

Research on the Dilemmas and Solutions of Course Scheduling in Secondary Colleges of Universities: A Case Study of the Faculty of Intelligent Transportation of ANHUI SANLIAN NIVERSITY

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Abstract: The Abstract: With the in-depth promotion of the connotative development of higher education and the integration of industry and education, the teaching work of new colleges represented by industrial colleges faces systemic challenges. Taking the Faculty of Intelligent Transportation of ANHUI SANLIAN NIVERSITY (hereinafter referred to as the Industrial College) as a case, this adopts the case analysis method and data statistical method to analyze the multi-dimensional dilemmas faced by the Industrial College in the work of course scheduling. The study shows that the root cause lies the combined influence of multiple factors such as conflicts in the time schedules of school and enterprise teachers, rigid resource sharing mechanisms, and outdated scheduling technologies. To this end, a three- relief path of "teacher synergy - space optimization - academic balance" is constructed to provide a reference for the teaching management of industrial colleges in application-oriented universities.

Keywords: Industrial College; Course Scheduling Management; Academic Balance; Faculty Collaboration; Teaching Resource Scheduling

1. Introduction

In recent years, with the expansion of university enrollment and the deepening of educational reforms, teaching operations have faced various issues and new challenges [1]. Teaching operations management is a vital component of university teaching administration and a key factor in ensuring the smooth conduct of teaching activities, with timetable scheduling serving as a critical link in this process. Effective course scheduling is a fundamental prerequisite for establishing a stable teaching order; it not only affects teaching effectiveness and student

learning outcomes but also directly impacts the quality of higher education, while simultaneously reflecting the overall level of a university's teaching management [2]. In particular, with the comprehensive advancement of the national strategy for industry-education integration, new types of secondary colleges, represented by industry-academic colleges, have emerged. These colleges generally adopt a teaching model characterized by "university-enterprise collaboration, project-driven learning, and the integration of theory and practice," which places higher demands on the course scheduling process. The traditional timetable-setting model, which is based on administrative classes and centered on theoretical courses, struggles to adapt to the needs of diverse faculty, flexible resources, and balanced student academic progress, with related conflicts becoming increasingly prominent. Currently, most universities in China still employ traditional timetable-setting methods. These methods may involve the use of spreadsheet software (such as Excel) or computer-assisted manual processes [3]. Existing research has largely focused on optimizing timetable-setting processes in general universities, with limited studies addressing the specific constraints of timetable-setting for industry-academic colleges.

This paper takes the Faculty of Intelligent Transportation of ANHUI SANLIAN NIVERSITY as a case study. Employing case study and statistical analysis methods, it systematically analyzes the scheduling challenges faced by industry-oriented colleges and their root causes, and constructs a three-dimensional solution framework to provide a reference for similar institutions. Established at the end of 2023 through the merger of four colleges, the college will introduce new majors such as New Energy Vehicle Engineering and Intelligent Transportation in 2025, making its scheduling conflicts particularly representative.

2. The Practical Predicament of Course Scheduling for Secondary Colleges (Industry Colleges) under the Background of Industry-Education Integration

2.1 Difficulties in Coordinating the Schedules of a Diverse Faculty

The faculty structure of the Faculty of Intelligent Transportation exhibits a typical "four-dimensional structure": industry mentors, full-time on-campus faculty, adjunct faculty, and shared general education instructors. Each category of faculty imposes unique and inflexible time constraints, creating a complex scheduling coordination dilemma. Time conflicts among industry mentors manifest as follows: according to survey data, over 70% of industry mentors, due to restrictions from their primary jobs, can only come to campus to teach during specific time slots on weekdays, resulting in a highly concentrated window of availability for scheduling. For example, in the first semester of 2025–2026, many programs will offer drone practical training courses. However, these courses are taught exclusively by two engineers from Sanlian Transportation Company, and all sessions must be held on Saturdays and Sundays. This results in 10 classes across different programs competing for the limited resources of these corporate instructors during that time slot, creating a severe shortage of available instructor time. This not only leads to an instantaneous overload of teaching resources but also makes the teaching schedule inflexible, encroaching on students' weekend rest or time for part-time jobs and other commitments. Furthermore, it creates the risk of a chain reaction of class rescheduling or cancellations triggered by corporate instructors being called back to their original workplaces for urgent tasks. Time conflicts for full-time faculty manifest in the fact that they must simultaneously handle both teaching and research responsibilities. Sometimes, to accommodate the schedules of external or industry instructors, courses are concentrated into a short period. For example, while a typical semester consists of 16 teaching weeks, the engineering competency training course is scheduled to be concentrated into two weeks—meaning the entire two-week period on the timetable is dedicated to engineering competency training, with other courses suspended. This results in an excessive teaching

