars,

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interactive learning modules, or mobile applications designed specifically for education (Basak Kumar, 2018). E-learning allows access to various learning resources via electronic gadgets such as computers, tablets or mobile phones (Tubagus et al., 2023; Aslan & Shiong, 2023; Muharrom et al., 2023).

Aldheleai (2015) stated that one of the main benefits of e-learning is flexibility. This allows students to access materials anytime and anywhere, enabling independent learning. Online courses and e-learning modules allow students who work full time or have a busy schedule to take lessons at their convenience (Nurhayati et al., 2023; Nurdiana et al., 2023; Erwan et al., 2023). E-learning encourages independent learning and the development of study skills. Students can manage their own time and take initiative in their learning. It teaches important skills in self-organization and motivating oneself to pursue education (Sarmila et al., 2023; Sulastri et al., 2023).

With e-learning, students can access a variety of learning resources, including videos, text materials, images, interactive simulations, and more. This helps meet a variety of learning styles and student needs (Haddar et al., 2023; Tuhuteru et al., 2023). In addition, these resources can be updated quickly to reflect the latest developments in the field of science (Ibrahim et al, 2020). E-learning also allows for better collaboration between students and instructors. Online communication tools, such as discussion forums and webinars, enable discussion and exchange of ideas between students and instructors, even if they are in different locations (Nyangaresi & Abeka 2019).

Learning management systems allow instructors to monitor student progress more efficiently. They can provide faster and in-depth feedback to students based on their performance in assignments and exams. This helps in improving learning (Savulescu, 2015). E-learning has opened the door to learning that is more inclusive and accessible to everyone, regardless of location or schedule. This is the right tool to face the demands of education in this digital era and continues to play a role in shaping the future of education. By continuing to improve its platforms and methods, e-learning will continue to play an increasingly large role in shaping the learning generation of the future (Aslan & Pong, 2023; Astuti et al., 2023).

Though knowledge can now be found quickly and easily on the internet, there are still some aspects of it that could be harmful, such as security flaws in e-learning platforms. Naturally, maintaining a system's security is essential to preserving the integrity of the data it holds. Once the system is linked to the internet and a computer network, ensuring data integrity becomes a difficulty. It is necessary to preserve the security and integrity of the data kept in the

system. With the exception of data that is flexible to amend, you may be certain that the information cannot be changed again to preserve its authenticity. In order to ensure that the system is available, it is necessary to consider the guarantee that it is accessible from any location. When a system is connected to the internet and a computer network, users of potentially hazardous e-learning platforms can readily access the system through these networks, raising the possibility of data being altered or destroyed. According to Li & Gong (2022), hackers frequently steal user personal information to resell. In addition, e-learning must use content protection, which safeguards the authenticity and intellectual property of course materials. In the meantime, due to the sharp rise in attacks in recent years, website-based applications must be protected.

According to H.F. Aldheleai et al. (2015), valuable assets on e-learning systems are typically targeted by hackers and must be protected if we do not want those assets to be known to hackers. These assets are typically found on e-learning systems. 1) E-learning system content or data; 2) User personal data; 3) User messages sent or received; 4) Network connectivity; and 5) Bandwidth. According to C. Savulescu et al. (2015), of the several targets targeted by hackers, the most dangerous risk to online learning systems is whether the target can be compromised by hackers. Possible openings include the following: 1) Denial of service attacks, or worms, can be sent by malicious software or take the form of viruses. Software malfunctions, data collection by espionage, information destruction due to vandalism or sabotage, hardware or equipment failures that compromise intellectual property rights (IPR), copyright piracy violations that jeopardize IPR, and blackmail for information disclosure are some possible causes.

There are various obstacles when using traditional database technologies to record financial transactions. It is seen, for instance, in real estate sales. The buyer becomes the new owner of the property after the money is paid. Both buyers and sellers are able to keep track of financial transactions on their own, but neither source is reliable. Both buyers and sellers might readily argue that they have paid the money even though they haven't received it, or that they haven't received it at all.

Transactions need to be verified and monitored by a reliable third party to prevent legal problems. The existence of this centralized authority introduces a point of vulnerability in addition to complicating transactions. Both sides will be harmed if the central database is breached.

Blockchain reduces these issues by establishing a decentralized, unchangeable transaction recording mechanism. A sophisticated database

system called blockchain technology makes it possible for information to be shared transparently across corporate networks. Blockchain databases keep information in chains of connected blocks. Since we cannot remove or alter chains without the network's approval, data is consistent throughout time. Blockchain is essentially a distributed ledger technology that keeps track of and validates transactions between many computers, or nodes. Blockchain relies on a consensus method, wherein network members verify and concur on the legitimacy of transactions, as opposed to a central authority. This decentralized nature, combined with cryptographic security, creates a trustless and tamper-proof system (Alruwalli, 2020).

