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Research on the Industry-Education Integration Project-Based Teaching Reform Model for Transportation Specialty Courses Oriented to High-Order Competency Cultivation: Taking "Parking Planning and Management" as an Example

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Abstract: This paper explores the necessity of curriculum reform for "Parking Planning and Management" in transportation majors. Based on the cultivation of students' high-order competencies, combined with the popular concepts of industry-education integration and project-based teaching, it proposes optimization adjustments. Meanwhile, it identifies existing problems in the teaching of related courses at Chongqing Jiaotong University and formulates targeted optimization strategies, ultimately forming an effective reform framework for transportation majors oriented to students' high-order competency development, which is worthy of in-depth exploration and practice.

Keywords: High-order competencies; Transportation majors; Industry-education integration; Project-based teaching; "Parking Planning and Management"

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1. Introduction

High-order competencies are core qualities essential for talents in the 21st century and a key factor for students to adapt to future career development. For undergraduate teaching in traffic engineering majors, focusing on the cultivation of students' high-order competencies in professional courses not only helps promote the formation of students' innovative awareness, the improvement of practical abilities, and the development of critical thinking but also is an important measure to implement the national talent training strategy and improve the quality of university talent training. As an important discipline for cultivating professional talents in the transportation field, carrying out educational and teaching reforms and proposing new teaching paradigms have important practical significance. As a well-known undergraduate university in the transportation field, Chongqing Jiaotong

University has actively explored industry-education integration project-based teaching in the course "Parking Planning and Management". The following will specifically discuss the teaching reform strategies for this course oriented to high-order competency cultivation.

2. Overview of industry-education integration and project-based teaching

At present, there is no unified and clear definition of industry-education integration in the education and academic circles, but it is generally believed that its essence is an educational policy and institutional system, similar to concepts such as school-enterprise cooperation and dual-system education. Industry-education integration aims to realize the in-depth integration of industry and education, not only cultivating talents for enterprises but also improving the degree of enterprise participation in education by integrating social forces, cultivating students' professional abilities and social service capabilities, and achieving a balance between talent supply and demand. By establishing a new collaborative talent training mechanism for industry-education integration, a demand-oriented talent training model can be established and optimized [1]. In the process of learning from experiences such as the dual-system and modern apprenticeship systems, industry-education integration has undergone localized adjustments and attempts, putting forward new requirements for undergraduate education in China with broad development prospects in the future.

Project-based teaching is a student-centered teaching method that emphasizes driving the learning process through real and meaningful project tasks. In project-based teaching, the teacher's role transforms into a guide, and students become the center of teaching activities. Students explore complex and open-ended problems, independently plan, collaborate to implement, and produce results [2]. This process promotes students' self-reflection, exercises their communication skills, teamwork abilities, innovative awareness, and lifelong learning literacy, laying a solid foundation for their all-round development. Compared with traditional teaching models, project-based teaching elevates undergraduate education to a new level and is expected to promote the modernization of transportation professional education.

3. Current situation and problems of transportation course teaching oriented to high-order competency cultivation

3.1. Imperfect industry-education integration mechanism, disconnection between teaching content and industrial reality

In the process of promoting industry-education integration practice in current teaching reforms of transportation majors, there is a common problem that form outweighs substance. Although universities have established cooperative relationships with enterprises, the cooperation forms are mostly short-term and medium-term internships, enterprise visits, and lectures, lacking in-depth cooperation such as the joint construction of training rooms, development of curriculum projects and resource libraries by schools and enterprises. This leads to the slow update of university curriculum systems, making it difficult to absorb first-hand enterprise cases and cutting-edge technologies, and insufficient research and practice on intelligent connected vehicles and big data-driven traffic management. Students have difficulty accessing front-line industrial work content, which limits their professional cognition and practical abilities, affecting their future career development in the transportation field [3-6].

