Integrate Blockchain in Educational System

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ABSTRACT

Blockchain is a technology that keeps information encrypted and secure so that no one can view it. Data is linked to each other in the form of blocks and these blocks are linked to each other in the form of a chain. This project proposes a blockchain platform for the integration of blockchain with the education system in the Sultanate of Oman. The aim of this project is to Integrate Blockchain in educational system. This project will help educational institutions to secure data from recognized problems. There are four objectives need to reach in this project. Firstly, to investigate problem and challenges educational systems and manage data. Secondary, to analyze the requirements of improving data management and security in educational sector. Thirdly, to development Block-chain technology in education. Finally, to publish a research paper which highlights the proposed solution. So, you can see that the best solution for data management and security in educational systems is the blockchain technology. It ensures that data is kept secure, and that information is transmitted securely. A modified waterfall methodology will be used to complete this project, which consists of five steps: requirements analysis, system design, code implementation, system testing, system deployment and maintenance.

Introduction

Blockchain is a technology in which all transactions and data are recorded decentralized ledger. In addition, all data are linked to each other in a data communication base by implementing blockchain technology. This how blockchain are stores and audits all data transaction. One of the advantages of blockchain technology is that no one can tamper with or change this data. Except for peers in the network (Komalavalli et al., 2020).

Types of Blockchain

- Public blockchain: This type of blockchain is open and transparent that anyone can use, and it does not pose any obstacle to those who can operate the database and change anything in it(guapta-vivek,2022). for example: bitcoin & Litecoin.
- Private blockchain: This type of Blockchain works in a closed environment where people cannot easily use it and join the network, record data or view the history. This type needs permission to do any task in the Blockchain. For example: ripple.
- Hybrid blockchain: This type of blockchain gives authority to a group of people to authorize access to the database. For example: Hyperledger.

Literature Review

Blockchain is an algorithmic system that consists of a series of blocks with an amount of information in each block, in addition to being a standard database with an enhanced security system. It has distinctive characteristics, including that it does not contain only one server, can store information on different data media, and ensures the integrity of information. (Boiko, 2022). Blockchain is a shared, decentralized database across nodes in a computer network, through which people can complete all their transactions or transfer money and other transactions, and this is done using a network of decentralized computers spread all over the world. Blockchain is likened to an accounting ledger because it is a public database in which digital information for exchanges is stored. Andoni et

al., 2019)Blockchain is a modern technology that attracts the interest of startups, technology developers and most organizations. Sources confirmed that Blockchain technology has the potential to bring many developments and innovations and bring many benefits. This technology is tamper-resistant and safe. (PricewaterhouseCoopers, 2016) Blockchain is a technology that can implement p2p system for transactions. This type of transaction can allow each network participant to transact directly with other networks without involving a third party in the transaction. (Sebastian Peyrott, 2017) On the other hand, this writer mentioned that Blockchain is a data distribution repository as well as verifiable. Blockchain works by combining the Noble concept of proof-of-work and public-key cryptography.

Types of Blockchain

There are many types of blockchain, Public Blockchain, in which anyone with the ability to access the Internet can subscribe to the Blockchain platform and then join the network as a node and then become part of the Blockchain. Once it becomes part of the blockchain it is allowed to confirm transactions, view recent and past records, or prove the full workings of an incoming block. One of the most important general uses of the blockchain is the mining and trading of cryptocurrencies. Bitcoins are examples of public chains. When using a public blockchain, it is necessary to adhere to security policies and procedures and to work on the security rules of the network. (Team, 2019). Private Blockchain which may only be used in a closed network. Companies and organizations use this type of blockchain so that only a small group of people are allowed to participate in that network. In this network, each organization can control the level of security, licenses, permissions, and access to the network. In addition, it is used in managing supply chains, voting, digital identity, and other uses. We conclude from this that the private network operates in a manner like the public network, but the private chain has a restricted and small network. Multichain projects are considered one of the most important examples of private blockchains. (Team, 2019). A hybrid blockchain that combines the features of a public and private blockchain. This type exploits both permission-based private network systems and permissionless public network systems of the blockchain. With the help of the hybrid network, users can manage who has access to the data stored in the blockchain. Hybrid blockchains are flexible in that they can simply integrate a private blockchain with several public chains. Transactions in the private blockchain network are verified by hybrid blockchains. Dragon chain is a prime example of a hybrid blockchain. (Team, 2019)