RESEARCH METHOD

The literature study approach was used to conduct the research. The literature study method involves gathering data from a variety of academic publications, books, journals, and expert viewpoints on pertinent subjects. conducted by looking through relevant publications and conducting keyword searches; the goal was to enhance data security through the construction and assessment of an e-learning platform built on blockchain. Additionally, a search was conducted for websites that create and assess e-learning platforms built on blockchain. The author will find it simpler to locate a variety of materials that are pertinent to this investigation using this strategy.

RESULT AND DISCUSSION

E-Learning Concept and Its Development

E-Learning is a learning process that involves the acquisition of knowledge and skills occurring through electronic media and technology. In the industrial era 4.0 with advances in technology and information, e-Learning refers more to distance learning-based learning involving internet networks. In short, it is called Online Learning. Urbana-Champaign's University of Illinois was the first to introduce e-learning. The University of Illinois introduced e-learning that uses a computer called PLATO, in a computer-assisted instruction system. The development of e-learning since then has continued along with technological developments and advances (Adejo et al, 2918).

Bidri et al (2023) report that in 1990, the Computer-Based Training Era began, where many e-learning applications emerged that used stand-alone PCs or were packaged in CD-ROM form. The material presented can be in written or multimedia form, such as audio and video, in mpeg-1, avi, or mov format.

Until 1994, Computer-Based Training continued to be accepted by the wider community. For this reason, Computer-Based Training is starting to appear in several more attractive packages and CBT is starting to be produced on a massive scale.

In 1997, the Learning Management System (LMS) appeared. This LMS comes along with the development of internet technology, where people around the world are starting to switch to using the internet. At that time, people began to feel the need for information that could be obtained quickly as an absolute necessity, which meant that location and distance were no longer an obstacle.

Based on this need, the Learning Management System finally arrived. The increasingly rapid development of LMS has given rise to a new standard of thought that can overcome interoperability problems that occur between one LMS and another. Several examples of emerging standards include standards issued by the Airline Industry CBT Committee (AICC), standards from IEEE LOM, ARIADNE, and IMS standards.

1999 is declared the year when website-based e-learning applications were born. The development of the Learning Management System into a website-based e-learning application is a total development, which changes the learning system and teaching and learning administration. Learning Management Systems are starting to be combined with magazines, newspapers and other information sites.

The content of e-learning is also increasingly rich, with a combination of multimedia such as streaming video and interactive displays, which comes in a variety of smaller and more standard data formats. E-learning allows flexibility and effectiveness in the learning process. Therefore, e-learning is said to be a future learning system that will continue to develop from time to time. It must be admitted that e-Learning is currently trending. Especially for professional companies, e-Learning has become a very effective, low cost, and time-saving method for employee training. In return, employees or workers who learn with this system benefit by being able to improve their skills and knowledge comfortably and easily. This E-Learning system can also be used by these companies or other large organizations to train their partners and consumers to increase adoption, retention, and ultimately, sales revenue for the company's or organization's products (Guo & Shi, 2021).

Data Security Challenges in E-Learning

Even while the internet has made it possible to rapidly and readily find knowledge, there are still some things that could be harmful, such security flaws in e-learning platforms. Naturally, maintaining a system's security is essential to preserving the integrity of the data it holds. Once the system is linked to the internet and a computer network, ensuring data integrity becomes a difficulty. It is necessary to preserve the security and integrity of the data kept in the system. With the exception of data that is flexible to amend, you may be certain that the information cannot be changed again to preserve its authenticity. In order to ensure that the system is available, it is necessary to consider the guarantee that it is accessible from any location. When a system is connected to the internet and a computer network, users of potentially hazardous e-learning platforms can readily access the system through these networks, raising the possibility of data being altered or destroyed. According to Li & Gong (2022), hackers frequently steal user personal information to resell. In addition, e-learning must use content protection, which safeguards the authenticity and intellectual property of course materials. In the meantime, due to the sharp rise in attacks in recent years, website-based applications must be protected.

According to C. Savulescu et al. (2015), among the several targets that hackers have targeted, the most dangerous risk to online learning systems is that if the target can be compromised, possible openings include the following: 1) Denial of service attacks, or worms, can be intentional attacks caused by software faults or can take the form of viral transmission. It might be a glitch in the software; 2) Espionage, which involves gathering personal information; 3) Vandalism or sabotage, which involves destroying information; 4) Hardware or equipment failure that may result in technical malfunctions; 5) Copyright piracy, which jeopardizes intellectual property rights (IPR); and 6) Blackmail for information disclosure.

