

# Design and Implementation of Library Seating Management System

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## Abstract

The library seating management system is an important part of the library's modern services. The system is based on the Spring and Spring Boot framework, and the system realizes a series of functions such as real-time query, reservation, and cancellation of seat resources, providing users with great convenience. With a simple operation, users can know the availability of seats in the library in real time and reserve them according to their needs. At the same time, the system also provides rich management functions, enabling administrators to easily configure and manage seat resources. The addition, deletion, modification and review of users, the generation of seats, the viewing of user usage records, and the addition or deletion of points for users' usage can also be carried out. This not only improves the management efficiency, but also provides more scientific and accurate data support for the management of the library. The system not only optimizes the user experience, but also promotes the scientific management and efficient utilization of library resources, and provides strong support for the modern services of the library.

## Keywords

Library, Seats Management, System Design, Management Efficiency, Spring

## 1. Preface

In today's era of rapid information development, China's population is growing year by year, and the expansion of universities has resulted in an increasing number of high-quality talents. Generally, libraries are designed and established during the initial construction phase of universities, which limits their capacity to meet students' usage needs. As students' demand for libraries, study rooms, and other learning spaces continues to grow, the existing educational facilities and resources, such as library seats, are increasingly in short supply [1]. This

leads to various management issues, such as seat reservation and competition for seats. Consequently, many students who need seats cannot find one, resulting in wasted resources and strained relationships among students. Seat reservation hinders effective resource sharing and utilization. Therefore, in light of the current issues faced by libraries, introducing a library seat management system will effectively alleviate and solve these problems. It will not only help students reduce the issues of finding and reserving seats, minimizing conflicts and easing the workload of library staff, but also make seat usage more regulated, providing a better learning environment.

## 2. Requirement Analysis

1) System Feasibility: The system is built on the mature Spring Boot framework. For the frontend, it utilizes JavaScript scripting language, CSS stylesheets, and HTML markup language, with IntelliJ IDEA chosen as the development tool [2]. The frontend technology ensures the interactivity and aesthetics of the user interface. IntelliJ IDEA, as a powerful IDE, provides a wealth of development tools and plugin support, further enhancing development efficiency.

2) System Operability: The system offers users a convenient and easy-to-use login interface, along with a simple and intuitive service interface. Different roles have different permissions, and users can easily operate the system by following the page prompts to make their desired selections [3], effectively improving management efficiency.

3) Functionality Scalability: The system serves the library and needs to provide basic functions such as seat inquiry, reservation, and management. Additionally, it must be able to efficiently expand to meet different practical requirements.

## 3. Major Methods and Technologies

In the process of planning the library seat management system, essential elements such as database management systems and web servers are indispensable [4]. This system chooses MySQL as the backend database management system. For dynamic web page development, we primarily rely on Java Web technology, and use the IntelliJ IDEA integrated development environment as the development tool to support the entire development process.

### 3.1. Spring MVC

Spring MVC promotes code organization and management through clear role separation (Model, View, Controller), enhancing the application's maintainability. These components work together to implement the application's functionality [5]. The Model is responsible for data management and business logic processing, the View focuses on data presentation, and the Controller acts as a bridge connecting the two, handling user interactions, invoking model operations, passing model data to the view, and making decisions based on business needs. The Model and View do not communicate directly but influence each

other indirectly through the Controller.

### **3.2. Spring Boot**

Spring Boot focuses on building microservices and greatly simplifies the initial setup and subsequent development process of Spring applications through pre-defined default configurations. This allows developers to focus more on the implementation of business logic without getting bogged down by cumbersome underlying configurations. Spring Boot also offers excellent scalability and maintainability, enhancing development efficiency and application stability.

### **3.3. Java Web Development Technologies**

Java Web development technologies encompass a series of tools and libraries aimed at building static and dynamic web pages, achieving database connectivity, and processing business logic. These technologies can be categorized into frontend and backend technologies based on their execution methods.

Frontend technologies mainly involve HTML, CSS, JavaScript scripting language, Vue, etc., which form the foundation of web design. HTML is used to create “hypertext” content that includes images, videos, audio, links, and client-side programs. Its structure primarily consists of the Head and Body sections, which describe page information and display visual content, respectively. CSS is responsible for formatting the page, while JavaScript controls dynamic interactions on the client side within the browser.

Backend technologies cover various core components, including Servlets, Java Server Pages (JSP), JavaBeans, and Java Database Connectivity (JDBC). When the server is responsible for data processing and executing system tasks, it must follow specific technical standards and specifications [6].

These technologies enable developers to write generic database access programs without needing to deeply understand the underlying implementation details. Additionally, due to the cross-platform nature of JDBC, developers can more flexibly choose and use various database systems.

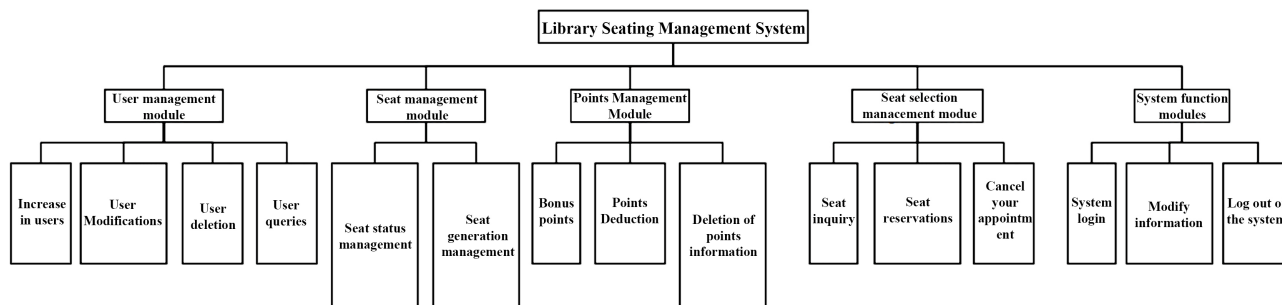
## **4. System Design**

The entire system can be divided into three parts: administrators, teachers, and students. The administrator’s end is aimed at managers and provides services such as user (i.e., students and teachers) management, study room and seat management, student points management, data analysis, and data log viewing. The teacher’s end provides services such as student points management and data analysis. The student end provides services such as seat viewing and reservation, and points status statistics.

### **4.1. Functional Module Design**

The library seat management system is divided into five different modules based on usage needs to manage uniformly and improve efficiency. The main divisions

are: User Management Module, Seat Management Module, Points Management Module, Seat Selection Management Module, and System Function Module. The functional modules of the system are shown in **Figure 1** System Function Management Module.



**Figure 1.** System function management module.

## 4.2. User Management Module

The User Management Module manages the users of the system, responsible for managing basic user information, including adding, modifying, deleting, and querying users. Since the system is used internally within the university and helps unify information management, user registration is not open, and administrators uniformly input the system and create accounts. This module is solely for administrators.