3.2. Insufficient and fragmented practical teaching hours, lack of cultivation of students' high-order competencies

Although major universities have actively built traffic simulation laboratories, intelligent transportation training platforms, etc., there are still deficiencies in practical application, and insufficient cultivation of students' digital literacy and intelligent skills. Practical teaching mostly focuses on single skill training, lacking comprehensive project designs that integrate multi-disciplinary knowledge and face real engineering challenges. For example, although there are open cooperative exploration and virtual simulation experiments in teaching, there is a lack of dynamic monitoring and continuous management optimization, resulting in low project completion rates among students; running simple models and idealized data is difficult to exercise students' ability to solve practical problems, and students lack in-depth experience in the practical complexity such as data collection, multi-objective trade-offs, policy constraints, and social impacts. At the same time, the lack of dual-track and dual-teacher supervision and feedback makes it difficult to effectively train and cultivate students' high-order competencies.

4. Industry-education integration project-based teaching reform strategies for "parking planning and management" oriented to high-order competency cultivation

4.1. Divide module tasks to form a project curriculum system

In the curriculum reform of "Parking Planning and Management" at Chongqing Jiaotong University, teachers sort out the necessary abilities and qualities for theory and practice, such as systematic thinking, interdisciplinary awareness, and problem-solving abilities, and integrate the concepts of industry-education integration and project-based teaching into teaching details. The university collaborates with external forces such as local government transportation and parking management departments, planning and design institutes, and smart parking enterprises to transform typical scenarios such as parking difficulties in old urban communities, peak-hour congestion in commercial areas, and temporary parking supply-demand imbalance around hospitals into teaching projects. Each project cycle covers the entire process of demand research, data analysis, scheme design, simulation evaluation, and report defense, enabling students to master core skills such as parking facility layout, parking space supply calculation, intelligent guidance system design, and policy tool selection through "learning by doing". Project tasks are set with multi-level goals: the basic level focuses on the application of technical specifications, the advanced level emphasizes multi-scheme comparison and cost-benefit analysis, and the high-level requires proposing institutional innovation or technology integration suggestions [7,8]. Jointly designed by on-campus teachers and enterprise mentors, progressive parking planning and management projects are formed to strengthen students' engineering practice, teamwork, and public communication abilities, and improve their professional literacy. For example, the course "Parking Planning and Management" at Chongqing Jiaotong University, as a first-class course in Chongqing and a model course for ideological and political education in Chongqing, has achieved good teaching results by dividing module tasks and integrating practical projects into teaching. It has effectively strengthened students' engineering practice, teamwork, and public communication abilities, improved their professional competence, and laid a solid foundation for their long-term and stable career development in the future. In short, dividing professional course content into module systems and specific projects to form school-based curriculum projects with the school's characteristics has far-reaching significance and impact.

4.2. Promote dual-track and dual-teacher mode to form an industry-education integration team

The cultivation of high-order competencies requires both theoretical depth and practical breadth, guiding all aspects of students' independent learning and exploration. The authors believe that guidance only from school teachers is obviously lacking in engineering experience and cutting-edge technology "guidance". Promoting the dual-track and dual-teacher education model and gradually building an industry-education integration team will achieve different positive effects. By cooperating with enterprises and assigning enterprise mentors, teachers are responsible for theoretical framework construction, methodology guidance, and academic standard training, while industry mentors provide real data, case backgrounds, technical tools, and implementation constraints, and participate in mid-term reviews and final defenses. Both parties jointly formulate project task books, scoring standards, and phased goals. For example, in the project "Optimization of Parking Resource Allocation Based on GIS", university teachers teach the principles of spatial analysis, and enterprise mentors demonstrate actual platform operations and point out common errors in data collection [9]. In addition, to highlight the training of students' high-order competencies and industry-education integration practice, promoting the two-way flow of teachers by setting up "industry professor" positions, co-building joint laboratories, and carrying out teachers' on-the-job training in enterprises will surely improve students' practical abilities and professional literacy. This in-depth integration not only enhances teaching effectiveness but also strengthens students' understanding and recognition of professional roles. Chongqing Jiaotong University has established the country's first industry-education integration community in the parking industry, providing a broader platform for dual-track and dual-teacher education and further promoting the construction of an industry-education integration team. In the future, there are many paths for teaching innovation in transportation majors, but promoting the dual-track and dual-teacher model can be extended to more professional education links, especially in similar professional education oriented to social service positions, truly realizing that technical and skilled talents make positive contributions to national and social development.

