



Construction and Implementation of Laboratory Course Scheduling System for Modular Teaching

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Abstract. As an essential place for teaching practice and scientific research in universities, how to reasonably allocate the resources of laboratories is a problem that every university needs to consider. The characteristic of modular teaching that emphasizes the combination of theory and practice has improved the utilization rate of the laboratory, but it also brings challenges to the scheduling and management of laboratory courses. Taking the School of Art and Design at Wenzhou University of Technology as an example, in response to the problems of complexity and low efficiency exposed by the traditional scheduling model under modular teaching, the entire process from scheduling to laboratory usage management was designed from multiple aspects such as architecture, functionality, and constraints, and a laboratory scheduling system was developed. During the trial run, the system achieved good results in shortening the course scheduling cycle, optimizing constraint processing, facilitating laboratory management, and improving teaching quality, promoting the informationization construction of the laboratory.

Keywords: course scheduling system; modularized teaching; Laboratory Management

1 Introduction

With the popularization of information technology and the continuous development of higher education, the management method of using computer technology to complete course scheduling has been widely introduced into the allocation of teaching resources, becoming an important content of laboratory management and a good way to arrange teaching resources reasonably [1-2]. At present, most universities have been able to use the educational administration system to complete course scheduling [3-4]. However, in practice, different from the public courses arranged by universities, some secondary colleges will adopt a modular teaching mode for professional courses in consideration of the connection between theoretical teaching and practical teaching. The concrete form is that the teaching of each course is concentrated in a few weeks during the semester, so students usually only take one or two professional courses per week, until the previous course is completed before starting the next one. Under this teaching mode, most courses are conducted entirely in the laboratory, which closely

integrates theoretical teaching with practical teaching. Students' ability to apply theoretical knowledge and methods to solve practical problems and practical skills will also be greatly improved [5-6]. But this mode makes the conventional academic management system and scheduling mode no longer applicable[7-9], bringing greater challenges to the traditional scheduling and management methods of the laboratory. The weekly courses are no longer fixed, and academic staff need to determine the order and related factors of courses based on the entire semester. The same courses may be held in multiple classes simultaneously, leading to a significant increase in laboratory occupancy and teacher hours during certain periods, making scheduling more difficult. Therefore, this article focuses on the problems discovered in work, combined with one's own profession, and takes the teaching mode of our secondary college as an example to conduct research and exploration on the laboratory scheduling system.

2 Current Situation of Course Scheduling

Because modular teaching has the characteristics of phased concentration, the functions provided by the educational administration system of our university cannot meet the actual needs of our secondary college. Therefore, our laboratory scheduling is still in the manual operation stage, and the main process is shown in Figure 1.

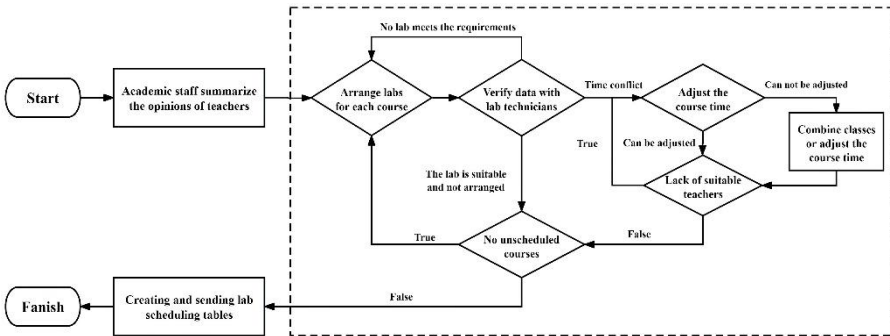


Fig. 1. Manual scheduling process

It can be seen from the flow chart that this course scheduling mode is cumbersome and inefficient, which mainly includes the following aspects.

1) The inconvenience of information acquisition affects the efficiency of course scheduling. Our college has built a large number of laboratories with diverse types, which are distributed across two campuses. However, there is a lack of a platform for sharing laboratory information, resulting in the specific information of each laboratory only being held by the relevant laboratory technicians. At the same time, various other information required for scheduling is scattered in different tables or systems, resulting in additional repetitive search work.

2) The inconvenience of laboratory information query affects the management of laboratory. Similarly, the acquisition of laboratory usage information by laboratory

technicians still stays in the traditional mode: According to the class schedule arrangement and the teacher's class adjustment, the academic staff will sort out the weekly laboratory usage table and send it to the laboratory technicians in different campuses. The academic staff will compile a weekly laboratory usage chart based on the schedule arrangement and teacher scheduling, and send it to the laboratory technicians in different campuses. The laboratory technicians will then open the laboratory and prepare materials according to the table. During the above process, the lack of timely synchronization of laboratory usage information often leads to inconvenience for teachers to adjust classes, daily borrowing of laboratories by teachers and students, and daily maintenance of laboratory technicians.

