Design of Hybrid Intelligent Platform for Teaching Experiment of Database System

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Abstract. Under the epidemic of Covid-19, it is urgent to change from the traditional model of offline experiments to the hybrid model of online-online experiments in computer science needs to be changed from the combination of traditional offline experiments in computer science. To improve the experimental teaching of the database principle in computer science, our teaching team tries to design and build a database system teaching experiment online-offline hybrid intelligence platform. By combing students' active participation and platforms' intelligence, this platform can provide various services such as intelligent recommendation and cocurriculum, enabling to enhance students' understanding of database interaction and cultivate their innovative practice ability. Moreover, in this platform, students can learn the theoretical knowledge of the course through intelligent recommendation for choosing UOOC or online teaching. In addition, students can answer questions to teachers in class online, and complete relevant practices in the platform according to the teaching requirements. Finally, students can perform flipped course display. The application of this teaching platform can improve the quality of classroom teaching and enhance students' practical interest. Moreover, it also can improve students' practical ability and learning creativity, and realize a new teaching mode with students as the main body.

Keywords: Database system; online and offline hybrid platform; experimental teaching; teaching platform design

1 Introduction

Over the past two years of the epidemic, colleges and universities across the country have actively explored a new model of online and offline mixed teaching[1-5], and there have been many successful experiences. The development and popularization of database technology has gradually attracted the attention of colleges and universities to the training of students' database technology. Under this background, the School of Computer and Software of our school plans to carry out a new model of database mixed teaching practice of "OOC online course", "teacher's offline question answering", "database teaching platform practice", and "flipped course display". By providing the design and implementation of six major database platforms for students to choose from, it improves students' interest in learning and practical ability, and cultivate excellent computer talents with solid theoretical knowledge and excellent hands-on ability.

In this paper, we introduce the database course teaching system, which consists of modules of course study, question answering, practice, and summary. In this system, students can master

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solid database knowledge, improve practical operation ability in the process of independent learning, hands-on practice, reporting, and communication. Moreover, there are certain intelligent functions. For example, the platform will conduct automatic and intelligent guidance, provide proficiency tests and questionnaires, and learn about the students' actual level and hobbies and other relevant information, so as to intelligently recommend different knowledge content pages for different students to achieve personalized education.

The University Open Online Courses (UOOC) are the first national local university MOOC resource sharing platform led by Shenzhen University, which can provide students with course learning choices and services[2]. During the epidemic, teachers can publish database online courses through UOOC, and students can learn online, and complete database course learning through teaching videos, online discussions, classroom tests, and after-class exercises. Noreover, after students complete online learning tasks, teachers can reasonably arrange offline Q&A under the school's epidemic prevention, and answer students' doubts in the process of online learning. This can effectively improve learning quality in the process of learning and thinking, and complete teaching requirements . In addition, teachers can arrange students to carry out database course practice, consolidate course knowledge through hands-on operations, and cultivate students' thinking ability and hands-on ability. This process can mainly be carried out through the teaching platform. The platform allows students to review knowledge, practice exercises, and practice operations to maximize their comprehensive learning ability. Finally, the MOOC has a course display module, which allows teachers to dynamically grasp the degree of knowledge mastery of students. This module also enables students to carry out supplementary learning of relevant knowledge, improving students' comprehensive ability of expression and sense of accomplishment, and providing positive feedback for subsequent learning.

In the following, the teching platform design is first introduced, and then the design of platform is given. Finally, the conclusions is given.

2 Teaching Platform Design

2.1 Platform Objectives

The teaching platform is designed to provide students with comprehensive teaching resources, and create a good experimental environment. It is also used to complement offline courses, and provide students with personalized course exercises. These processes try to give students a good learning experience.

(1) Based on the three paradigms of database, the platform uses MySQL statements to design and write data tables, and creates related stored procedures and triggers according to the actual needs of the system to complete the initial establishment of the database.

(2) The platform connects to the database through php, which completes the interaction between MySQL and the web interface, and realizes the operation of "creating, reading, updating and deleting" tables dynamically by the client.

(3) On the basis of the B+ tree, the platform uses the leftmost prefix principle to optimize the index of the database, which greatly speeds up the query speed and improves the query efficiency.

(4) In the SQL optimization of complex associations, the platform selects the driving table by comparing the data volume and query filter conditions of different tables to minimize the query cost.