## 4.3. Seat Management Module

The Seat Management Module manages the seats in the library. It can set the number of seats in the library study rooms, set the status of individual seats, set the categories of library study rooms, and query the status of study room seats. It allows for flexible management of different study rooms and different seats. This module is solely for administrators.

## 4.4. Points Management Module

1) Points Management Module: This module manages students' points. It adds points for students who use the system normally and deducts points for violations such as occupying others' seats, reserving but not showing up, etc. Reasons for both point additions and deductions are recorded so that students understand their actions. This helps regulate uncivilized behavior, improves personal qualities, and makes effective use of library resources. This module is for administrators and teachers, while students can only view it.

2) Points Rules: Each student starts with 100 points. Points are added and deducted according to specific rules. For example: -5 points for not signing in after reserving a seat, -5 points for not signing in on time, -5 points for leaving a seat for more than an hour, -5 points for loud talking in the library, -5 points for eating odorous food in the library, +5 points for sitting on time, +5 points for

every accumulated 5 hours of study, etc.

3) When a student's points drop below a certain number, some study rooms will not be available to them.

### 4.5. Seat Selection Management Module

The Seat Selection Management Module manages students' seat selection. Students can filter seats by date and time according to their needs, choose a target seat, and make a reservation. If they cannot arrive on time due to uncontrollable factors, they can cancel the reservation without affecting their points, ensuring reasonable allocation of limited resources. This module is solely for students.

Figure 2 Seat Reservation Process.

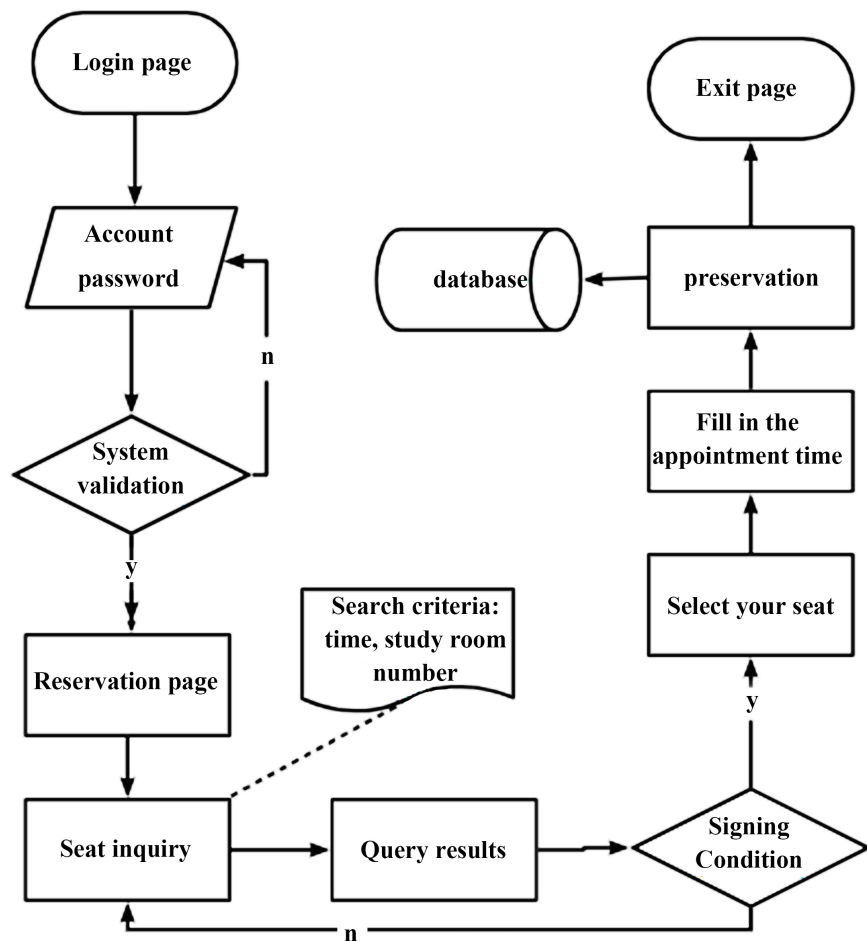


Figure 2. Seat reservation.

### 4.6. System Function Module

The System Function Module includes user login, logout, and information modification, as well as viewing library violations and seat occupancy. This module is available to all users without distinction. Figure 3 Password Modification Process.

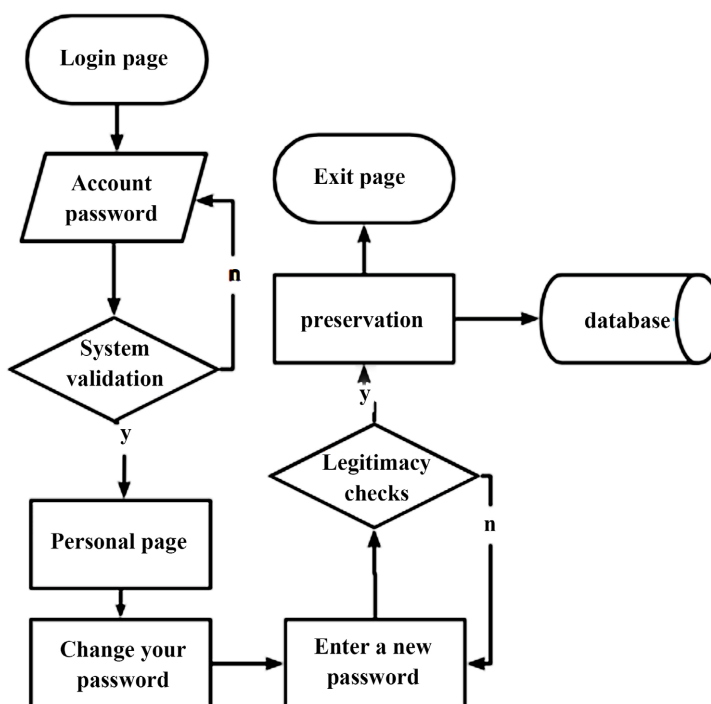


Figure 3. Password modification.

## 5. System Implementation

### 5.1. Login Interface

When the system has started, Users can Log into the system through this interface, as Shown in Figure 4 Login Interface.

