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Cultivation Strategies and Methods for Interdisciplinary Innovative Talents in Rail Transit

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Abstract: With the rapid development of the rail transit industry, the demand for innovative talents with interdisciplinary capabilities is becoming increasingly urgent. This paper explores the strategies for cultivating interdisciplinary innovative talents in rail transit majors. By analyzing the challenges and opportunities within the current educational system, it proposes strategies to optimize the curriculum, strengthen practical teaching, and deepen industry collaboration. Case studies are used to demonstrate the effectiveness of these strategies. The research shows that a systematic curriculum design, practice-oriented teaching methods, and effective university-industry cooperation are key to achieving interdisciplinary talent cultivation in rail transit. This study provides theoretical support and practical guidance for rail transit education reform and talent development.

Keywords: rail transit, interdisciplinary innovative talents, cultivation strategies, cultivation methods

Introduction

In the context of the new industrial revolution and the accelerated process of globalization, society has raised new demands for the knowledge system of engineering disciplines. As an intelligent product that integrates mechanical, information, control, and electrical engineering, the talent cultivation model for rail transit urgently needs transformation and upgrading (Wen, Du, and Cui, 2021) . This paper, guided by the strategy of building a strong transportation nation, combines domestic and international experiences in interdisciplinary talent development. It focuses on the cultivation needs of interdisciplinary innovative talents in rail transit and proposes strategies to optimize the curriculum, strengthen practical teaching, and promote the integration of industry and education. The paper also provides specific details on how to implement these strategies, aiming to enhance students' abilities in integrating knowledge across different disciplines, applying innovation, and solving complex problems.

1 Analysis of the Demand for Interdisciplinary Innovative Talents in Rail Transit

Interdisciplinary innovative talents are professionals who can apply knowledge from multiple disciplines to innovate and solve problems in complex environments (Gao et al., 2018). In the rail transit field, these talents not only need to master professional knowledge in rail transit engineering, mechanical-electrical engineering, and signal control, but also require a foundational understanding of data analysis, computer science, and communication networks. Their core competency lies in integrating knowledge across different disciplines to drive the optimization, intelligence, and sustainable development of transportation systems (Li et al., 2020; Wu et al., 2020).

The construction and operation of rail transit systems involve multiple interdisciplinary intersections, making the demand for interdisciplinary innovative talents particularly urgent, especially in the following areas:

1.1 Passenger demand forecasting and service optimization

Accurate passenger demand forecasting relies

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on data analysis, sociology, and computer science, utilizing machine learning models to predict peak passenger flow and demand patterns, thereby optimizing operations and enhancing the passenger experience.

1.2 Train scheduling optimization

The intelligent scheduling of trains requires the integration of traditional scheduling theory, algorithm optimization, machine learning, and real-time data analysis to improve the efficiency and precision of scheduling systems. Innovative talents need to possess knowledge in electrical engineering, data analysis, signal control, and computer science.

1.2 Rail transit signal system design

The design of signal systems needs to integrate signal control, electrical engineering, communication technology, and data analysis to ensure safe and efficient train operation. Innovative talents must integrate communication and control systems to enable real-time data collection and analysis.

1.3 System fault detection and maintenance

Fault detection in rail transit systems relies on big data analysis and signal processing technologies, combining electrical engineering and computer science to implement automated monitoring and diagnosis, thereby improving the reliability and safety of the system.

2 Current Status and Challenges in Talent Cultivation for Rail Transit Majors

Currently, the talent cultivation for rail transit majors still mainly focuses on basic courses from a single discipline, neglecting the integration and application of interdisciplinary knowledge. This traditional educational model cannot meet the demand for innovative talents with multidisciplinary backgrounds in modern rail transit systems. The specific issues are reflected in the following aspects:

First, the curriculum system is relatively narrow and lacks interdisciplinary integration (Yuan, Guo, & Zhu, 2021). Most universities' rail transit programs are heavily focused on engineering technology and traditional rail courses, with insufficient coverage of fields such as mechanical-electrical engineering, data analysis, and signal control. Students lack opportunities to integrate knowledge from different disciplines, making it difficult to cultivate their ability to solve complex problems (Yang, Chen, & Xu, 2021; Wu et al., 2020).

Second, the practical teaching component is weak. Most universities have limited practical teaching resources, including experiments, hands-on training, and internships. Students lack experience in real-world work environments, particularly in practical operations such as data analysis, equipment operation, and system integration. As a result, they struggle to meet the growing technical demands of the industry.

Furthermore, the education system does not align well with industry needs. As rail transit technologies continue to evolve, the industry's demand for talent is changing rapidly. However, university curricula are slow to update and fail to respond to the actual needs of the industry in a timely manner. For instance, courses on emerging technologies like intelligent rail transit are scarce, and students have limited exposure to cutting-edge technologies like artificial intelligence, affecting their adaptability and competitiveness in the industry.