Blockchain Architecture

Blockchain is an interesting technology that people can access but it is difficult to change the data once it is recorded within the blockchain. The term blockchain semantically means a chain of blocks. Each block contains a unique set of transactions. In addition, this information stored within the block depends on the type of blockchain. Blocks are added by the mining process and executed by mining nodes. This technology relies on encryption to ensure authenticity and security. After confirming that the cipher is correct, the block is added, after which the mining nodes start propagating the block to the rest of the network. Then, in the process of sharing the new block across all nodes and updating the contents by moving the new block from one node to another, the new block information remains available to network members, but cannot be tampered with. All these operations are performed by the blockchain software automatically and easily, and each has a cryptographic fingerprint called a hash. The blockchain saves and stores information in batches called blocks, and all blocks are linked to each other in the form of a parallel line. If the data is saved once, it is not subject to change or cannot be reformulated. However, the stored mass can be changed, e.g., changing y to x at a specific time. The figure following the steps for blockchain work step by step:

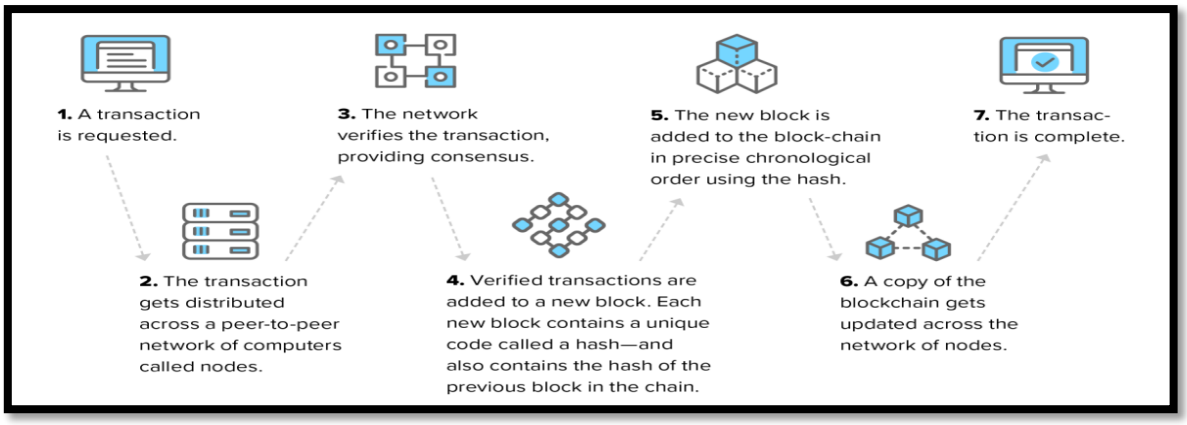

Figure 1. (How blockchain work) (Bryson et al.2017).