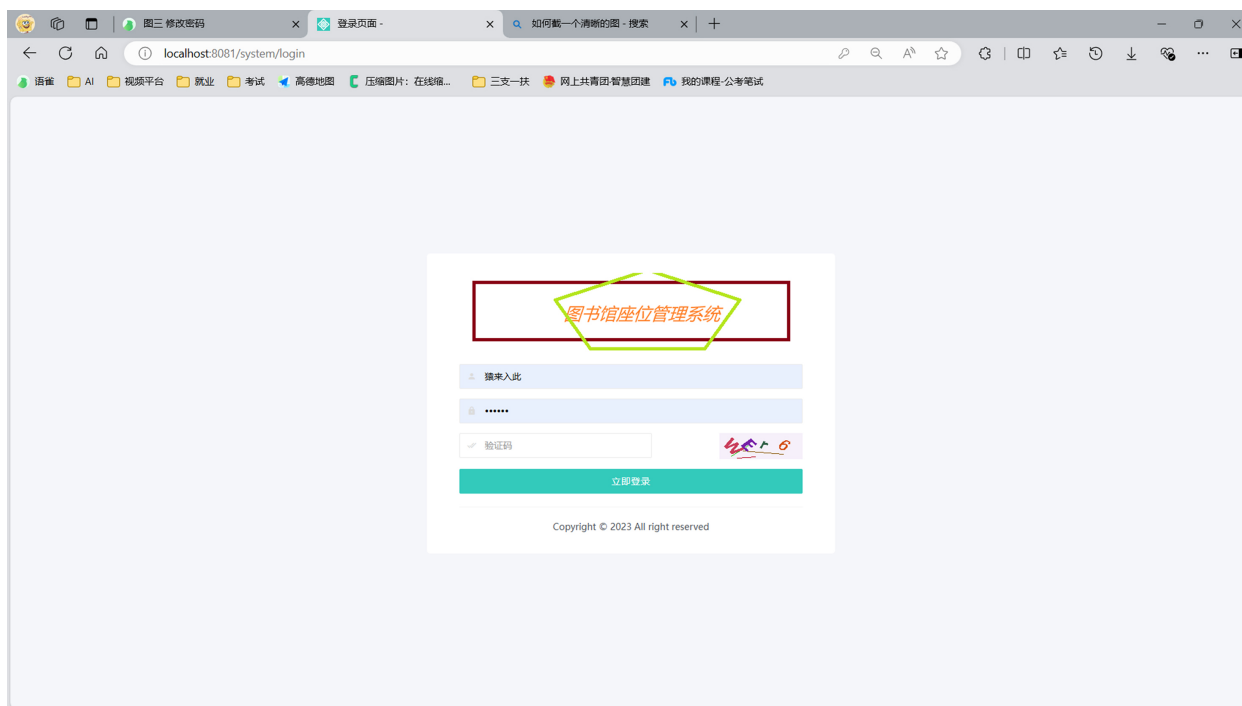


Figure 4. Login interface.

## 5.2. Violation Statistics and Seat Occupancy Statistics Interface

This interface can provide statistics on the number of violations and seat occupancy, helping administrators formulate management strategies and allowing students to understand their own study habits. Below are screenshots of the implementation of two types of data statistics, as shown in **Figure 5** Violation Statistics and **Figure 6** Seat Occupancy Statistics.

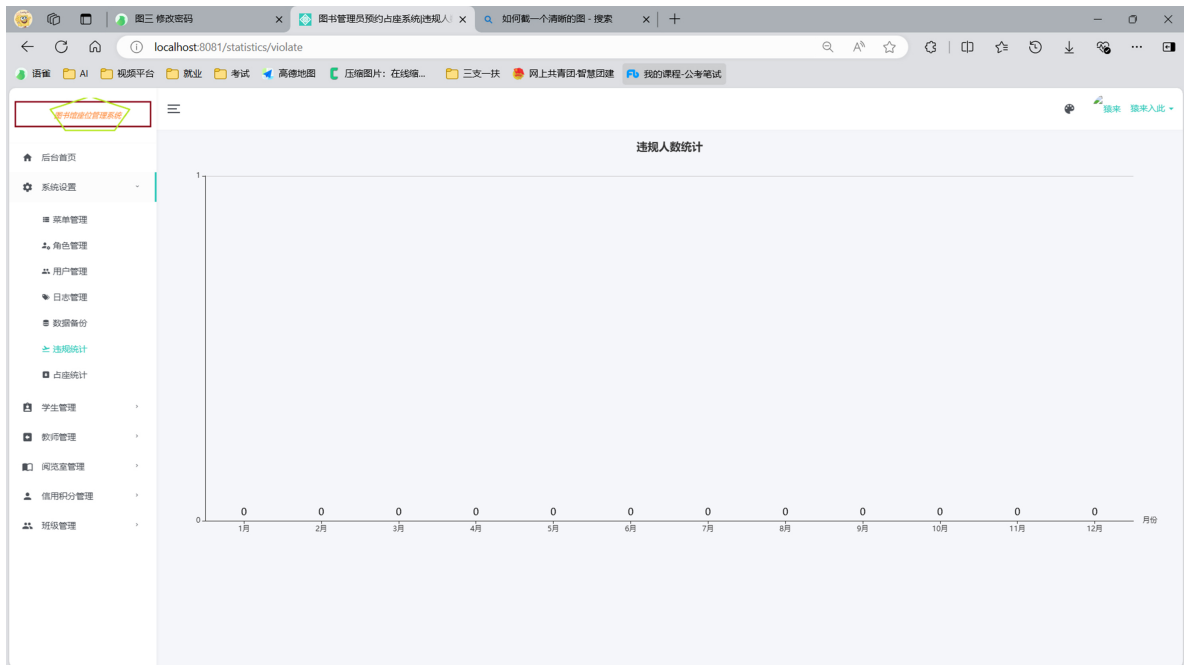


Figure 5. Violation statistics.