3) There are many limiting factors in modular teaching, which leads to more conflicts in course arrangement. In the process of scheduling classes, academic staff not only need to know the course and laboratory information, but also need to fully consider many factors such as teachers, classes, majors, time, and even the campus. They constantly adjust factors such as whether the courses are compatible, the teachers, the number of consecutive classes, and the location of classes to avoid conflicts from multiple aspects. The shortage of these resources often causes contradictions in the manual course scheduling process, but it is difficult to be immediately noticed, resulting in that the arrangement has been roughly completed when it is discovered, and it needs to be solved through large-scale adjustment, which is time-consuming and laborious.

4) Data statistics rely on manual labor, resulting in repetitive work. Due to the lack of information system support, when it comes to teaching and management processes involving data statistics such as class hours and laboratory usage, the staff can only calculate based on the final formed schedule. The entire process relies entirely on manual statistics, exposing issues such as slow statistical speed and inaccurate statistics.

3 System Planning

The goal of this project is to take our college as the specific implementation object, design based on the current situation of course scheduling and teaching characteristics of our college, provide users with a visual operation interface, display data, optimize the course scheduling process and laboratory management process, break away from the dilemma of traditional manual scheduling, reasonably meet the work needs of academic and laboratory staff, improve management efficiency and external service level, and ensure the completeness and accuracy of data.

3.1 Architecture Design

This project adopts the B/S structure (Browser/Server) to develop a course scheduling system. The back end mainly completes the logic and data processing parts, analyzes and processes scheduling conflicts, and combines MySQL to complete data reading and writing work. At the same time, the interface design is based on RESTful API

design theory. This kind of interface has a unified design style, and the interface designer and the interface caller follow the same principle, which makes the whole project development standardized and easy to coordinate [10]. And use JSON (JavaScript Object Notation) as the standard format for interface data transmission, which is more unified and friendly for front-end data parsing, and the data transmission efficiency is better than other transmission formats. The front-end mainly provides an operation interface and displays relevant data. This project uses the Vue.js framework for front-end development, which has the advantages of lightweight, component-based development, rich third-party UI (User Interface) libraries, and fast running speed, which is conducive to saving development time and meets the requirements of this project.

3.2 Module Design

As shown in Figure 2, according to functional requirements and transaction division, the system is mainly divided into two parts: teaching information module and laboratory information module. The teaching module mainly includes the information of classes, teachers, teaching tasks and the corresponding management. The basic data comes from the teaching management department and is managed by academic staff. The laboratory module mainly includes laboratory information and corresponding management. The basic data comes from the laboratory management department and is managed by the laboratory technicians. The course scheduling function is provided by two modules, which provide initial data for laboratory use arrangement after completion. Through the division of modules, the work responsibilities of each department can be clarified, and all relevant information is easy to obtain and unify.

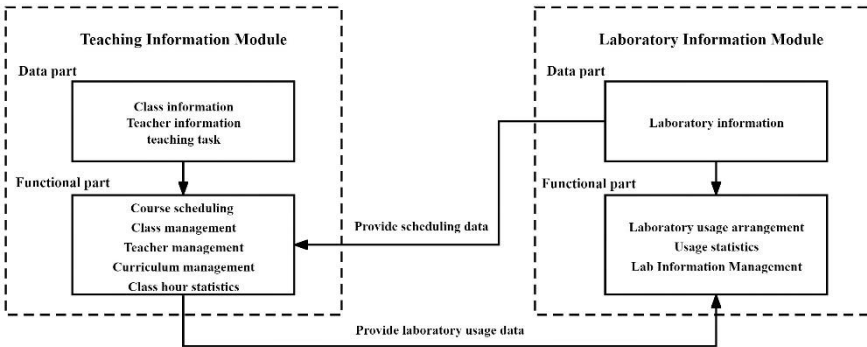


Fig. 2. Modular structure

3.3 Constraint Design

In mathematical problems, scheduling is often understood as an optimization problem with multiple constraints and objectives to seek relative optimal solutions [11]. The constraints involved in this project can be divided into hard constraints and soft

constraints. The hard constraint includes that the laboratory course arrangement of each period should meet the uniqueness; The time for each teacher to teach should be unique; Each lesson learned by students should have completeness, etc. In the system, hard constraints are directly handed over to the back end for logical processing, and the front-end only displays the eligible options, which directly avoids the conflicts caused by hard constraints. Soft constraints include not arranging teachers to teach in two campuses one after another within a day; A course can use multiple laboratories simultaneously; A course can be taught by two teachers together; Multiple classes can be combined for the same course. These constraints are displayed by the front-end in the system and selected by the academic staff to constrain.