(5) The platform chooses the InnoDB storage engine[3], which has great advantages in ensuring the integrity of transactions and realizing concurrency control. In the teaching platform, InnoDB can meet the needs of students who frequently use the database for independent exercises through the commit and rollback of transactions.

(6) The platform uses the bootstrap framework and the grid system to implement a responsive layout, making the platform page display more beautiful and user-friendly.

(7) The platform uses oscache caching technology[4] to cache the identified hotspot data for a period of time, and thereby reducing frequent interactions and the pressure of direct access to the database.

(8) The platform adopts big data analysis+AI +5G technology, which will identify the knowledge and weak links that users are interested in, so as to carry out accurate push and improve the learning efficiency of users.

2.2 Functional Requirements

Based on the platform goals introduced in the previous part, this part mainly introduces the functional requirements of the platform and the realization of each function. The frame diagram of each function of the platform is shown in Figure 1.

2.2.1 User Management.

It can store a large amount of different user information and perform user management quickly and effectively. Users log in through the platform, and the platform presents different functional interfaces to users according to the requests of different users.

2.2.2 Resource Management.

Teachers upload materials and teaching resources required for experiments through the system for students to browse, retrieve and download.

2.2.3 Experiment Management.

The system provides a variety of database management software downloads, such as SQL server, MySQL, etc., to help students install the experimental environment locally for course practice.

2.2.4 Front-End Page Management.

The platform page display is completed through front-end technology design, including user login interface, user management interface, resource management interface, experiment management interface, etc[5].

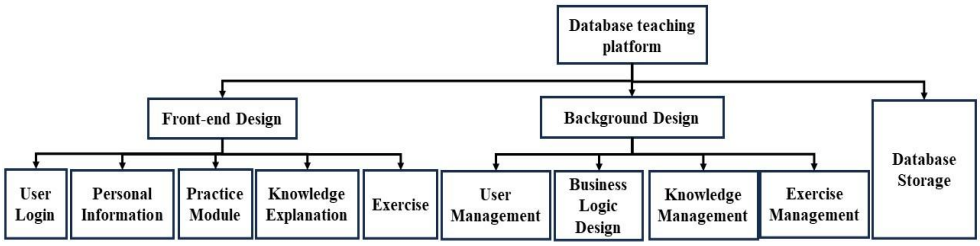

Fig. 1. Diagram of database teaching platform

2.3 Performance Requirements

2.3.1 High Throughput.

The platform design needs to meet the performance requirements of high throughput, the high concurrency requirements of data in the front-end and back-end interaction process, and the requirements of data backup and migration.

2.3.2 Load Balancing.

In the process of platform design, load balancing is one of the key components, which can improve platform performance by distributing load to multiple services, and obtain data such as platform deployment architecture and load balancing strategy.

2.3.3 Read and Write Separation.

In order to ensure the smooth operation of the database, the platform database needs to separate reads and writes, and specify how to implement the write node and read node, as well as the switching strategy and data synchronization strategy[6].

2.3.4 Partition Sharding.

The platform‘s architectural blueprint necessitates a precise delineation of data segmentation strategies, with a deliberate dispersion across designated database hosts. It mandates discernment regarding which voluminous datasets warrant horizontal partitioning, coupled with meticulous deliberation regarding their allocation, whether to distinct database repositories or specific tables. Such determinations should be predicated upon a thoroughgoing examination of the requisites, culminating in an assessment of both the practicability and testability of the system.

2.3.5 High Availability.

During the platform construction process, it is imperative to consider high availability as a focal requirement. The primary goal is to ensure seamless and faultless operations. This necessitates the utilization of advanced technologies such as cluster management and fault-tolerant HA (High Availability) techniques. In addition to comprehending the underlying principles of high availability technologies, it is equally crucial to establish a clear technical architecture, thereby satisfying the requirement for data consistency verification during fault switchover processes[7].

2.4 Database Requirements

The database caters to students and is designed to facilitate interaction with databases through PHP-based web pages. Its main objective is to enable students to comprehend the integration of PHP with databases. By applying the SQL concepts learned in theoretical classes to practical PHP interactions, students gain a deep understanding of web development principles. This fosters the ability to implement basic web page interactions.

