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Modular Teaching Design and Implementation of "Rail Transit Operation Organization" Course under the Integration of Post Course Competition and Certificate

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Abstract

Based on the construction of the "Rail Transit Operation Organization" course, the course content is reconstructed by integrating the job operation standards of urban rail transit operation duty officers and dispatchers, combining the 1 + X vocational skill level (intermediate) certificate standards of urban rail transit station management, and incorporating the technical regulations of vocational skill competitions, such as urban rail intelligent transportation. Taking the "Telephone Block Method for Receiving and Sending Trains" project as an example, this article introduces the implementation of modular teaching in this project, providing reference for modular teaching in other courses.

Keywords

On-The-Job Course Competition Certificate, Modular Teaching, Train Organization, Telephone Blocking Method

1. Introduction

On April 13, 2021, Vice Premier of the State Council Sun Chunlan proposed at the National Vocational Education Conference: "accelerate the construction of a modern vocational education system, integrate the design of vocational education systems for secondary, higher vocational, and undergraduate education, deepen the reform of 'three educations', comprehensively educate students through 'job courses, competitions, and certificates', and improve the quality of education". This is the first time that the concept of "job course competition certificate" has received policy recommendation and high recognition at the national level. The integration of job, course, competition, and certification focuses on "job" as the

basis and clarifies the course positioning; reconstructs the course according to the content, and enriches the course forms based on skills competitions; deepens course evaluation based on "Vocational Skills Certificate" (Zhang, 2023). We should take the "job" standards of the industry as the starting point, focus on the integration of industry and education, and cultivate high-quality technical and skilled talents (Cao, 2022). The course of "Rail Transit Operation Organization" is aligned with the professional standards and work processes of rail transit operation duty officers and dispatchers. Through the reform of the "curriculum", it promotes the "classroom" revolution, combines the skills competition of urban rail transit operation majors, such as train duty officers, attendants, and urban rail intelligent transportation, and develops and integrates multiple types of vocational skill level certificates, such as the 1 + X certificate for urban rail transit station attendants. It promotes the comprehensive education of "job curriculum competition certificate", cultivates high skilled talents in rail transit, adds value to the industry, and empowers schools, teachers, and students.

2. Overall Design of Modular Teaching

Modular teaching refers to a teaching model that divides teaching content into different modules according to specific knowledge or ability requirements for teaching. Rail transit operation organization is a core course of urban rail transit operation and management major, offered in the fourth semester with a total of 64 class hours. The main content includes the foundation of train operation organization, train signal system, train scheduling work, station train operation organization, train operation organization in case of equipment failure, train operation organization under abnormal conditions, vehicle base operation organization, construction organization, etc. The aim is to cultivate students' technical skills in preparing train operation diagrams, using train automatic control systems, organizing station receiving and dispatching train operations, responding to train operation organization in case of equipment failure and abnormal conditions, vehicle base and construction operation organization, etc.

After more than 20 years of construction and exploration, this course is based on the national professional standards for urban rail transit operation and management (2022), the school's professional talent training plan, and is aligned with the vocational skill standards for urban rail transit station attendants and train duty officers. Combined with the technical regulations of the National Vocational College Skills Competition for Urban Rail Intelligent Transportation, it integrates the 1 + X vocational skill level (intermediate) certificate standard for urban rail transit station attendants, new technologies such as integrated operation of the four networks of rail transit and fully automatic operation of rail transit, as well as new standards such as the "Smart Urban Rail Transit Development Outline" and "Technical Specification for Train Automatic Operation System (TACS)". According to the job scenarios, the course content is reconstructed into three modules and nine projects with progressive ability requirements, as shown in **Figure 1** below.