An & Chen (2021) classified these threats into three categories based on information system vulnerabilities in e-learning, which include the following: a) Privacy flaws in users. Individual privacy leaks can seriously affect victims, particularly in terms of prestige loss. Interpersonal. User privacy is crucial in e-learning since it might ruin the atmosphere for instruction and learning. Because there is a risk that the user's private information will be compromised by intentional activities or even exposure of the user's privacy data if their privacy is not protected. Hackers can sniff or steal data in transit and once they get the data, they can sell the data without the user's permission.

Blockchain Technology Basics

In addition, blockchain technology can be seen as an approach that concentrates on optimizing the application of computer technology in order to build a network of linked blocks, or as the name implies, a collection of groups. Thus, it can be said that an asset located within a business network can be tracked using a collection of linked blocks that include multiple records of a certain set of transactions (Aggarwal & Kumar, 2021).

Blockchain is thought of as a digital transaction in and of itself, which is based on its structural form and has a structure of its own. Each person's recorded notes, or what is termed a block, will be connected to one another with this obvious structure so that they resemble a chain (Tolbatov et al, 2018).

Ubaka et al (2020) stated that blockchain is a database that stores information electronically in digital format. One type of information it has is transactions. Once created, these transactions cannot be changed, tampered with, or questioned. This creates impenetrable transaction transparency and security without the need for a trusted third party.

Each transaction forms its own data block. Blocks are limited to a certain capacity, and every time a new transaction occurs, additional blocks are created hence the name blockchain.

A sophisticated database system called blockchain technology makes it possible for information to be shared transparently across corporate networks. Blockchain databases keep information in chains of connected blocks. Because the data cannot be removed or altered without network consensus, it is consistent in time. Therefore, an immutable or immutable ledger to track orders, payments, accounts, and other transactions can be created using blockchain technology. The system is equipped with built-in safeguards against unauthorized transaction entry and to establish uniformity in the shared view of these transactions (Zarour et al, 2020).

The list of transactions is locked simultaneously and the unique marker on each block is added to the next block, creating an immutable chain. A block usually consists of current transaction information and a hash (unique code) of the previous block (Judmayer et al, 2019). If one of the blocks is tampered with, it will cause the block's hash to change and invalidate all subsequent blocks. Let's say one of the blocks is tampered with and all subsequent block hashes are recalculated, then there is a possibility that the block chain has been compromised. To overcome this problem, there is a concept called proof of work (POW).

Blockchain technology has the following main features:

1. Decentralization

In blockchain, decentralization is the process of moving authority and decision-making from a centralized entity (person, business, or organization) to a dispersed network. Transparency is used by decentralized blockchain networks to lessen the requirement for participant confidence. Additionally, these networks forbid users from controlling or imposing authority over one another in ways that can impair the network's efficiency.

2. Decree

Something that is immutable cannot be altered or substituted. As soon as a transaction is entered into the shared ledger, nobody can alter it. Both transactions are visible to the network and must be added in order to correct any errors found in the transaction record.

3. Consensus

The blockchain system establishes rules regarding participants' consent to record transactions. You can record a new transaction only if the majority of participants in the network give their consent (Li et al, 2019).

Implementation of a Blockchain-Based E-Learning Platform

File sharing is a component of the blockchain implementation process that is carried out through e-learning design. Depending on the requirements of each user, including administrators, instructors, and students, e-learning offers multiple access levels.

At the moment, the majority of decentralized online learning platforms provide learning that varies widely in quality. Worse still, because there is no integrated certification system, learning outcomes are not widely acknowledged. It should come as no surprise that e-learning yields subpar outcomes. An effective approach to record data about online educational learning is using the blockchain's chronological data record. A timestamp can be appended to each record of student learning data, which can be stored on the blockchain in chronological sequence and include study hours, course materials, and exam outcomes (Lam & Dongol, 2022). Cryptography-based recording techniques protect data accuracy by removing potential threats like manipulation or erasure. Any educational platform or institution will be able to track students' learning paths over time and across geographic locations

because of decentralization, distributed databases, and the collaborative upkeep of blockchain technology. Hardware expenses will go down and platform efficiency will rise as a result. Blockchain-based learning records not only fully record student learning data but also guard against manipulation and deletion, providing strong guarantee for the veracity of such data.

Simultaneously, learning data that has been encrypted for security can be shared over a network and downloaded by businesses with ease. Employers can validate students' information and gain further insights into their learning states by utilizing blockchain-based data. Thus, blockchain technology can prevent fraudulent documents, phony degrees, and other forms of misuse in higher education and provide a platform that employers, teaching platforms, and students can all rely on. Nevertheless, customers should ensure before signing up for a service that the security offered by the provider meets their requirements (Savulescu, & Al E, 2015).