workload for full-time faculty during specific periods, encroaching on essential research and lesson preparation time, with the pressure being particularly acute for new faculty members; Time conflicts with external instructors manifest as follows: Instructors from other universities or research institutions must balance their teaching schedules with their original work commitments, resulting in more limited and unpredictable availability. A typical conflict arises when an external expert, hired on short notice to replace a departing full-time faculty member, is only available to teach on Thursday afternoons—a time slot that completely conflicts with the college's laboratory availability. This creates a scheduling dilemma, and adjusting the timetable involves significant logistical challenges and is difficult to implement. Many instructors shared for general education courses are external faculty members from the departments responsible for these courses, and they face similar scheduling conflicts.

2.2 The Dilemma of Limited Resources

The establishment of Industry Colleges is an inevitable requirement of national strategy and industrial transformation in the new era [4]. Driven by policy direction and the needs of social development, the scale of university enrollment continues to expand. As shown in Table 1, the number of students in Industry Colleges has increased year by year, straining the university's already limited teaching resources during course scheduling. Among the eight undergraduate institutions in Anhui Province that have established Industry Colleges, only our university and Xinhua College are private undergraduate institutions. There are significant differences in the government funding mechanisms between public and private universities. Public universities rely primarily on government fiscal allocations, while private universities depend mainly on funding from their sponsors and tuition revenue; government funding for private institutions is largely in the form of incentive-based grants and subsidies. According to the "2023 Implementation Plan for Special Funds to Promote the Development of Private Education," institutions that apply for and successfully complete specialized classroom (training lab) construction projects in the current year will receive a subsidy covering 50% of the total construction costs (with a maximum subsidy of 500,000 yuan per institution) [5]. This

funding disparity directly results in a scarcity of resources for private Industry Colleges. Currently, our university's Industry College has only 46 multimedia classrooms available for scheduling, while the total number of laboratories and training rooms is just 44. The average weekly utilization rate of multimedia classrooms reaches 90%. The average utilization rate of laboratories exceeds 75% and is on an upward trend (Figure 1). In daily teaching arrangements, theoretical courses are mostly scheduled in multimedia classrooms; due to limited resources, the scheduling of these classrooms remains consistently saturated. However, this high frequency of instructional use not only accelerates resource wear and tear but also significantly shortens the lifespan of equipment. Various devices are prone to malfunctions or damage; the average number of weekly repairs for multimedia equipment at our university exceeds seven. Equipment failures frequently occur during class hours, making it difficult for maintenance staff to find available

time slots in the same classroom for timely repairs on the same day. In some cases, there are no other vacant classrooms available for temporary substitution, which affects teaching effectiveness and creates a vicious cycle. On the other hand, practical instruction relies heavily on specialized equipment, yet these critical teaching resources are in short supply due to high construction costs. Take the college's microcontroller and embedded systems laboratories as examples: because individual units are expensive, the college can only procure a limited number of sets, while class sizes at our university are typically capped at 60 students per class. This contradiction directly results in many majors having class sizes larger than the number of available hardware units in the laboratories, forcing teaching organizers to adopt a system of small classes and multiple sessions conducted in rotation. This further exacerbates the pressure on laboratory resources and the complexity of teaching schedules.