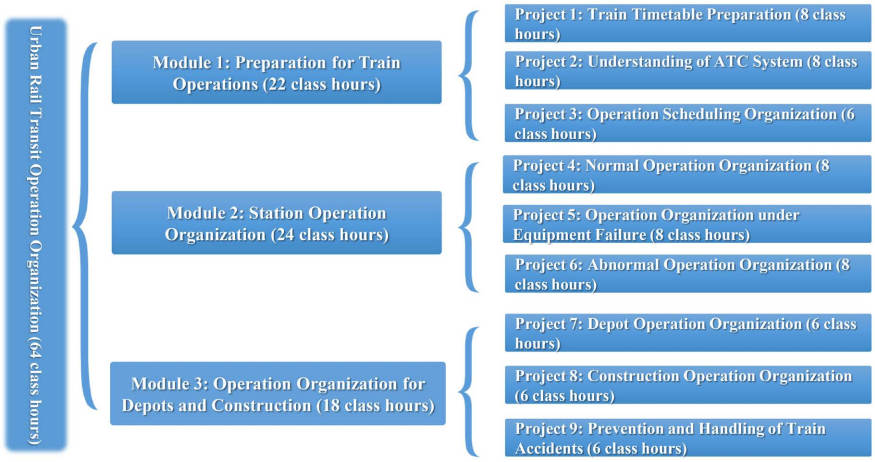

Figure 1. Modular course content reconstruction of rail transit operation organization.

3. Building a Modular Course Team

The implementation of modular courses requires a course team capable of teaching modular course content. As a core course in urban rail transit operation and management, rail transit operation organization aligns with the operational standards of important train operation positions such as urban rail transit duty officers and dispatchers, and incorporates the core competition content of the National Vocational College Skills Competition for Urban Rail Intelligent Transportation and the vocational skill level standards for urban rail transit attendants. The course content is important and difficult, and it is crucial to form a modular course team capable of teaching the course in order to ensure students' learning effectiveness. The course is taught by three different teachers according to three major content modules. The course team teachers need to be composed of teachers with industry and enterprise working backgrounds, who are proficient in different fields. They should learn from each other's strengths, prepare lessons collectively, analyze learning situations, determine teaching goals, key and difficult points, select appropriate teaching methods, develop course resources, and design course evaluation methods, in order to maximize teaching effectiveness

The modular teaching team for this course consists of three teachers, namely senior engineers with rich experience in the rail transit industry, teachers with rich frontline teaching experience who have won the first prize in the National Teacher Teaching Ability Competition, and teachers with rich experience in guiding skills competitions and teaching. Such a team divides work and cooperates to determine teaching modules according to their respective strengths, ensuring the implementation of modular courses and improving students' learning outcomes.

4. Implementation of Modular Courses

Taking the example of train operation organization under equipment failure in Module 2 Project 5, introduce the modular teaching implementation process of this project. Based on the characteristics of "multiple operation steps and complex

practical training process" in the course content of this module, an innovative modular teaching mode of "theory + assessment + practice + assessment + application" is adopted (Sun et al., 2024), which first divides the project content into small modules, and then completes the learning and assessment of theoretical content according to the method of theory first and practice later, and then implements modular teaching through the practice and assessment of practical training tasks.

4.1. Content Analysis

Under normal circumstances, the operation of urban rail transit trains is automatically managed and monitored by the automatic train monitoring system ATS. However, when the equipment fails and cannot be restored normally for a short period of time, the train dispatcher will issue a "downgraded train operation" dispatch command, which uses telephone block method to organize train operation. As a backup blocking method, although the telephone blocking method may reduce the efficiency of the entire rail transit network, it is the last backup blocking method that can be used in the event of equipment failure. Therefore, the "telephone blocking method" is the core content of Project Five and a skill that urban rail operation students must master. It is also an important part of daily drills and skill competitions conducted by various urban subway companies.

4.2. Analysis of Learning Situation

The course of "Rail Transit Operation Organization" is set in the fourth semester, and students have already studied professional courses such as "Application of Rail Transit Transportation Equipment" and "Rail Transit Lines and Stations" in the early stage. They are familiar with the application of station interlocking equipment and train block method, and have heard of "Telephone Block Method"; At the same time, students are very interested in practical course content, especially in using a combination of virtual and real training equipment to recreate real production scenes in enterprises, allowing students to immerse themselves in the learning and practice of typical production training projects, which can greatly improve students' learning effectiveness; For students with different learning backgrounds (unified enrollment students, vocational college students, and transfer students), a hierarchical PBL practical training teaching method is adopted, with students as the main body to carry out project-based learning. Students discover and solve problems in practice (Wu et al., 2023).