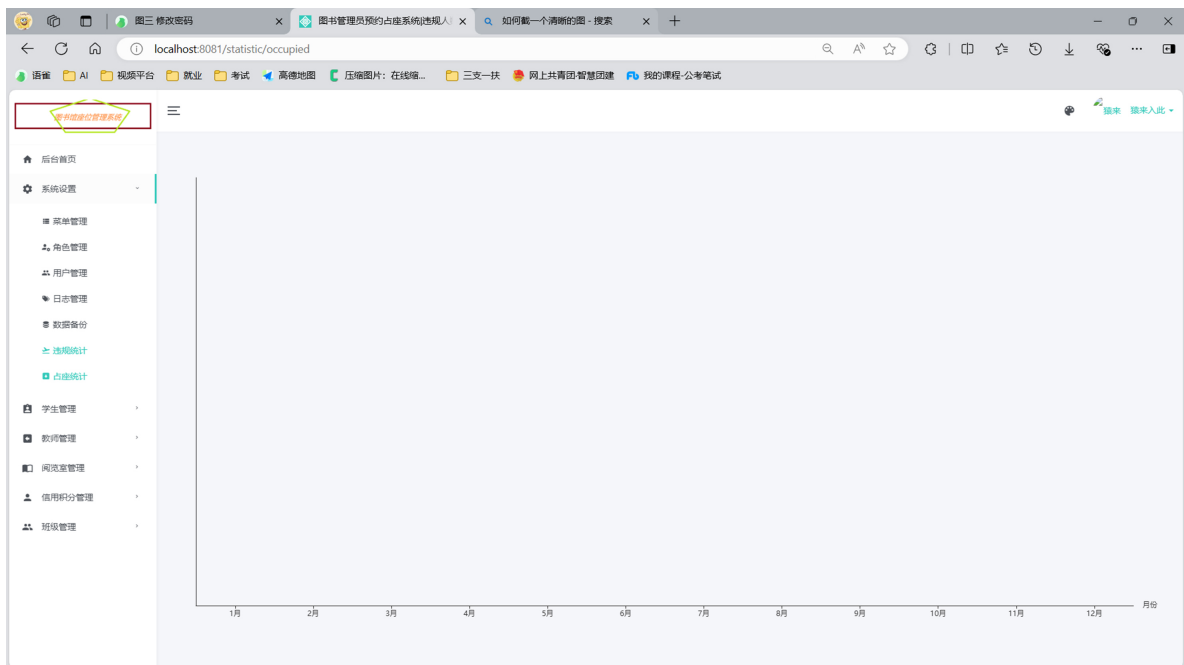
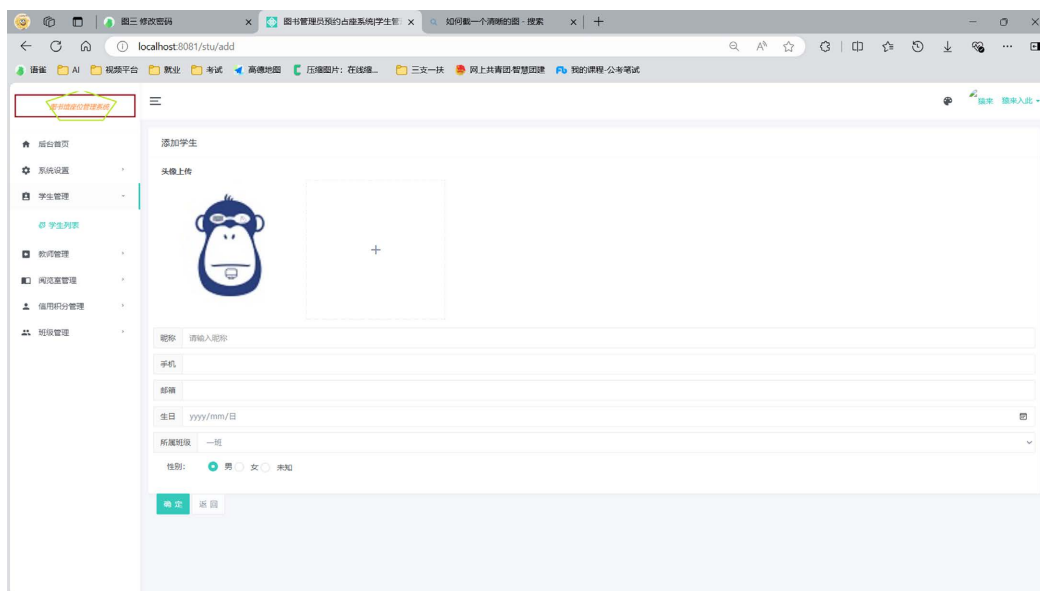


Figure 6. Seat occupancy statistics.

### 5.3. User Addition Interface

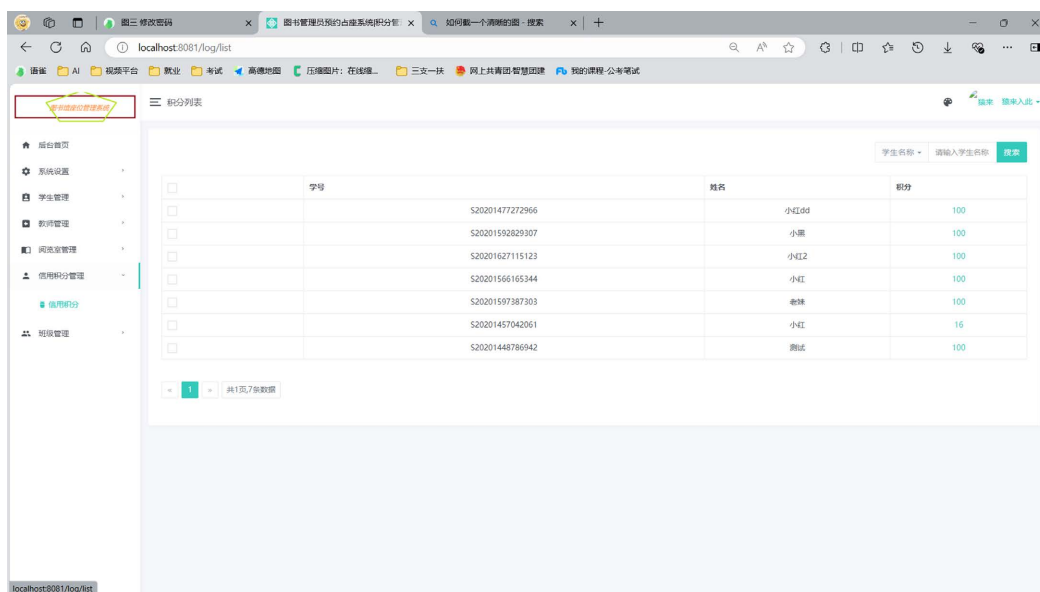
User management includes the addition, modification, and deletion of students, teachers, and administrators. Among these, role addition is particularly common. When an administrator accesses the page, the option to “Add Role” will be displayed. When the user clicks this option, the system will navigate to the role addition page, as shown in **Figure 7** User Addition.



**Figure 7.** User addition.

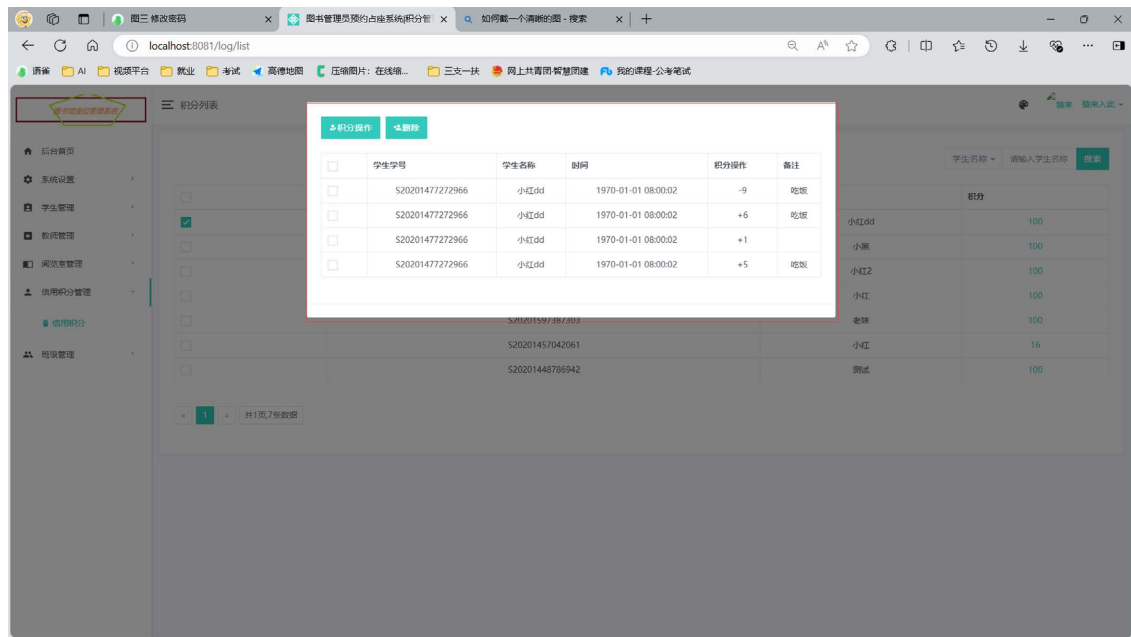
### 5.4. Credit Points Management Interface

Users can check on their points or manage them, as shown in **Figure 8** users in credit points management.