4 Function Realization

4.1 Data presentation and management

In the system, the basic data used in course scheduling is displayed and managed to facilitate the use of relevant personnel and the dynamic synchronous update of data.

1) Experimental Course Data. The data comes from the curriculum arrangement. In order to facilitate the docking of educational administration system data, it supports batch import of additional records and single additional records through Excel files, and supports one-click clearing, single record deletion and modification.

2) Class Data. The data is sourced from the teaching management department and supports adding, modifying, deleting, and one click sorting functions.

3) Teacher Data. The data is sourced from the teaching management department. It supports the functions of adding, modifying, and deleting. Relevant personnel can learn about the basic information and contact information of the staff of the college through the teacher information page.

4) Laboratory Information. Data comes from the laboratory management department, support for adding, modifying, deleting functions. The laboratory technicians can update and record the latest situation of the laboratory in time, which is convenient for the academic staff to quickly obtain the information required for scheduling and adjusting lessons through the laboratory information interface.

4.2 Course Scheduling

After completing the basic data settings mentioned above, academic staff can schedule courses on the course scheduling interface. The basic status of this interface is to display the status of all scheduled courses for the current semester (see Figure 3). Each square block in the table represents a course, and the text information on it includes the teacher of the course, the course name, and the laboratory where the course was taught. At the same time, other information can be obtained based on the position of the square block. By clicking the "Add" button, a new interface will pop up, which will automatically load information such as classes to be scheduled, spare laboratories, courses to be scheduled, and teachers available for the corresponding time. It supports special arrangements such as joint class scheduling and two teachers

attending classes together. After selection and confirmation by academic staff, the newly added course schedule will be updated and displayed directly on the original schedule interface. The modification and deletion operations can be directly performed by clicking on the corresponding course block. The calculation of class hours no longer requires manual calculation. Users can download the corresponding Excel spreadsheet by clicking on the "Schedule Export" and "Class Hours Export" buttons.



Fig. 3. Course scheduling interface

4.3 Laboratory Management

After completing the course scheduling, you can arrange laboratory usage in the laboratory interface. The whole interface is embedded with tables to display data by week, to distinguish different campuses by color, with one-click import schedule arrangement, one-click empty, single record add and delete, query and other operations. Academic staff click the "Course Schedule Usage Import" button, and the system automatically generates corresponding laboratory usage arrangement records according to the schedule arrangement. As the semester progresses, academic staff can make quick judgments on course adjustments and suspensions based on current usage and select suitable spare laboratories at appropriate times. At the same time, academic staff can also update approved course applications in real-time and add or modify records on the laboratory user interface. The laboratory technicians conduct daily routine tasks such as opening and closing doors, organizing equipment, etc. based on usage arrangements. At the same time, they will also update information on the interface in real time according to the situation of teachers and students borrowing equipment and places, equipment maintenance and other temporary work.

5 Implementation Effect

At present, the laboratory scheduling system for modular teaching has been put into trial operation and has initially achieved the expected results.

(1) With a platform for recording and updating information, it is convenient to obtain and transmit information, making the connection between laboratory

management and academic affairs more convenient and smooth. Academic staff can obtain all the data required for scheduling in the system, eliminating the steps of "verifying data with lab technicians" and "creating and sending laboratory scheduling tables" in Figure 1.

(2) Optimized the laboratory course arrangement and management process. The system effectively avoids conflicts in the traditional scheduling process through constraint design, allowing academic staff to no longer fall into the cycle of "discovering and resolving conflicts" and smoothly complete scheduling. The scheduling system reduces the fatigue caused by repetitive work, improves work efficiency, and plays a certain role in improving laboratory management level and teaching quality.

(3) Laboratory technicians can directly update the laboratory situation and understand the laboratory schedule through the system, which facilitates the borrowing and maintenance of the laboratory. At the same time, the system stores the data during the scheduling process, which can be directly exported when teacher information, class hours, laboratory usage rate, and other data are needed, laying a solid foundation for the comprehensive informatization of the laboratory.

(4) In addition, the system is also effective in quickly dealing with teaching conflicts. For example, when the laboratory needs to be replaced temporarily, it can provide the most rapid decision-making information for the relevant personnel and reduce the risk of teaching accidents.

6 Conclusions

The laboratory scheduling system for modular teaching has reformed traditional management methods, fully utilizing modern information technology, and improved the efficiency and level of experimental teaching management. Afterwards, we will continue to optimize based on feedback from actual operations, making the use of the laboratory and course arrangements more scientific and reasonable, laying a foundation for teachers to better carry out practical teaching activities, and improving the level of academic management. It is conducive to the rational allocation of teaching resources in schools, promoting the process of teaching reform and modern management of schools, in order to achieve the goal of high-quality education. At the same time, it is hoped that the laboratory scheduling system for modular teaching can bring reference significance to schools facing similar difficulties.

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