Additionally, the flexibility of the curriculum is low, and interdisciplinary content is scarce. The traditional curriculum system has not effectively integrated interdisciplinary knowledge, and some courses are outdated, lacking alignment with the latest developments in the rail transit field. The lack of practical teaching resources is also a major issue. Not only is experimental equipment insufficient, but some universities still lack dedicated rail transit simulation software and intelligent control devices. Moreover, external practical opportunities are limited, preventing students from gaining in-depth involvement in actual projects and lacking the skills to solve real-world problems.

Finally, the depth and breadth of industry cooperation are inadequate. Cooperation between the rail transit industry and universities is mostly limited to short-term internships, and students often struggle to participate in actual project development and

technology applications. This prevents the deep integration of industry, academia, and research. Furthermore, the lack of direct communication with industry experts limits students' understanding of industry-leading technologies and real-world demands, affecting the relevance and applicability of talent cultivation.

3 Strategies for Cultivating Interdisciplinary Innovative Talents in Rail Transit

3.1 Optimization and innovation of the curriculum system

3.1.1 Designing interdisciplinary course modules

(1) Modular Course Structure

Create modular courses that integrate multiple disciplines, such as "Big Data and Scheduling Optimization in Rail Transit." These modules should be project-driven, using real-world rail transit cases to help students engage with different disciplinary knowledge. For example, the "Big Data and Scheduling Optimization in Rail Transit" module can combine data analysis and scheduling system knowledge, helping students understand how to use data to optimize train schedules and improve efficiency (Wang et al., 2021; An, Hu, & Wang, 2014).

(2) Integrated Course Design

Introduce courses like "Intelligent Scheduling and Decision-Making in Rail Transit," which combine knowledge from data science, signal control, and management science. Case-driven teaching should be employed, where students simulate scheduling decision-making scenarios and practice applying interdisciplinary knowledge in rail transit.

(3) Dynamic Course Adjustment

Adjust module content in a timely manner according to industry development, such as adding new technology modules related to rail transit automation, the Internet of Vehicles (IoV), and other emerging technologies.

3.1.2 Implementing flexible elective and practical courses

(1) Elective Courses

Introduce elective courses covering cutting-edge technologies, such as "Internet of Things (IoT) Applications in Rail Transit" and "Trends in Rail Transit Intelligence." These courses can help students master the latest industry technologies, stimulating their interest in learning and fostering their ability to explore independently.

(2) Practical Courses

Add hands-on courses, such as "Train Signal Control System Practice" and "Rail Transit Scheduling Simulation," to cultivate students' practical skills through experimental projects. In these practical courses, students can not only strengthen their professional abilities but also improve their teamwork and problem-solving skills, better preparing them for their future careers.

3.2 Practice-oriented education and teaching

3.2.1 Project-based learning

(1) Project-Driven Approach

Incorporate real-world rail transit projects into the curriculum, such as "Train Scheduling Optimization Based on Data Analysis" and "Fault Detection and Maintenance of Signal Control Systems." These projects allow students to apply theoretical knowledge learned in class to real-world scenarios, enhancing their problem-solving abilities. For example, in the "Train Scheduling Optimization Design" project, students are required to use train schedules, track equipment, and data analysis knowledge to explore how to optimize train schedules and improve transportation efficiency based on real case studies.

(2) Team Collaboration

To better simulate interdisciplinary collaboration in real rail transit systems, students are organized into cross-disciplinary teams. Each team member is responsible for different areas of expertise, and students collaborate to solve challenges in the project. This process not only helps develop their ability to integrate knowledge across disciplines but also enhances their communication and coordination skills, enabling them to leverage their strengths in a team and drive the successful implementation of the project (Lv, 2016).

3.2.2 Experiments and internships

(1) Experimental Courses

Introduce experimental courses related to rail transit, such as "Train Communication System Testing" and "Rail Transit Signal System Experiments." These experimental courses will simulate system testing to help students master data analysis and signal control technologies through hands-on practice. In the experiments, students will face real technical challenges, prompting them to apply theoretical knowledge to solve problems. By engaging in hands-on activities, students will not only understand the practical applications of the course content but also develop meticulous experimental skills and teamwork abilities.

(2) Industry Internships

To further enhance students' practical experience, arrange internships with rail transit companies and track equipment firms. During the internship, students will gain direct exposure to actual rail transit operations and maintenance projects. For example, they may participate in scheduling optimization or system maintenance at rail transit companies, gaining in-depth insights into industry operations. This internship experience will not only provide students with valuable industry knowledge but also lay a solid foundation for their future career development.