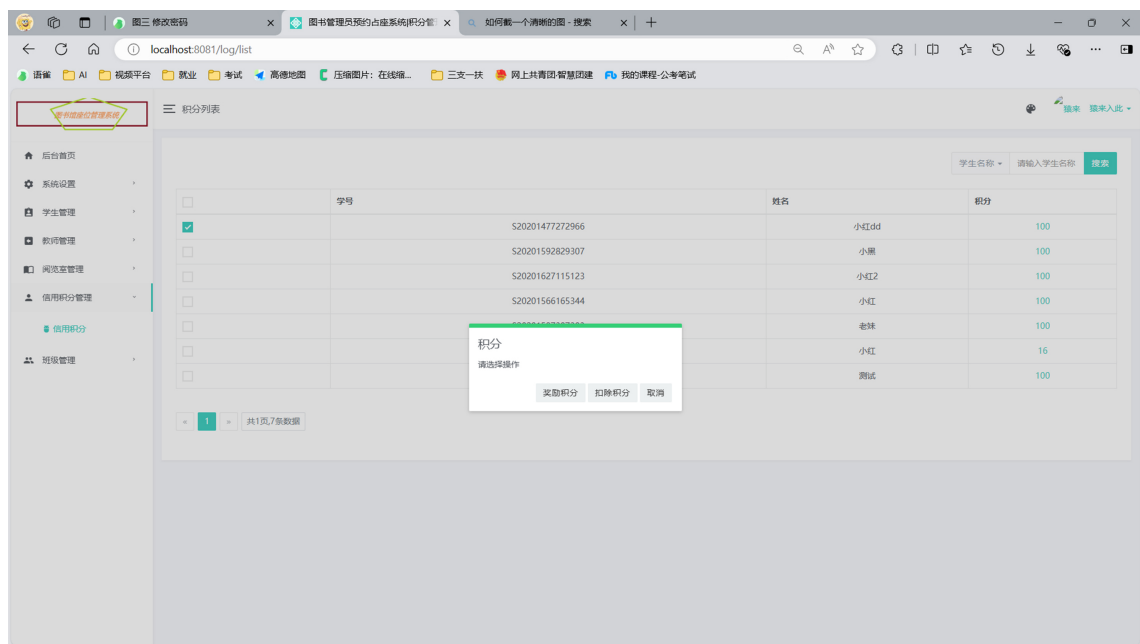
**Figure 8.** Users in credit points management.

Administrators can find relevant students by searching for their names, and then click on their points to manage them, as shown in **Figure 9** Points Management.



**Figure 9.** Points management.

Clicking on “Points Operation” will display **Figure 10** Points Operation 1. Choose to reward or deduct points, and fill in the number of points and the reason for the operation, as shown in **Figure 11** Points Operation 2. Click “Confirm” to complete the points operation.



**Figure 10.** Points operation 1.

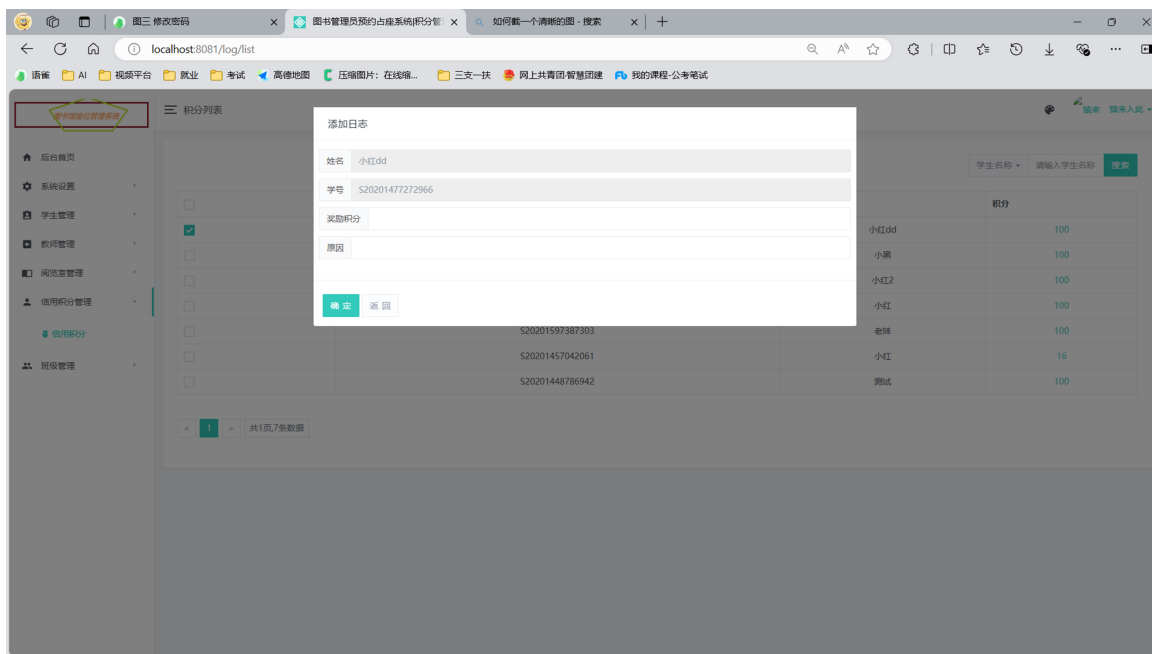


Figure 11. Points operation 2.

### 5.5. Seat Reservation Module Interface

The Seat Reservation Module covers core functions such as seat reservation, seat confirmation, leaving the seat, and canceling reservations. These form the cornerstone of the library seat management system. Next, we will detail the specific implementation of this module.