The main benefits of blockchain in e-Learning according to research by Guo & Shi (2021) are as follows:

1. Smart-contracts (smart contracts)
2. Certification
3. Intellectual property protection

Product details according to research by Ferrag & Shu (2021), namely:

1. UI: User interface

All users, regardless of their preferred mode of learning, will have access to the resources required to develop a learning plan, including reading lists, video tutorials, online forums, and live discussions. The option to hold online study sessions for groups will be put into practice. Using the online course builder, any member of our ecosystem who want to share his knowledge with others can condense their own learning structure into a format that is both convenient and palatable. Presenting a straightforward and understandable interface that is appropriate for both inexperienced and seasoned users is another area of attention.

2. Participants

Anyone can join the MindLink system as a participant, regardless of experience. Affordability is the primary requirement for a global learning system. This creates additional needs for the distribution of organizational materials in the future. Participants in the process now have the opportunity to pursue careers as editors, translators, copyists, etc. The educational materials that are displayed are unrestricted, provided that they don't break any laws and don't have violent content, SARA, or extremist messages.

3. Monetization

There won't be any limitations on course prices, and any user will be free to set their own rates for their services. The only condition that must be followed is that the transaction must be kept within the MindLink structure. An even more preferred transaction method is to use MLToken, as a solution for managing tokens like fiat currency which was developed in the same way. Besides that, payment using MLToken will not be mandatory, but bonuses will be obtained for those who use it.

4. Knowledge Database

Initial content filling will be carried out at product launch. Content will be created by working closely with engaged partners and subsequent collaboration with them. As partners, legal entities such as universities or educational portals will help us in digitizing the information they have and sharing it in our database; but each individual can also play a role in this process.

5. Intellectual Property Management

Tracking intellectual products will always be an expensive process. Because the cost of patent protection is carried out only with the help of third parties involved specialized structures and bodies. With the implementation of blockchain technology even independent self-releasers will be able to protect and track the usage of specific resources or documents. By using smart contracts, the use of one's intellectual property for rewards becomes possible.

6. Use of Smart Contracts

Smart contracts can do more complicated things than regular agreements. This can provide various opportunities for our partners (Universities, Education Portals) and even ordinary teachers.

Evaluation of the Impact of Blockchain Use on Data Security

The impact of blockchain technology on industry and data security is significant (Haque et al, 2023). Blockchain technology is a system that allows digital transactions to be validated in a decentralized and secure manner. Below is a further explanation of the impact on the industry and data security:

1. Enhanced Data Security

Blockchain technology uses strong cryptography to secure every transaction and information stored in blocks. The data entered into the block cannot be changed or manipulated without the knowledge of all participants in the network. This makes blockchain technology one of the

safest ways to store data, especially in cases where data security and integrity are critical, such as in the financial or healthcare industry (An & Chen, 2021).

2. Transparency and Reliability

Every transaction made in blockchain technology can be seen by all parties involved. This creates a high level of transparency, reduces the risk of fraud, and allows all participants to verify and monitor transactions easily (Chai & Liang, 2022). Additionally, the possibility of system failures brought on by central failure can be reduced because data is not centralized in a single authority.

3. Business Process Automation and Efficiency

Smart contracts on blockchain can help automate commercial processes. Programs known as smart contracts are designed to carry out specific tasks automatically in response to predefined criteria. This can reduce the time and costs required to verify and execute traditional contracts.

4. Reduction of Transaction Fees and Times

In traditional systems, some transactions require an intermediary party, which can be time consuming and costly. In blockchain, transactions can be carried out directly between the parties involved, eliminating the need for intermediaries. This can reduce the costs and time involved in the transaction process.

5. Transformation of the Supply Chain and Logistics Industry

Blockchain can be used to track supply chains accurately and transparently. This can help verify product origins, reduce the risk of counterfeit products, and optimize the overall logistics process.

6. Finance and Digital Asset Management

Blockchain has also had a major impact on the financial industry by enabling the transfer of digital assets (such as cryptocurrencies) without intermediaries. This can facilitate fast and cheap cross-border transactions and more efficient investment management.

7. New Development Potential

Blockchain technology is still in the exploration and development stage. Several industries have begun exploring blockchain's potential applications in terms of medical data sharing, property ownership, copyright management, and more.

However, despite the many benefits offered by blockchain technology, there are still challenges to overcome, such as scalability, transaction speed, and legal regulations. Despite this, this technology continues to change the way

we view data security and digital transactions in various industrial sectors (Alshahrani, 2021).

CONCLUSION

E-learning offers flexibility and efficacy in the learning process, according to the findings of research reviews. Even while the internet has made it possible to rapidly and readily find knowledge, there are still some things that could be harmful, such security flaws in e-learning platforms. Blockchain is a computer database that electronically saves data in an electronic manner. Blockchain technology has a big impact on data security and industry. Blockchain technology is a mechanism that makes it possible to validate digital transactions securely and decentralized.

The application of blockchain technology in the field of education has enormous potential. Many blockchain-based platforms have recently been introduced, and numerous applications have been developed in a variety of disciplines, including education, as a result of the advantages this technology offers.

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