4.3. Implementation of Modular Teaching

4.3.1. Case Import

Based on the application scenario and implementation process of the "telephone blocking method", a case study was used as the task introduction: "On X month X day of X year, the operation was organized according to the X train schedule. At X hour X, the interlocking area equipment of a certain station displayed gray,

and both the center and the station could not monitor the train, which could not be restored in a short period of time. The dispatcher ordered the use of telephone blocking method to organize train operation between station A and station C." This case aims to raise students' awareness of the equipment failure in the interlocking area and the huge impact it has on the normal operation of rail transit, and to cultivate their professional qualities of safety production and standard operation.

4.3.2. Project Implementation

The operation process of telephone blocking method is divided into four stages: "confirming faults, manually preparing routes, receiving and dispatching trains using telephone blocking method, and fault recovery". With the help of the "Urban Rail Intelligent Transportation" competition virtual simulation training equipment, each stage is set as a separate training task, and students practice in pairs (Li & Li, 2024).

1) Phase 1: Confirm the fault

The main task of this stage is to confirm the fault situation and issue dispatch commands for organizing train operations using telephone block method. The specific content includes confirming the fault with the station and arranging for the station to prepare for manual handling of the route, verifying the train position with the train driver of the entire line, verifying the train position with the station, and issuing dispatch commands using telephone block method to organize train operation. The specific training tasks that need to be completed are shown in the following **Figure 2**. Equipment required for homework: train operation diagram, station track board, dispatch telephone, etc.

2) Phase 2: Manual preparation of route

When the station interlocking equipment fails, it may cause the turnouts in the area to fail to automatically switch to the required position for the route. Therefore, station staff need to go down the line to check the turnouts and manually move them to the required position, that is

Manually prepare the route. This section is not only the core content of the "Telephone Block Method Train Receiving and Dispatch Project", but also the core content of the urban rail transit duty officer vocational skills competition, urban rail intelligent transportation competition, and urban rail transit station 1 + X certificate certification. It is a core skill that must be possessed by the urban rail transit attendant profession.

When implementing this task, students need to perform five homework tasks: receiving homework commands, preparing homework tools, checking hand cranked switches, second-hand shaking, and three confirmations. The specific standard operating procedures that need to be completed are shown in the following **Figure 3**. Equipment required for homework: Hand cranked switch tool kit, physical switch.

3) Phase 3: Under the telephone block method, the station connects and sends out the first train operation