Blockchain is a technology used to conduct transactions and securely store data. All data is saved in one block. Each cryptography hash in the block is connected to the hash before it. Additionally, each block has all the transactional information, including the time stamp, data contained in the block, and its hash. The block data and other transactional information cannot be changed by anyone. Therefore, it is safe and highly trustworthy. (Bryson et al.2017). The following illustration illustrates how the hash links blocks together:

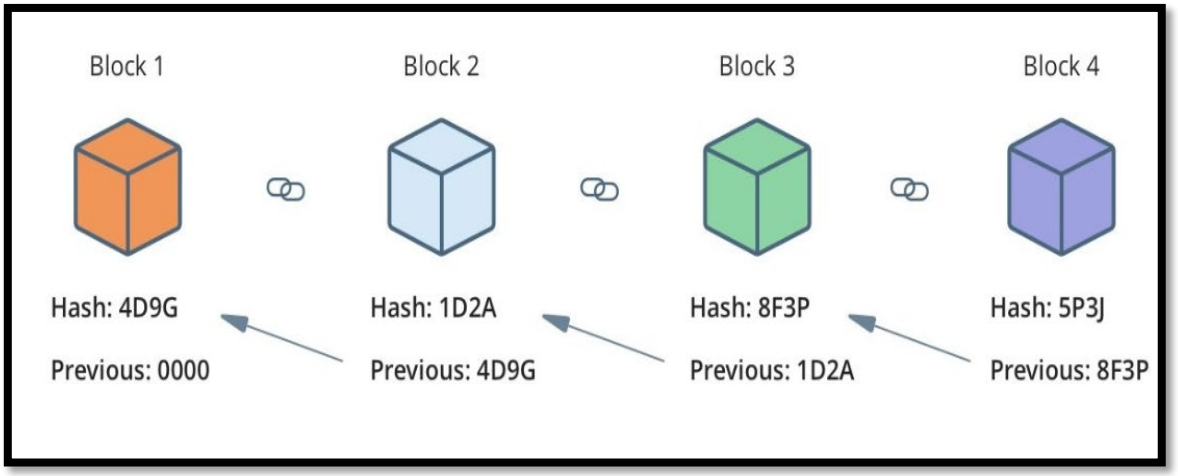

Figure 2. Block details (Himanshi, 2021).

Thus, if one block changes, all subsequent blocks will be invalid. The hash mechanism is used to prevent tampering. In today's era of development, modern machines can calculate hundreds of thousands of hashes per second, so it is easy to manipulate blocks. The blockchain has implemented a Proof-of-Work mechanism to mitigate problems with tampering. This mechanism helps slow the creation of new blocks. Therefore, the Proof-of-Work mechanism was implemented because it makes it difficult to manipulate the block chains and takes about 10 minutes to calculate the Proof-of-Work. If one group of them is manipulated, all the blocks that follow it will need to be reinstalled. On this basis, the security of the blockchain comes due to its distinction in the use of the proof-of-work and fragmentation mechanism. There is another process that the blockchain uses to secure the block chains called (distribution). This process takes place by the blockchain for a network called: p2p, which allows anyone to join it, assuming that the blockchain is public. After anyone joins this network, he becomes a node and gets a full copy of the blockchain, after that this node can use the copy of the blockchain to check that everything is OK. (Cherednichenko, 2020). Blockchain technology are used a Digital signature, it is an asymmetric encryption method that encrypts data using two different types of keys. Each node in the blockchain network is connected to the node behind it, and each node has a ledger with blocks on it that are chained together and connected by

hashes. Blockchain uses asymmetric encryption and digital signatures because it is protected from manipulation, fake authentication, and other hacks. (Himanshi, 2021).