3.3 Industry collaboration and communication

3.3.1 Enterprise cooperation projects

(1) Joint Development Projects

Collaborate with rail transit companies on practical projects, such as the "Construction of Rail Transit Data Analysis Platform" and "Optimization and Testing of Intelligent Train Systems." In these projects, students will not only participate in data collection and analysis but also experience the system optimization process firsthand. Students will have the opportunity to take on various roles within the project, engaging in all stages from data processing to system design. This hands-on experience will provide students with a deeper understanding of industry needs and enhance their practical abilities in data analysis and system optimization.

(2) Corporate Lectures and Mentorship

Invite experts from the rail transit industry to give regular lectures, sharing their experiences and the latest research findings. These experts will also serve as project mentors, guiding students throughout their projects. Through interaction with industry professionals, students will gain insights into cutting-edge technologies and development trends in rail transit, fostering their innovative thinking. This not only provides valuable learning opportunities but also helps students establish connections with industry professionals, benefiting their future career development.

3.3.2 Academic exchange and cooperation

(1) Academic Seminars

Organize regular interdisciplinary seminars and technical forums in the field of rail transit, inviting industry experts, scholars, and corporate representatives to share their latest research achievements and technological advancements. These seminars will focus on current hot issues in the rail transit industry and future development trends, encouraging students to actively participate in discussions and present their own perspectives. By interacting with experts, students will gain a deeper understanding of cutting-edge technologies and learn how to apply academic research to real-world problems, fostering their research skills and innovative mindset.

(2) International Cooperation

Establish partnerships with international rail transit universities and institutions to conduct cross-border exchange activities, expanding students' global perspectives. These activities may include student exchange programs, joint research projects, and participation in international academic conferences.

4 Implementation Methods for Cultivating Interdisciplinary Innovative Talents

4.1 Layered teaching and personalized guidance

In interdisciplinary courses for rail transit, a layered teaching approach is applied, grouping students based on their knowledge foundation and

interests. Personalized learning content and project tasks are designed for each group to improve students' learning efficiency and mastery of knowledge through tailored learning objectives and difficulty levels.

Pre-class quizzes and group discussions are used to initially assess students' disciplinary backgrounds and interests.

Students are then grouped according to their interdisciplinary interests and abilities, with project tasks assigned according to varying levels of difficulty. For example, students with strong data analysis skills may work on large-scale train data analysis projects, while those with strong design abilities could work on train service optimization design tasks.

After completing each project, group presentations and peer feedback sessions are held. Teachers evaluate students based on their overall performance, creativity, and interdisciplinary abilities, and teaching methods are refined through feedback surveys.

4.2 Case-driven modular curriculum method

Through modular course design, students engage with real-world rail transit cases (e.g., "Railway Signal System Optimization" or "Automated Train Driving Applications"), gaining practical knowledge and skills related to real-world scenarios.

Each module is designed based on industry needs, such as "Rail Transit Signal Processing," "Train Control Systems," and "Environmental Impact Assessment of Rail Transit."

Each module includes case analysis, interdisciplinary knowledge introduction, and the design of practical solutions, encouraging students to innovate while learning the fundamentals.

In-class group discussions are arranged to guide students in independent research and interdisciplinary application, leading to feasible solutions to the cases at hand.

After each module, feedback is collected through surveys and reflection reports, gathering students' responses on their grasp of key concepts, case difficulty, and interdisciplinary applications, allowing for further optimization of the curriculum.

4.3 Project-based and simulation-based teaching methods

Given the complexity and dynamic nature of rail transit, scenario simulation and project-based teaching methods are used to enhance students' comprehensive decision-making skills in complex environments. These methods are particularly effective in cultivating students' innovation abilities in emergency response, train scheduling optimization, and system maintenance.

Simulation tasks are designed, such as "Handling a Railway Emergency" or "Train Scheduling Management During Peak Hours," where students take on roles and simulate operations to experience real-world emergency responses.

In project-based teaching, students are divided into groups to complete interdisciplinary projects, such as "Designing a Smart Rail Transit Platform," integrating knowledge from information technology, data analysis, and engineering management.

After the simulation tasks, students' performances are evaluated based on their ability to integrate interdisciplinary information and respond to emergencies. Continuous improvement of the simulation-based teaching design is carried out through surveys and feedback.

Conclusion

The cultivation of interdisciplinary innovative talents in rail transit requires a systematic curriculum and practical opportunities closely aligned with industry needs. In the future, with the development of intelligent and automated rail transit, interdisciplinary innovative talents will face new challenges and opportunities. We must continuously optimize the teaching system, expand international cooperation, and explore the application of cutting-edge technologies. This will ensure that students are equipped with a global perspective and innovation capabilities, contributing to the future development of the rail transit industry.

Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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