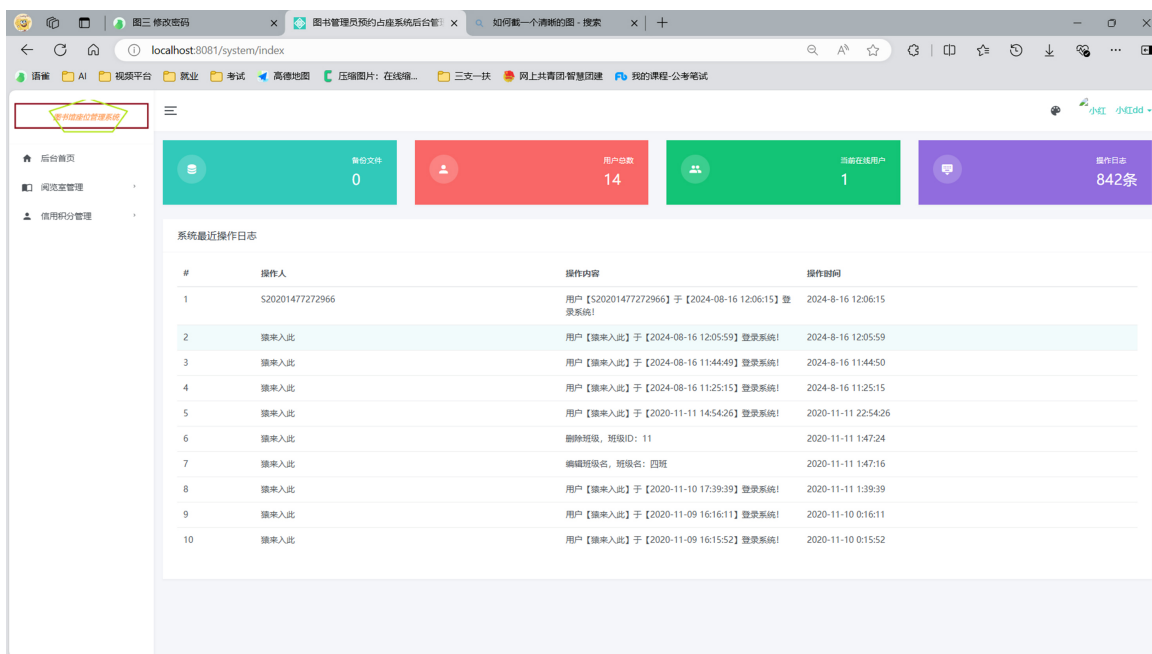


Figure 12. Student interface.

Seat Query: Students open the library seat management system in their

browser, enter their account, password, and verification code, and click confirm. If the student ID and password are correct, they log in successfully and enter the personal homepage, as shown in **Figure 12** Student Interface. The left side of the page is the navigation bar, which includes the main backend page, reading room management, and credit points management. Under reading room management, there are seat management, reading rooms, and student seat reservation records.

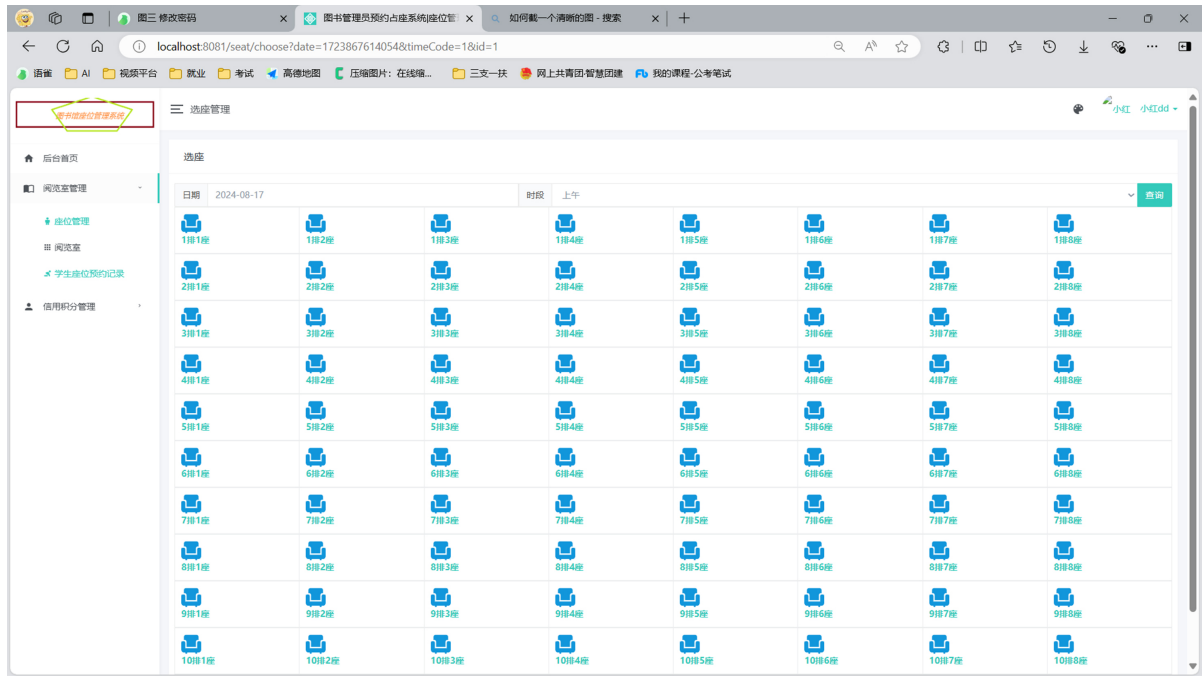


Figure 13. Seat map.