Table 1. The Number of Students in the Faculty of Intelligent Transportation of ANHUI SANLIAN NIVERSITY in the Past Three Years

Academic Year	2023–2024	2024-2025	2025-2026
Enrollment	4,345	4,643	4,946
Number of Administrative Classes	98	106	112

Note: Data sourced from the Class Advisor Class Management Statistics Report of the School of Faculty of Intelligent Transportation of ANHUI SANLIAN NIVERSITY (2023–2026)

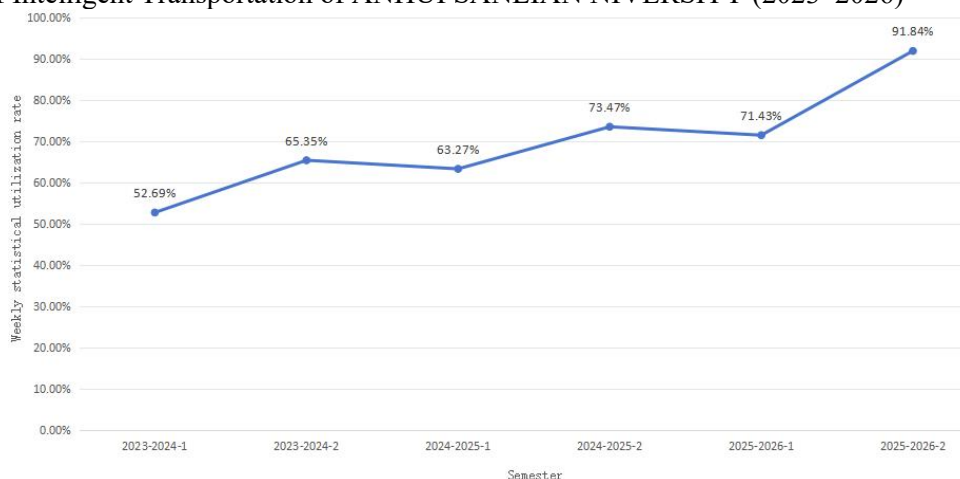


Figure 1. The Weekly Usage Rate of Classrooms in the Faculty of Intelligent Transportation of ANHUI SANLIAN NIVERSITY over the Past Three Years

Note: The data is sourced from the Qingguo Educational Administration System of ANHUI SANLIAN NIVERSITY. The classroom utilization rate = the total number of classrooms used in each period (including class schedule arrangement, examination arrangement, and temporary activities)/ the number of classrooms

2.3 High Academic Pressure on Students

Corporate mentors typically concentrate their teaching sessions into specific time blocks, often choosing a full weekday or the weekend for the convenience of commuting. This highly concentrated teaching schedule forces students to absorb a large amount of specialized

knowledge in a short period, leading to learning fatigue, significantly reduced learning effectiveness, and even a reluctance to study. Courses such as engineering training, which are concentrated over a two-week period, cause other courses to remain dormant for extended periods. This uneven distribution of weekly schedules results in insufficient continuity of knowledge and disrupts students' continuous learning rhythm. Additionally, after intensive instruction, students must complete corresponding assignments, practical training tasks, and course assessments within a short timeframe. This reduces the time allocated to other courses, hindering the development of knowledge systems in those subjects. Due to constraints on corporate instructors' availability and the limited number of training facilities, students' schedules are often forced into an irrational distribution during the scheduling process, which leads to poor learning outcomes. Corporate instructors typically employ a project-driven teaching approach. Some students may initially struggle to adapt to this model, leading to high academic stress, difficulty keeping pace with the instructor's pace, and even complete disengagement from the project by its conclusion—ultimately undermining the overall effectiveness of industry-education integration. Timetable design must fully account for students' learning patterns; traditional scheduling methods are entirely inadequate for addressing the complexity of timetable planning required by industry-education integration programs.