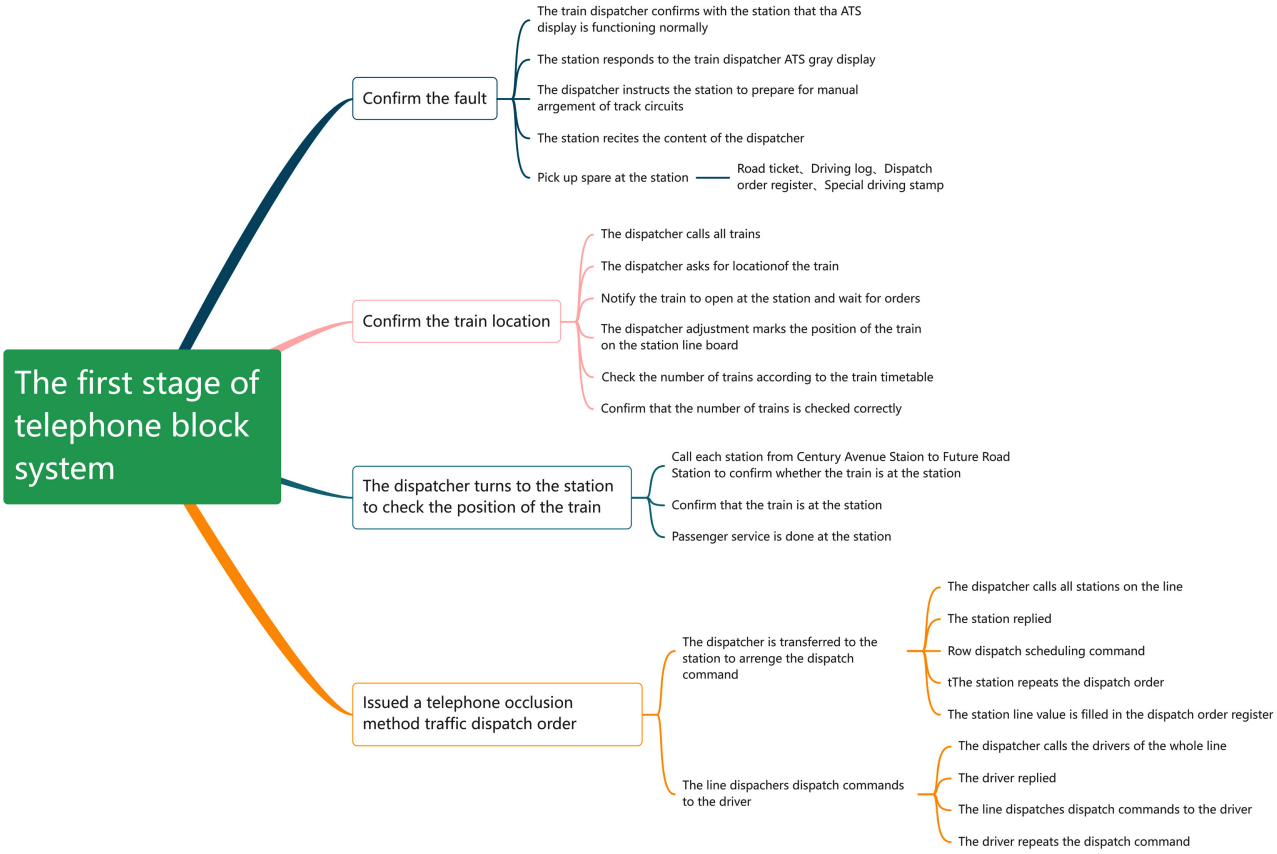

Figure 2. Telephone block method Phase 1—fault confirmation.

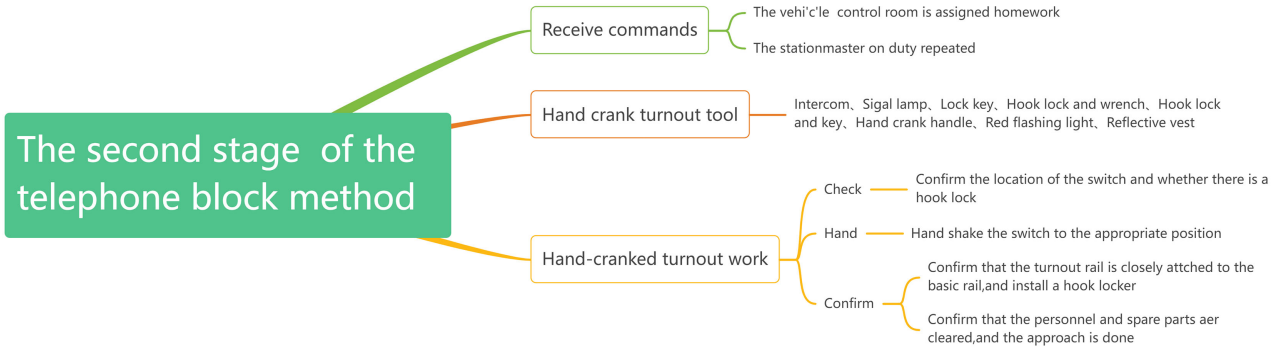

Figure 3. Telephone block method second Stage—manual preparation of route.

After the completion of the first two stages of homework, it indicates that all preparations for the telephone blocking method have been completed, and the third stage officially adopts the telephone blocking method for receiving and dispatching trains. The content of this stage is the core content of the telephone blocking method. The operation process is complex, and students often miss some steps when learning. Therefore, in the teaching implementation process of this module, more attention will be paid to the summary of the operation process. At the same time, the content of this module involves filling in road tickets, train logs and other standing books, with a wide range of contents. Next, we will learn the

key skills first, and then follow the station as an intermediate station, to first receive train 012, and then send train 012 to learn the operation process of the telephone blocking method (Table 1).