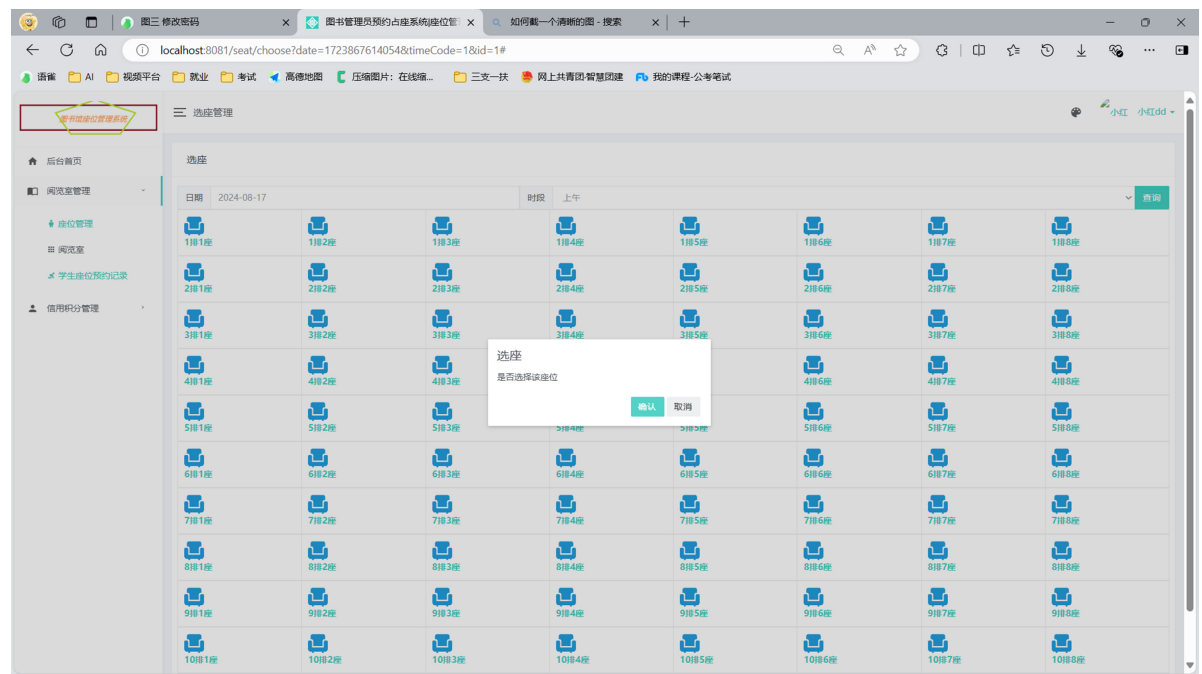
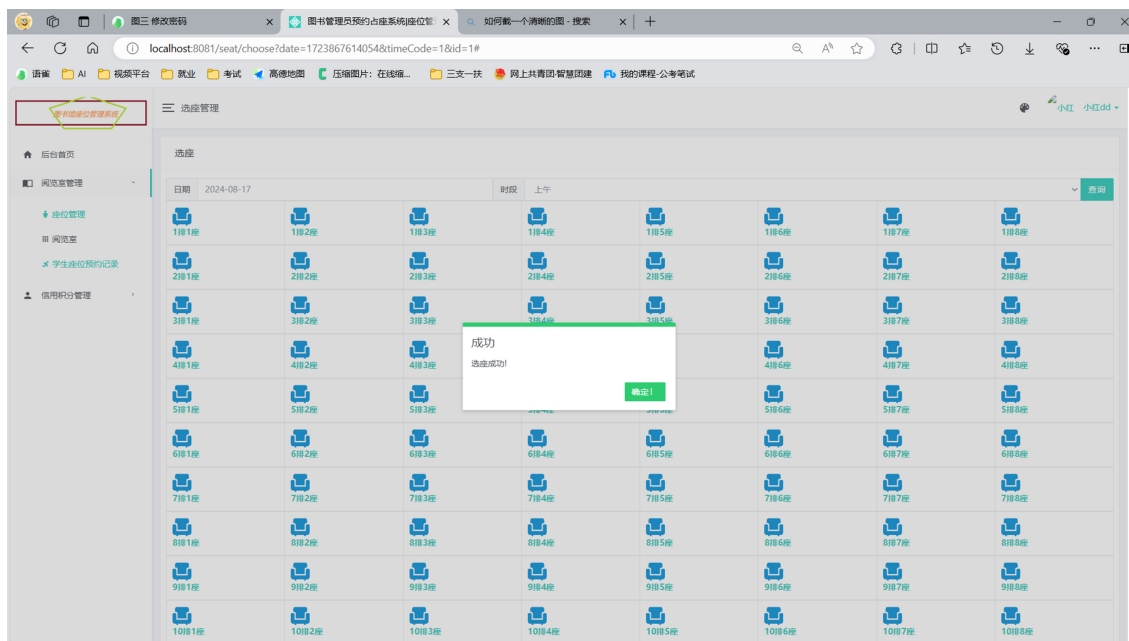


Figure 14. Seat selection.

Click on “Seat Management” on the left. Clicking on seat management will display all study rooms, such as Reading Room 1, Reading Room 3, etc. Clicking on “Select Seat” will show all seats (including available and unavailable ones), as shown in **Figure 13** Seat Map, making it convenient for students to view and choose. Blue represents available seats, while red represents unavailable seats.

Seat Reservation: Choose the date and time slot, click on the seat, select the seat, and confirm, as shown in **Figure 14** Seat Selection.

If the rules are met, a dialog box indicating successful seat selection will be displayed, as shown in **Figure 15** Seat Selection Successful.



**Figure 15.** Seat selection successful.

If the seat selection rules are not met, such as selecting an already occupied seat or attempting to reserve a seat when already having a reservation, a dialog box will show “Seat Selection Failed, You Have Already Reserved a Seat”, as shown in **Figure 16** Seat Selection Failed.

Seat Confirmation: Due to system limitations, only administrators can manually confirm that a student has arrived at the seat. However, in general, there are multiple ways to confirm a student’s seating status. With the development of embedded technology and IoT technology, Zixiang Meng and Chonghao Ju studied a dynamic allocation system for study room seats based on VB6.0 and RF cards [1], which uses RFID technology for student identity verification, combined with VB6.0 technology to improve system stability. Similar research includes the RFID-based library study room management system developed by Renchi Tang, Miaomiao Qian, *et al.* [2] [3]. Bo Du applied microcontroller technology to the seat management system [4], Xiangbin Wang researched a study room seat management system based on reader time-division multiplexing technology [5], and Dongming Ma and Meng Zhang studied how to use IC cards

to achieve intelligent management of library study room seats [6]. Additionally, there are library study room management systems based on fingerprint recognition technology and sensor-based systems.

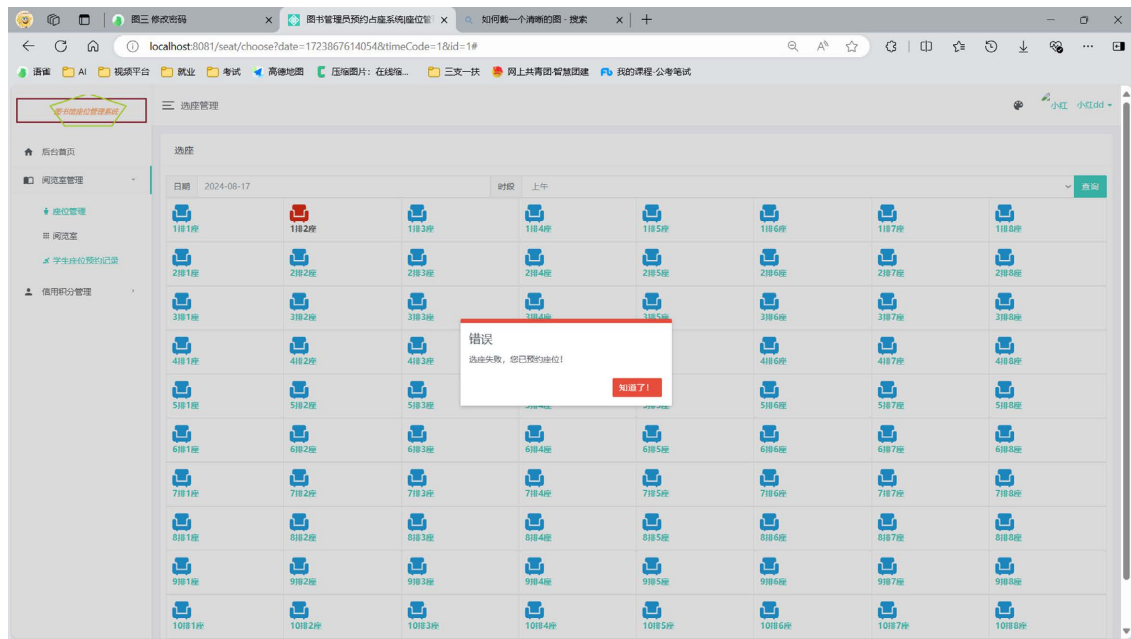


Figure 16. Seat selection failed.