3. Causes of the Challenges

3.1 Institutional Lack of Deep Industry-Academia Collaboration Mechanisms

In school-enterprise cooperation, the initiative of enterprises to participate is influenced by many factors. Essentially, the goal of business operation is to pursue economic benefits. If a certain investment fails to produce immediate results, it is inevitable that the willingness and intensity of the investment will be greatly reduced [6]. At present, many school-enterprise collaborations remain at the surface level of agreements. The teaching tasks of enterprise mentors are often the work arrangements of the enterprises rather than institutionalized teaching responsibilities, and the teaching time of enterprise mentors is difficult to be integrated into the teaching cycle of the schools. The

number of instructors arranged by enterprises is often limited, which increases the difficulty of course scheduling. There is a lack of institutionalized arrangements for school-enterprise collaboration. The teaching of enterprise mentors is mostly arranged temporarily, which increases the communication time cost of the teaching secretary, leads to the extension of the course scheduling time of the college, and further affects the course scheduling progress of the entire school.

3.2 In terms of Resources, Information Haring is Fragmented

The "Three Schools and Three Departments" management model has led to a persistent "departmental ownership" mindset regarding teaching resources, particularly high-end practical training equipment. Some hardware equipment required for teaching can also be utilized in laboratories within other departments. However, when scheduling classes, academic secretaries lack visibility into the university's overall teaching resources and focus solely on their own college's teaching space resources, making it difficult to achieve efficient integration of university-wide resources. There is a lack of a university-wide, transparent resource-sharing platform and a dynamic scheduling mechanism. This results in a situation where the schedules of certain laboratories are fully booked, while those of other similar laboratories remain sparse.

3.3 Technically, the Intelligence Level of the Course Scheduling System is Insufficient

The level of information technology infrastructure in academic administration is a key technical factor constraining improvements in management efficiency [7]. Timetabling is one of the most challenging tasks for academic affairs staff in the Academic Affairs Office and individual colleges throughout the semester [8]. The university's current Qingguo Academic Affairs Management System was purchased and has been in use since 2005. While the system can handle basic timetable scheduling tasks, it is unable to effectively manage the unique and complex constraints of the School of Industry. The system's level of intelligence is low, resulting in a high reliance on manual scheduling, which is inefficient and lacks intelligent conflict detection. Verification of timetables often relies on manual, inefficient checks. Given the large

number of administrative classes in the School of Industry, manual verification may also lead to oversights.

3.4 Weakening of the Student-Centered Philosophy

In actual course scheduling, academic secretaries often prioritize constraints related to faculty availability and objective limitations on teaching resources. Timetable scheduling is typically completed before the end of the semester, and at times, they are forced to rush to meet predetermined deadlines. Factors such as the balance of students' academic workload and their individual growth needs are relegated to a secondary position. By the time the semester begins, it becomes difficult for academic secretaries to adjust the schedule once they discover imbalances in the weekly timetable during the verification process.

4. Solution: Establishing a Three-Dimensional Collaborative Governance System for "Faculty-Space-Academics"

4.1 Faculty Time Dimension: Establishing a Four-Dimensional Flexible Faculty Scheduling Mechanism

To address the time conflict issue of enterprise mentors, the centralized teaching mode can be changed, and a hybrid teaching model of "online recording and broadcasting + offline Q&A" can be adopted. The college signs a school-enterprise cooperation agreement with the enterprise, and the calculation method of class remuneration for all teaching activities is stipulated in the agreement to ensure the stability of teaching. For courses that can use virtual simulation teaching software, the first class is taught offline by the instructor. The instructor mainly explains the learning requirements, completion goals, and final course assessment of the course to the students, and designates the mid-term learning progress and the end time of the online course. In the middle of the course, enterprise mentors give offline lessons in designated classrooms, allowing students to report on their previous learning progress and keep track of their learning situations. For courses that require practical operation, such as drone training courses, a hybrid teaching model of "online recording and broadcasting + offline practical operation" can be adopted. All theoretical and practical knowledge about drones will be explained online,

while offline, each student will be guided to practice for half a day according to their major. During the online learning period, if students encounter any problems, they can contact their tutors online. The tutors can specify the time slots for communication every day, which will not affect the normal working hours of the company. This model can effectively alleviate the time conflicts among teachers on campus. As for the issue of time conflicts among external teachers, it is necessary to establish a database of external teachers. The college should appoint a dedicated person to maintain the information of external teachers, especially the information on which courses each external teacher can teach and the records of the teaching time available to external teachers each semester. It can deal with the sudden departure of external teachers or the suspension of classes due to unexpected situations, and quickly find replacement teachers from the teacher database to take over the teaching without affecting students' learning progress.