Table 1. Skill requirements for the third stage of telephone block method.

Order	Skill point name	Specific skill content
First	Fill in the route ticket	The train duty officer at the departure station needs to fill in a route ticket and hand it over to the driver as a driving voucher. The contents of the route ticket include the direction of train operation, telephone record number, train number, operating section, speed limit of the first train, name and date of the station train duty officer, and stamped with the special seal for train operation.
Second	Fill in the driving log	he station duty officer is required to fill out the train log, which includes the train number, telephone record number, time of agreeing to block the adjacent station, time of departure from the adjacent station, and time of arrival at the current station when receiving the train; The contents of the train log during departure include: train number, telephone record number, time of agreeing to block at this station, time of departure at this station, and time of clearing at neighboring stations.
Third	Fill in the station line board	The station track board is a tool used by the telephone block method to mark the position, block status, train position, and other information of switches on the line during train operation. In the section, "–", "+", and "⊕" are used to represent the section request block status, agreement block status, and train occupation section status, respectively.
Fourth	Report time	When using the telephone block method to organize train operation, this station needs to report the departure time of the train from this station to the previous station (departure station), the next station (receiving station), and the train dispatcher: "XX time XX point XX minute XX second XX station clearance".
Fifth	Display the departure signal	The station attendant displays the departure hand signal to the driver: use the green light to curve upwards and make a circular turn towards the direction of the train.

The specific standard operating procedures for receiving and departing vehicles are as follows Figure 4.

4) Phase Four: Fault Recovery

The investigation team will continue to track the situation of fault handling. After receiving the report from the on-site signal repair personnel that the equipment has been restored to normal, the maintenance team will inform the on duty director and the investigation team that the interlocking area equipment at the library station has been restored to normal. The duty director has decided to resume normal driving. The content of this stage is relatively simple. The specific content is to issue a dispatch command to cancel the telephone block method for

organizing train operations to all stations and drivers along the line. The stations and drivers need to repeat the command and fill out the dispatch command registration book (Figure 5).