Educational Risk

The operation of any educational institution is a complex process because all educational institutions are responsible for providing students with a safe, productive, and risk-free educational environment, whether the students are 6 years old or 40 years old. But there must be risks for learning, and educational institutions must take measures to mitigate and reduce the risks by adopting risk management strategies. The education industry is an easy target for fraud, cybercrime, or electronic extortion. Although users, whether students or faculty members, obtain their login information to enter their accounts and emails, accounts can be hacked and access information that is considered sensitive or personally identifiable information. Such as student grades that are hacked from teachers' accounts, or tampering with addresses and contact numbers, in addition to stealing information from user accounts. There are many risks that must be calculated and reviewed by educational institutions, and local and state regulations must be developed to deal with a variety of educational departments. (Fabbri, 2020). With the technological development, all institutions are working on their activities electronically and keeping their data electronically. For example, educational institutions save all their data and the data of all people in the institution, whether they are students, teachers, or administrators. Every system is better developed and improved. Each institution has plans based on it for the success of that institution. For example, an annual implementation plan is drawn up for schools, and this plan is developed annually. In addition to the strategic plans implemented by schools, school operations such as lesson planning and teaching methods. But most of these strategies are subject to penetration and forgery. (Fabbri, 2020). But educational institutions are exposed to danger unless the risks are addressed, and measures are taken for incidents that occur to the institutions. For example, if the institution encounters electronic attacks and does not take action to solve this problem, it may suffer material losses and damage to the reputation. Educational operations are represented in recruitment, financing, and data management. Educational risks fall under several areas, including:

Cybersecurity and Data Risks

With the increase in learning, new vulnerabilities are created, so educational institutions face the threats of hacking and the Internet. Every organization should have special legal obligations to protect the privacy of information to avoid breaches that lead to financial and reputational damage to that organization.

Special events and conferences: All institutions are based on hosting conferences and special events for the success of the institution and to raise revenues and produce that institution in a good way, but it can represent risks and lead to losses unless those actions are planned successfully.

Financial irregularities: represented in theft of the institution's budget, whether the theft was direct or by fraud. Employees or criminals exploit the complex financial operations of an educational institution, and through criminal operations, money is stolen. Stolen costs can be very high so all organizations should research and think about ways to strengthen financial guarantees and ways to secure them and try to avoid this type of fraud.

Damage to reputation*:* After the occurrence of many problems and events to the institutions, these damages the reputation of the educational institution, which leads to a reduction in its ability to attract students. Therefore, educational institutions must establish methods and consult with their insurance advisor to create a package policy that helps the institution to repair its reputation.

Integrate Blockchain in Education

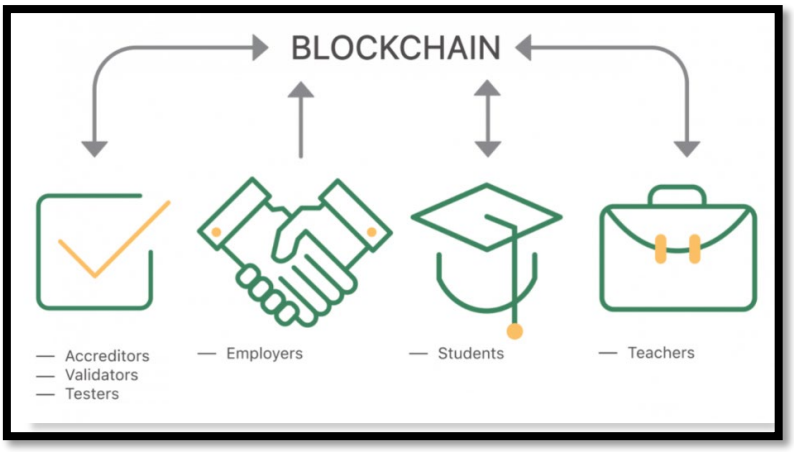

Figure 3. Blockchain Integration (Rivera, 2021)