The database incorporates features such as stored procedures, triggers, and related functions. Simultaneously, it offers educational support by explaining the implementation of functions within the teaching platform's internal framework. Students can enhance their practical skills and cognitive abilities by learning and understanding how to create stored procedures necessary for specific database functions, setting up triggers for dynamic page responses, and gaining insights into writing MySQL statements within the database and their integration with PHP.

2.5 Security Requirements

As the platform caters to students and stores their input and output data, it is necessary to ensure the information security. To address this concern, we have implemented relevant security measures.

The database platform restricts the display of database permissions, granting this privilege only to authorized individuals, and ensuring effective management of "skip-show-database" permissions. Simultaneously, it enforces limitations on the permissions of administrators and all users, exercising control over user access.

To enhance security during platform usage, certain data requires encryption. The database employs MD5 encryption technology, converting user-input information into a 32-character encrypted string[8]. This process is irreversible and offers a high level of security.

3 The Design of Platform

3.1 Front-End Design

3.1.1 User Login Module.

In the user login module, users can log in by entering their own account and correct password information. The system automatically verifies whether the entered account and password exist and conform to the specified criteria. When the "Login" button is clicked, the system performs regular expression validation to determine the accuracy of the entered account and password. If the account does not exist, users have the option to register themselves through the "User Registration" process, using their student ID and name to create an account and set a password. It is important to note that passwords must adhere to a length requirement of 6-20 characters; any password exceeding or falling short of this range will prompt users to re-enter their password.

When users forget their password, they can click on the "Forgot Password" option and provide their student ID, name, and other relevant information to recover their password, as illustrated in Figure 2.

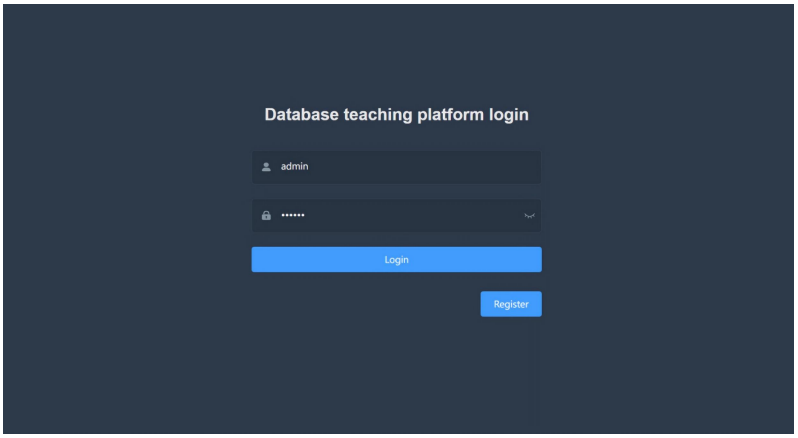

Fig. 2. Teaching platform login page

3.1.2 Personal Information Module.

Within the platform system, the personal information module is a crucial component for students. It includes personal details such as student ID, email address, contact information, and additionally supports operations like changing profile pictures and setting nicknames. When users forget their login password, they can reset it through email or phone number verification.

3.1.3 Course Practicum Module.

This module is divided into two sub-modules: front-end design and back-end design. Here, we take the building of a shopping system as the example to illustrate its functionalities.

In the front-end design, there are five main features: user login, personal information, product display, shopping cart, and order management. In the product display section, newly registered users can specify their preferences, and the system will automatically recommend products that match their interests[9]. Users can also search for their favorite products using keywords or images.

In the back-end design, there are four main functions: user management, product management, category management, and order management. In category management, products are classified in detail, allowing users to quickly and intuitively select their desired items. Students can apply their database knowledge in practical coursework to construct a customized database system, such as a shopping system or an online fitness appointment system, as part of their course practicum.

3.1.4 Knowledge Explanation Module.

In this module, the primary audience is students, with the aim of helping them better understand the functions of a database system. For example, in a shopping system platform, this module provides detailed explanations of the corresponding functionalities within the shopping system. It combines theoretical knowledge taught in the classroom to assist students in gaining a deep understanding of the internal construction principles of a platform system. For instance, it elucidates the specific theoretical concepts, such as triggers, are implemented within the practical context of a shopping system. It explains where and how these concepts are applied in the system, offering videos or documents that provide insights into these topics within the Knowledge Explanation Module. This module tries to facilitate students' comprehension of how database systems work by bridging the gap between theory and practical implementation, enabling them to grasp the internal architecture of a platform system more comprehensively.