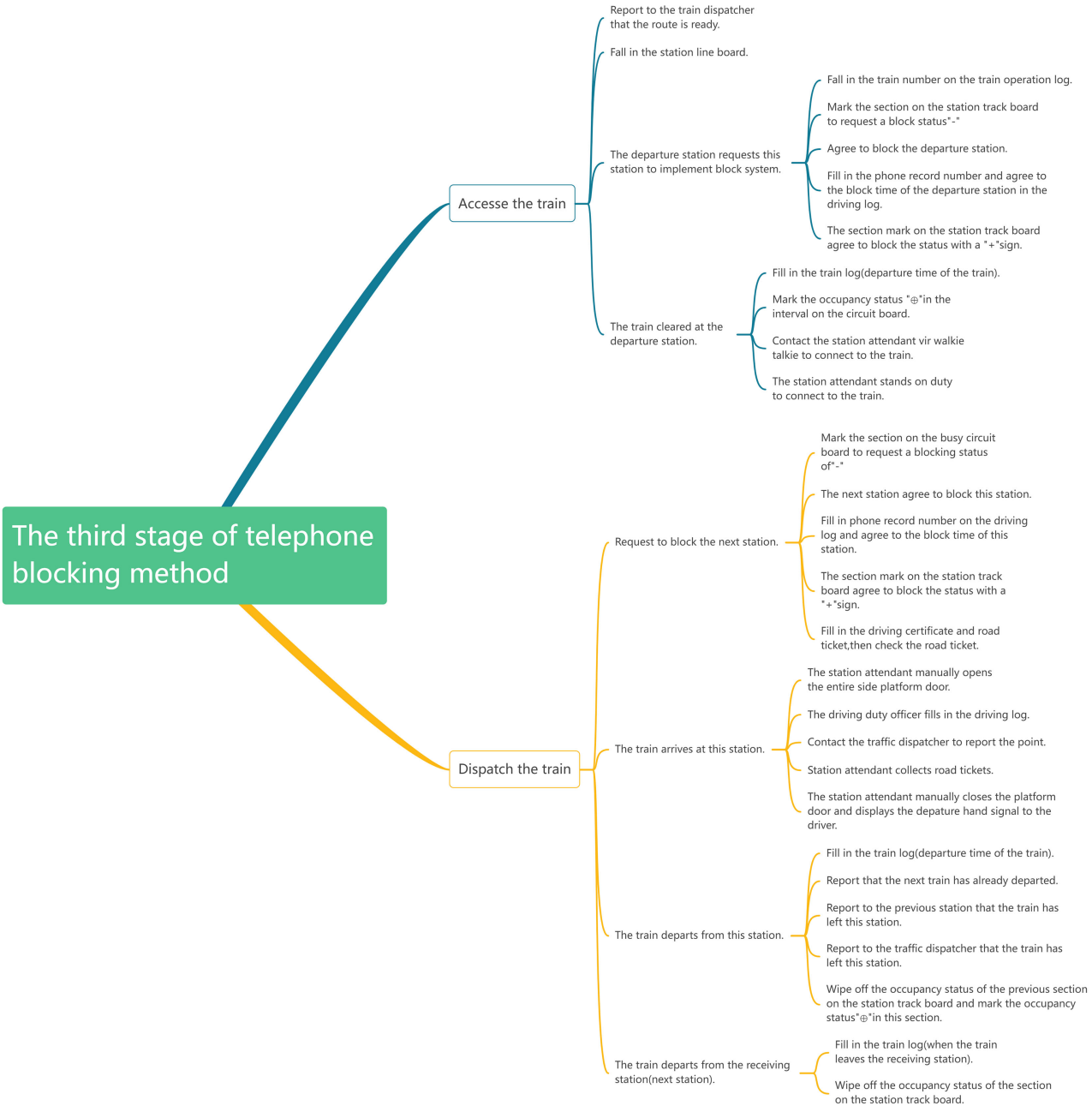

Figure 4. Telephone block method Phase III—receiving and sending trains.

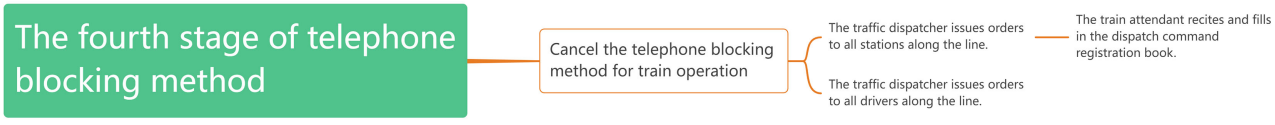

Figure 5. Telephone block method Stage 4—fault recovery.

4.4. Student Learning Effectiveness

Implementing the concept of "student-centered" and setting different learning goals for different teaching objects, the teacher team monitors student dynamics 24/7 through mobile terminals, quantitatively monitors student learning situations, and responds to students' difficult questions with a 100% response rate. The enthusiasm for student participation continues to increase, with an average grade steadily improving by about 5% year by year, and a 100% pass rate for student courses. Through the study of this course, the pass rate of relevant modules in the 1 + X exam for current students has reached 85%. Class students have won 1 first prize and 2 second prizes in the China Skills Competition for Urban Rail Transit Train Duty Attendants/Waiters and Urban Rail Transit Train Dispatchers, as well as 4 provincial professional skills competition awards. The integration of job, course, competition, and certification has improved students' learning outcomes.

5. Summary

The integration of vocational courses, competitions, and certificates is an important way for the reform of core courses in vocational colleges. Course teams should pay attention to the organic integration of course content with job assignment standards, vocational skill level certificate standards, and skill competition standards, timely introduce new technologies and norms in the industry, update teaching resources, flexibly apply action oriented teaching, project-based teaching, situational teaching and other teaching methods, reconstruct teaching processes, carry out modular teaching with division of labor and cooperation, improve course teaching effectiveness, and enhance the quality of talent cultivation. This paper takes the core course of urban rail transit operation and management "rail transit operation organization" as an example, and reconstructs the modular teaching content according to the requirements of the integration of post course competition certificates, which effectively improves the learning effect of students and has good reference significance for the implementation of modular teaching in other majors in higher vocational colleges.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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