Blockchain in the scope of education may be a new concept for the world and for most school systems, so it has become difficult to determine or predict whether institutions will adopt the technology or not. Blockchain is a fast-growing technology in this age of technology that evolves with time and that speaks little by little. Blockchain technology is constantly updated, and accordingly these updates make it difficult for attackers to spoof. Since there is no single server, attackers will not be able to penetrate the encrypted system and steal data (Boiko, 2022). The number of student records in institutions is almost infinite, so the blockchain is used to keep records of students and transactions. The usual way of keeping records takes more time with lots of paper documents and checking each record separately. Blockchain can eliminate the implications of this method and simplify verification procedures. This will help save teachers and administrators time and effort when it comes to such transfers between schools and states. By using the blockchain, it is possible to facilitate the transfer of the student's record and data to verify the transfer process. (Boiko, 2022). Blockchain is a valid technology in development, especially in the field of education. Some examples of the development of blockchain in education will be mentioned. First, the renewal of the knowledge reward system, which is a system based on the renewal of ways to acquire and share knowledge through the knowledge points system based on the blockchain. In addition, this system monitors knowledge levels and measures people's competence. Marisha Hales, Chief Operations Officer, indicated that the textbooks will be assimilable, and there will be a system of automatic answers to the collection of questions that are used in education, training, and other academic media. Moreover, children will be given the opportunity to participate in earning tokens that will be applied to university education until they reach the age of majority. Secondly, to make the credentials more credible, an application called Blockcerts Wallet was released to facilitate the sharing of digital certificates between schools, employers, and relatives and not to tamper with them. Created and managed by a system that collects and manages student records from many schools using IBM Blockchain across the IBM Cloud, this system helps schools, recruiters and stakeholders make it easier to verify the credibility of the data provided to them. Third, keep records securely and easily accessible in the cloud. Copies of records and data are saved in an encrypted way in the blockchain chains, which helps people to get their lost papers, or for schools whose servers may be down, or the data is completely erased for some reason, or for those who find it difficult to obtain copies of their records. For these reasons, records are kept in the form of copies in the cloud in the blockchain. (Rivera, 2021).

Blockchain Platforms

- Hyperledger Fabric: It is a suite of blockchain development tools designed as an enterprise distributed ledger application and is supported by the Linux Foundation. This kit helps create blockchain applications. In addition, various components can be integrated into a design using the Hyperledger ecosystem.

It works effectively in closed blockchain platform applications to improve speed and security. Can accommodate a variety of data formats by providing a smart contract model including accounts and unspent output models (UTXO).

- Ethereum: This platform is the most popular among developers who create decentralized applications (dApps). This platform is quite like the Bitcoin Blockchain. Alternative blockchains can carry out transactions more cheaply and faster than Ethereum. However, there are many more platforms and exchanges for non-fungible tokens which are classified as a type of digital asset that can be traded on the blockchain. Moreover, it has a robust ecosystem of tools for building smart contracts in Solidity that run in the Ethereum Virtual Machine.
- XDX Network: Represented in the XDC protocol, which is a global open-source network, XDC was created primarily by developers to enhance and tokenize institutional trade finance operations. Blockchain developer platforms have distinct hybrid capabilities, which makes for applications and projects that require interoperability and require high scalability. To ensure compatibility between the hybrid blockchain and financial institutions, XDC uses the ISO 20022 Financial Messaging Standard. This helps financial institutions and shareholders to deploy smart contracts, thus centralized systems can be transformed into powerful decentralized networks on the XDX blockchain developer platform.
- Quorum: It is an enterprise-focused blockchain developer platform, capable of handling transactions in a short time through a system based on voting and other algorithms. A design that allows you to integrate Ethereum updates quickly and smoothly. Quorum is the source and free to use Blockchain unlike other Blockchain tools. It is difficult for Quorum to be accessible to everyone because it is designed by developers in a way that is inaccessible by nature. It can handle applications that need special transaction speed and fast processing. Moreover, it addresses the issue of log secrecy that Ethereum and other blockchain cryptocurrency platforms have failed by offering private and public transactions across the chain.
- Steller: It is a modern and basic system for blockchain developers that is designed for a variety of DeFi applications. This system includes very secure methods to prevent suspicious parties from participating in financial transactions. This system uses a protocol called Stellar Consensus that shortens the time it takes for the public blockchain to process and finalize transactions.