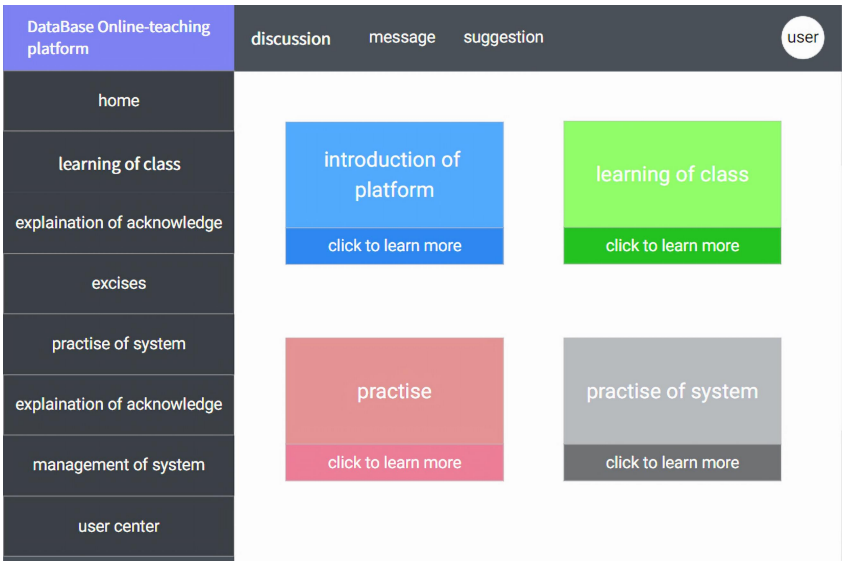

Fig. 3. Database teaching platform homepage implementation renderings

3.1.5 Exercise and Practice Module.

It is crucial for students to understand how to write and use SQL statements in various scenarios. In the Exercise and Practice Module, the platform offers an SQL statement practice system to help students become more adept at writing SQL statements based on their theoretical knowledge and enhance their problem-solving skills.

Additionally, this module has a learning and discussion area where students can engage in collaborative learning when they have questions or uncertainties about specific exercises. This fosters a learning-centric atmosphere within the teaching platform.

The platform's homepage interface is depicted in Figure 3, providing students with easy access to these exercise and practice resources.

3.2 Back-End Design

3.2.1 Main Technologies of the Online Learning Platform.

The technologies employed in the platform can be categorized into server-side backend development and database technology. The former utilizes Java, while the latter relies on MySQL. The choice of MySQL is driven by several factors: its speed, efficient use of storage space, relatively lower overall cost, and support for multi-threading and SQL database language. MySQL is a preferred choice for backend databases in various software, websites, and small-scale application.

3.2.2 Overall System Design.

The platform's system design comprises of two major components: backend data management and information services.

Backend Data Management: This component facilitates user information management and the design of business logic. It collects students' learning data and provides corresponding intelligent content recommendations.

Information Services: This component can be further divided into two subparts:

1. Knowledge Management: It offers teaching videos and related learning materials to help students study and comprehend course content.

2. Exercise Management: It provides an exercise repository, allowing students to practice freely and test their knowledge.

The overall design of this system aims to provide comprehensive learning support, including knowledge dissemination and practice opportunities, to meet the educational needs of students. Meanwhile, backend data management ensures the security of student information and the efficiency of teaching services.

3.2.3 User Module Design.

The system is mainly used by administrators, teachers, and students. Administrators are responsible for platform management and user management, assigning different platform usage permissions to teachers and students. They can also use the information management module to understand the situation of each user and adjust the push of various information based on data analysis results [10]. Teachers can upload video courses and view their evaluations, while students can view, select, and evaluate video courses and complete their learning tasks through the learning center.

3.2.4 Business Logic Design.

Students are important users of this platform. The login page is aesthetically pleasing and simple, with basic username and password input fields and login and registration buttons to facilitate new user registration.

The teacher user interface focuses on facilitating teachers to upload learning materials. Teachers can use the upload interface of the course module on the course provider side to upload related learning videos and materials.