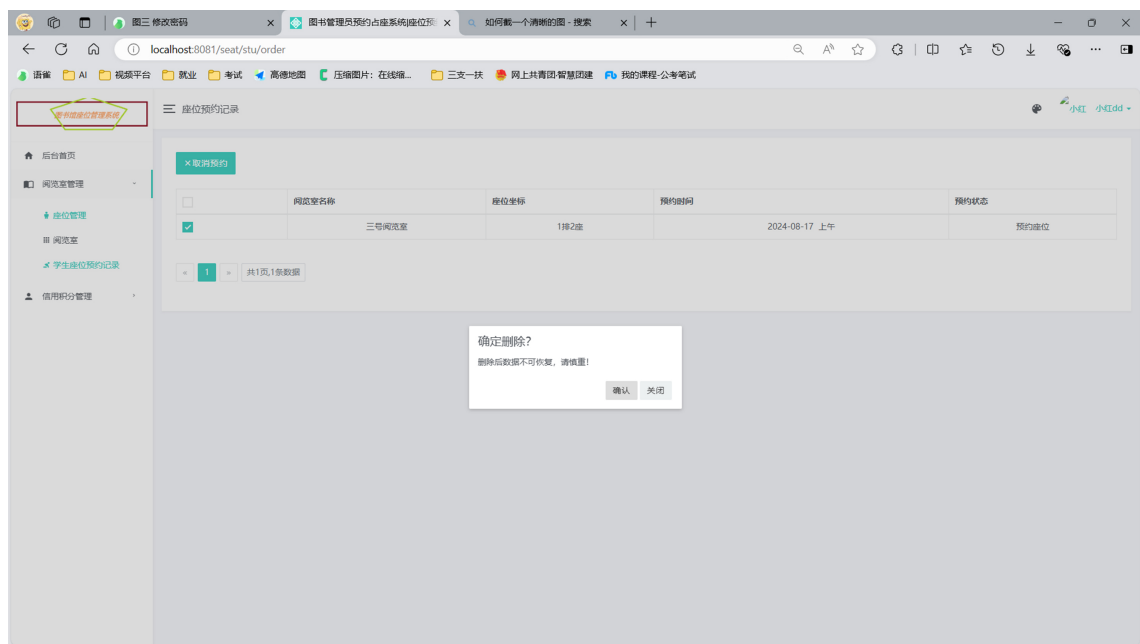
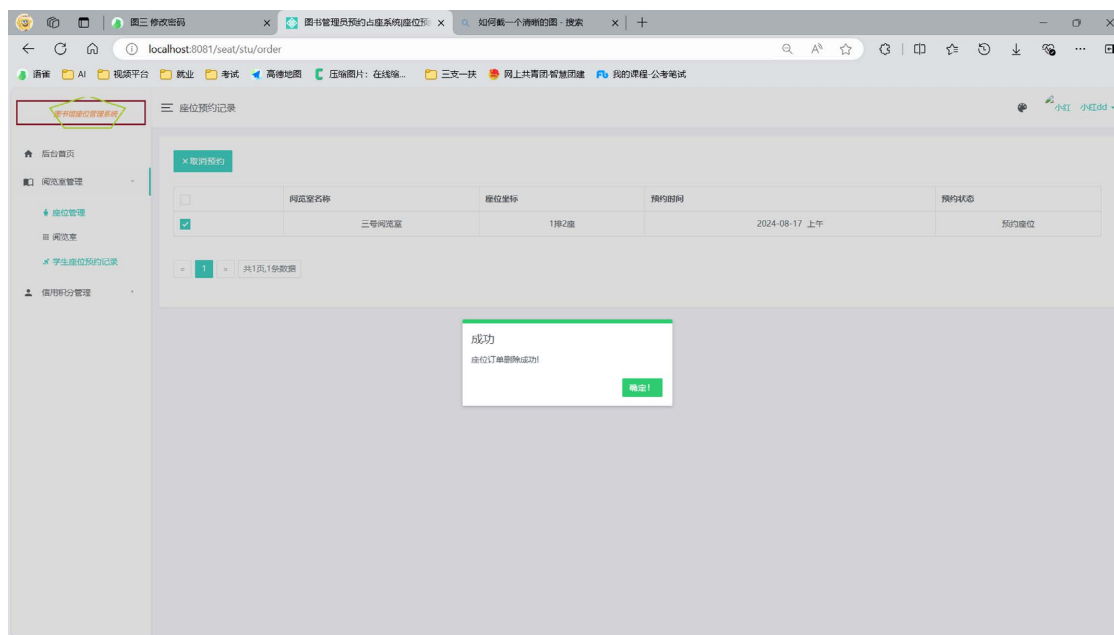


Figure 17. Cancel reservation.

Seat Cancellation: When students cannot go to the library to confirm their seats on time, they can cancel the previous reservation in the system. The specific operation process is as follows: First, click the “Reading Room Management” option on the left side of the interface; then, enter the “Student Seat Reservation

Records” page; on this page, students can browse their existing reservation records; find the reservation record to be canceled, click on it; finally, click the “Cancel Reservation” button to complete the cancellation operation, as shown in **Figure 17** Cancel Reservation.

Click “Confirm” to successfully cancel the reservation, as shown in **Figure 18** Successful Cancellation of Reservation.



**Figure 18.** Successful cancellation of reservation.

## 6. Conclusions and Outlook

The library seat management system is a key tool for enhancing the efficiency of library services. This system provides functions for seat inquiry, reservation, and cancellation, which help improve seat utilization, reduce seat occupation issues, and create a fairer and more orderly learning environment for readers. Administrators can manage users, study rooms, and classes, as well as handle points management. The system is easy to operate and user-friendly, allowing readers to easily reserve seats and enjoy convenient services.

With the continuous development of IoT technology and smart devices, the library seat management system will advance to a higher level of intelligence and automation in the near future, achieving more convenient management. By incorporating more IoT technologies, the system can achieve comprehensive monitoring and management of library spaces, resources, and equipment. Utilizing big data and artificial intelligence technologies, the system will have the capability to deeply analyze and predict reader behavior, thereby providing readers with a more personalized service experience.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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