Blockchain Tools

It is important to know about blockchain tools especially for blockchain professionals because that knowledge and experience will help them to stay relevant in the blockchain business and to benefit the development of the blockchain. Some of the best blockchain tools:

- Meta Mask: It is one of the best blockchain development tools because it is a software coin wallet that connects a web browser with Ethereum developer tools. Users can work with it to transfer and receive Ethereum-based currencies, as well as to store and process account keys and view transactions. Meta Mask uses a web browser or mobile application developer browser to access and interact with decentralized applications. Moreover, it is a very ideal tool for blockchain development because it does not require a live node of Ethereum to function, so it is easy to communicate with the Ethereum network. (Debopriyo et al., 2022)
- Geth: It is a popular tool for blockchain developers that helps users mine Ether to develop applications that run on the Ethereum Virtual Machine, and this feature makes it one of the preferred tools for blockchain development. Geth is a tool that allows transferring tokens, logging blocks, creating Ethereum, and writing smart contracts. After the development of blockchain development tools, Geth became compatible with most operating systems such as Windows and Linux.
- Solidity: It is a programming language for building and developing smart contracts on blockchain development tools networks. This language is classified as the most perfect programming language among developers because it runs on the Ethereum Virtual Machine. Moreover, this programming can be used to create smart

contracts in blockchain technologies and create a chain of transaction records. Among the most popular languages used in programming Geth to create smart contracts for Ethereum Apps are C ++, Python, JavaScript.

- Truffle: One of the blockchain development tools, which includes a large library of libraries and configurations specialized in creating innovative smart contracts and other elements of the blockchain development tools. This tool develops complex technologies in the blockchain and creates challenging Ethereum Apps. In addition, through this tool, it is possible to conduct Typescript, JavaScript, and Solidity tests. (Debopriyo et al., 2022)
- Solc: It is a blockchain development tool that is best for creating output and executing smart contracts on the Ethereum Virtual Machine. The main purpose of using this tool is to convert solidity scripts into scripts that the Ethereum Virtual Machine can understand. Also, blockchain developers need to use this tool to translate smart contracts into a format that can be read by the Ethereum Virtual Machine. (Debopriyo et al., 2022)
- Web3j: This tool was created by the creators of the Java WebSocket API for developing blockchain technology, which helps developers to connect and interact with development tools based on decentralized applications and Ethereum. This tool supports the Ethereum wallet. This tool also allows the creation, distribution, and trading of smart contracts from Java code. This tool also enables the automatic creation of interfaces for Java smart contracts. This tool is also distinguished in that it eliminates the need to create different programming languages to interact with transactions.
- Mist: It is a tool for Blockchain development and serves as a one-stop-shop for managing people's assets and contracts on the Ethereum Blockchain. It is essential for anyone who wants to use the platform. This tool can explore and access applications. (Debopriyo et al, 2022)
- Ganache**:** Rapid development tool for shared applications Ethereum and Corado. This tool replicates every feature and creates accounts using Ether tokens. Developers thoroughly test their applications by using this tool, as it allows creating, sharing, and validating applications. (Debopriyo et al., 2022)
- Drizzle: This tool is a feature of the Truffle Drizzle. The Ethereum Redux data store is the core of blockchain tools for developers. This store is based on the popular React framework that synchronizes on-chain nodes and transaction data and compiles front-end dApps. This tool can create user interfaces to run in delayed and non-deterministic contexts. (Debopriyo et al., 2022).

Conclusion

By searching and investigating the blockchain technology, which is a set of encrypted blocks connected to each other in the form of chains that are difficult to penetrate, and the information in the blocks cannot be changed, so it is a technology that enhances trust between the two parties. There are types of blockchain technology, and each type is used according to the reason for use and the level of security required for the transaction. All institutions need blockchain technology, including educational institutions, because they need to sort and save information in a secure way that does not allow information manipulation. Educational institutions use the blockchain to save student data, in addition to keeping papers, files, and copies of all users working in that institution. Blockchain technology is based on continuous development in order not to give attackers opportunities to steal information and others. Therefore, we can integrate blockchain technology into education systems to reduce these problems.

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