Administrators can create, modify, and delete users and user information. Students can modify and view account information, view learning center content and the latest push, and the backend can provide an interface for intelligent grading of exercises. Teachers can see their uploaded teaching videos and materials as well as course evaluations. In addition, each teaching video needs to be tagged before it is successfully uploaded, so that the database can categorize the videos and push them to suitable students.

3.3 Application Design

3.3.1 Application Classification Management.

The application platform module classifies different platforms by setting different tags, such as shopping, leasing, and appointment, to facilitate students in quickly finding the platform pages they need. The database teaching platform provides students with 6 experimental practice platform displays based on different directions, including car reservation system, charity management system, coupon tracking system, luxury goods leasing system, online fitness management system, and silent car auction system. At the same time, the system supports students to upload their own implemented database platforms and update them to the existing application platform module[11-15].

3.3.2 Application Function Analysis.

Luxury goods leasing system: The system implements 5 functions: search for bags produced by each manufacturer; ② best customers; ③search for customer purchase records; ④return bags; ⑤ add bags; and ⑥add consumption records. It creates a stored procedure for bags, which returns the name and color of a bag by receiving specific parameters. It also creates a stored procedure for the best customers, sorting users based on the total rental duration from high to low [16-18]. When a user rents a bag, the trigger is used to dynamically update the status of the bag, realizing the luxury goods leasing system. Figure 4 shows the interface of this system.

id	Name	Color	Manufacturer	Operation
101	Claudia	White	Louis Vuitton	Rent
102	Cabas Piano	Multi	Louis Vuitton	Rent
103	Monogram Prochette	Multi	Louis Vuitton	Rent
104	Satchel	Camel	Coach	Rent
105	Hippie Flap	Green	Coach	Rent
106	Bleeker Bucket	Blue	Coach	Rent
107	Messenger	Black	Prada	Rent
108	Fairy	Multi	Prada	Rent
109	Glove Soft Pebble	Mauve	Prada	Rent
110	Haymarket Woven Warrier	Gold	Burberry	Rent

Fig. 4. Rent bags page of a rental system

Online fitness management system: This system queries and processes the following tasks: which customers are over 40 years old, which customers are very healthy or moderately healthy and participate in the gold fitness package, and how many customers each coach has. It creates two stored procedures. The first one displays customer ID, last name, first name, and email address. It only lists customers who are very healthy or moderately healthy and participate in the gold plan. The second one adds up all the customers of each personal trainer through a query. It displays the last name and first name of the personal trainer as well as the number of customers. Finally, the system generates a monthly cost report for each trainer for each customer. Figure 5 shows the interface of this system.

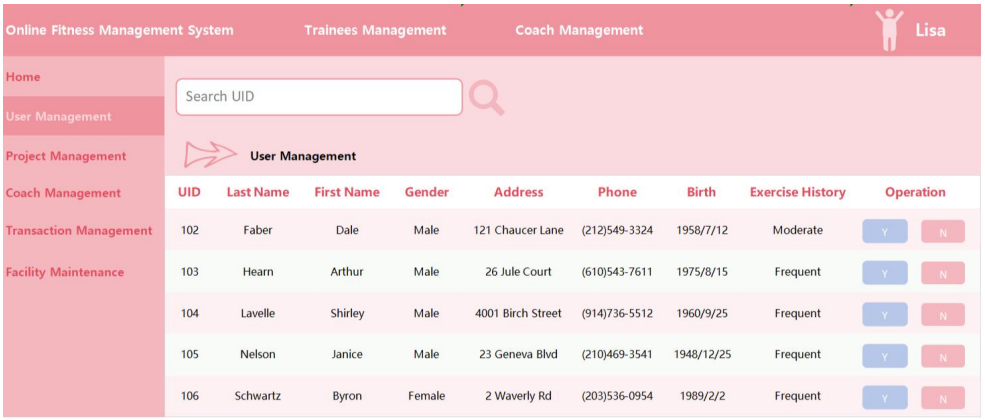

Fig. 5. Online fitness management system page display

Automotive Auction System: The automotive auction system is designed to facilitate the bidding process for cars. It features a custom navigation bar that allows users to access all tables, forms, queries, and reports. The system records all bids for cars and provides multi-table join queries to display the available newer cars and all cars of a specific brand. Additionally, it showcases the maximum bid and the winners and losers of each auction. The system also includes stored procedures that allow users to query and display information such as car ID, last name, bid amount, highest bid, and bidding success status. Finally, the system generates a report summarizing the available cars based on their production year. Figure 6 shows the interface of this system.