4.2 Spatial Optimization Dimension: Establish a School-Wide Shared Resource Pool

To break the privatization of college resources, the school should establish a school-level platform for sharing practical training resources. Teaching secretaries can log in to the platform to clearly access information such as which practical teaching methods are available for each laboratory or practical training site, the number of students it can accommodate, and the available time periods. Secondary colleges have the priority to use the resources of their own departments and to arrange courses for them. Other departments need to apply to the resource provider for use. Only after obtaining the consent of the resource owner can they use it. The equipment is maintained by the unit to which the resource belongs. At the end of the year, the school will increase the financial subsidies for the providers of experimental and practical training site resources. In practice, a hybrid training mode of "virtual simulation + physical operation" can also be explored. For experimental and practical training courses that rely on scarce equipment, develop high-quality virtual simulation teaching modules. For laboratories with similar functions and low utilization rates, they can be merged or renovated to enhance the efficiency of resource

utilization [9]. The offline practical operation part can be taught in segments, which can effectively relieve the pressure on equipment and optimize students' learning time and space.

4.3 Academic Balance Dimension: Set up an Academic Load Early Warning Module

The school has introduced a new intelligent course scheduling system and added an academic load early warning module. It is necessary to transform the concept of "student-centeredness" into the rule constraints of course scheduling in the educational administration system. In the process of arranging the class schedule, both the teaching progress and the scientificity and rationality of the learning time should be taken into account to achieve an effective unity of teaching progress and learning quality [10]. The daily class hours should not exceed six. Theoretical classes should avoid being arranged in four consecutive periods. Due to the internship work arrangement, graduating classes will be given priority for course completion. Physical education classes should be arranged in periods 3 to 4 or 7 to 8 as much as possible. Online self-study courses should be arranged in 1-2 or 5-6 periods as much as possible. Online courses should not be adjacent to offline courses to avoid students' tight commuting time. Try to have as few classes as possible on weekends. Many students go out to do part-time jobs on weekends, etc. Schools should conduct centralized training for users of different module systems to master the functions and usage of the new system proficiently. During the course scheduling process, the teaching secretary can monitor the daily and weekly class schedules of the class in real time through the intelligent course scheduling system to predict the load curve, and assist in course scheduling for load warnings. In addition, the teaching secretary can advance the course scheduling for each semester, collecting in advance the time requirements of enterprise mentors and external teachers as well as the special needs of each class. For instance, when some majors start school-enterprise cooperation classes, it is necessary to specify a fixed weekly class meeting time. During the course scheduling process, special needs can be dealt with in advance instead of adjusting the class schedule through the procedures of class adjustment and cancellation after the class schedule is released before the start of the school term. It is not

conducive to the stability of students' learning pace and also increases the additional workload of educational administration. Only by arranging the class schedule from the perspective of students can their learning enthusiasm and efficiency be stimulated. Only by meeting the students' class scheduling requirements can better teaching effects be achieved [11].

5. Summarize

This article takes the Faculty of Intelligent Transportation of ANHUI SANLIAN UNIVERSITY as a case to explore the course scheduling predicament of secondary colleges and the solutions under the background of industry-education integration. Research shows that the difficulty in course scheduling in industrial colleges is mainly manifested in time conflicts among teachers, insufficient resource supply, and unbalanced academic arrangements. The root causes lie in the lack of a school-enterprise collaboration mechanism, information short-circuiting in resource sharing, lagging course scheduling technology, and the weakening of the student-centered concept. The significant gap in financial input between public and private colleges and universities has further exacerbated the resource shortage problem of private industrial colleges. To this end, this paper proposes a three-dimensional path of faculty collaboration, spatial optimization, and academic balance, which can provide a reference for similar universities to optimize course scheduling management and ensure the quality of industry-education integration teaching. Future research can further expand the sample scope, compare the course scheduling management models of different regions and types of industrial colleges, and explore the application effect of intelligent course scheduling algorithms based on artificial intelligence in the scenarios of industrial colleges.

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