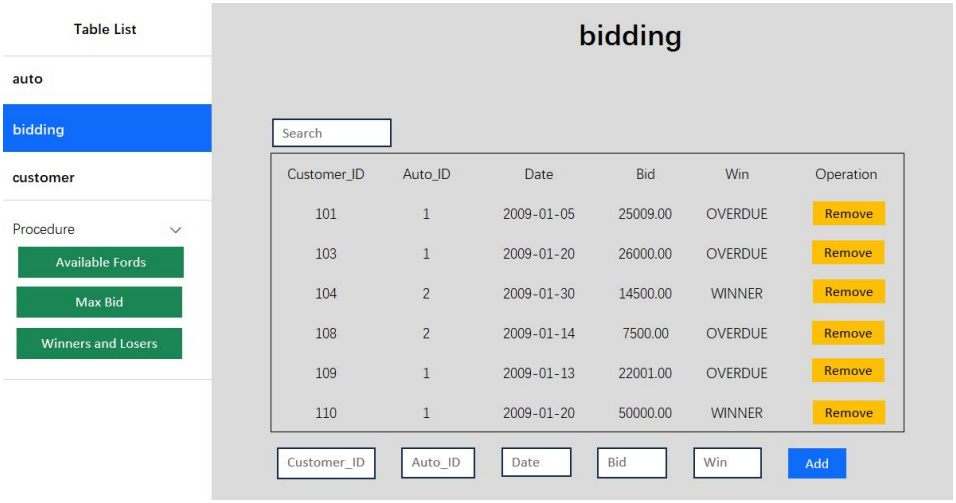

Fig. 6. Silent car auction system page display

Automotive Reservation System: The automotive reservation system is designed for a car-sharing business. It utilizes a relational database to store and manage car reservation data. Once the database design is completed and verified, the system creates database tables and populates them with data to generate a website. Customers can use the website to book and select cars. The website displays car rentals, along with various queries and reports. It includes a subform, five queries, one report, and a custom navigation pane. The system records reservations for each car. The queries provide insights into student customers who violate driving rules, popular pickup locations, vehicles that can accommodate a certain number of passengers, and rental trends. Another query allows the company to increase the rental prices of their vehicles. The report summarizes the rental income for the current month and the amount charged to each customer. The custom navigation pane allows access to all tables, forms, queries, and reports. The web interface is implemented using PHP to ensure a better user experience[19, 20].

Charity Management System: The charity management system is an application that uses MySQL and PHP to facilitate the management of donations to charitable organizations. The system includes various queries and functions that allow the company to easily record donations for each charity. These queries enable administrators, donors, and charitable organizations to access important information. Additionally, the queries list the project expenses for each charity, the donors of a specific charity category, the top donors for a specific charity, the frequency of donations by donors, and matching gifts for a specific charity.

Coupon Tracking System: The coupon tracking system is an RBMS application implemented using MySQL and PHP. It enables an e-commerce company to market and sell coupons online. The system includes a form and a subform that allow for coupon transaction reservations[21]. Furthermore, it creates queries to help the company answer important questions such as which transactions can be obtained at a specified maximum price compared to the regular price, how cost-effective a transaction is, which transactions have at least 100 registrations and can

proceed, and what the most popular transactions are. Finally, a query is created to generate a report listing all customers who have registered for the current transactions.

4. Conclusions

This paper introduces a hybrid database teaching model that combines "UOOC online courses," "offline Q&A sessions with teachers," "database teaching platform practice," and "flipped course demonstrations." By focusing on the process of building the database teaching platform, it explores a new approach to enhance students' self-learning ability and promote the integration of course teaching and practical application. The teaching practice platform is developed using technologies such as PHP, MySQL, and Java, providing various functions including knowledge explanation, exercise practice, and database teaching practice, effectively meeting the needs of daily teaching. Throughout the development process, multiple framework technologies were employed, resulting in a clear, visually appealing interface with comprehensive functionality and a certain level of innovation. However, due to time constraints and limited technical expertise, there are still some deficiencies in UI page layout and feature design. The system will continue to be modified and improved in the future.

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