4.3. Strengthen digital application and implement the three-in-one talent training practice

Parking planning and management is an interdisciplinary field of technology, data, and public policy. To cultivate students' high-order comprehensive abilities, Chongqing Jiaotong University breaks the limitations of single skill training and constructs a three-in-one ability training module of "data acquisition - model construction - policy design". At the data level, students are guided to use multi-source heterogeneous data, such as mobile phone signaling, video recognition, and questionnaires to master methods for extracting parking behavior characteristics and predicting demand. At the model level, they are trained to use tools such as queuing theory, discrete choice models, and Agent-Based Simulation for parking supply-demand simulation and scheme evaluation. At the policy level, students are required to propose implementable management strategies such as differentiated pricing, shared parking, and time-sharing opening in combination with factors such as local finance, land ownership, and public acceptance. This emphasizes the full-chain thinking of "from data to decision-making", avoiding students falling into the misunderstanding of "valuing technology over governance" or "talking about policies without basis" [10–12]. Relying on projects developed by both schools and enterprises, student teams conduct explorations. For example, by analyzing nighttime parking heat maps, a student team found a large number of idle unit parking spaces in a certain area, then designed a "community-unit" shared parking agreement template, and demonstrated its feasibility with a cost-benefit model, which was ultimately included in the municipal pilot program. Such training has significantly improved students' systematic analysis and policy transformation abilities. With digital

empowerment, the three parties form a joint force to effectively improve teaching efficiency and quality.

4.4. Implement comprehensive supervision and create a diversified evaluation mechanism

Traditional evaluation methods, mainly based on final reports or exams, are difficult to fully reflect students' higher-order competency performance in complex projects. Chongqing Jiaotong University has established a diversified evaluation system covering three dimensions: "process participation, achievement quality, and social impact". The process dimension focuses on soft skills such as teamwork, problem iteration, and time management, quantified through log records, phased reports, and peer evaluations; the achievement dimension focuses on technical rationality, innovation, and implementability, scored by joint review of schools and enterprises; the impact dimension measures whether the project generates practical value, such as whether it is adopted, whether it triggers community discussions, or whether it forms policy proposals. For example, a group's proposed "three-dimensional parking transformation + resident points incentive" scheme for old communities was not immediately implemented due to high costs, but its resident willingness survey method was adopted by the sub-district office for other people's livelihood projects, and it still obtained a high score [13]. In addition, a "digital portfolio" is introduced to record the entire process evidence chain of students from project approval to completion, serving as a visual certificate of ability growth. The evaluation results are not only used for course scores but also as an important basis for recommending internships, competition selection, and graduation project topics [14,15]. This evaluation mechanism forces students to shift from "completing tasks" to "creating value", truly realizing the promotion of learning and abilities through evaluation.

5. Conclusion

In summary, to enable transportation professionals to achieve higher achievements and comprehensive development of individuals and careers, it is necessary to train and cultivate their high-order competencies. In the curriculum reform of "Parking Planning and Management" at Chongqing Jiaotong University, by infiltrating the concepts of industry-education integration and project practice, and adopting strategies such as dividing module tasks, promoting dual-track and dual-teacher mode, strengthening digital application, and creating a diversified evaluation mechanism, students' high-order competencies have been effectively improved, and students' correct values and practical views have been established. This also provides a useful reference for other universities to innovate talent training models for transportation majors, helping to promote the improvement of teaching quality and talent training quality in transportation majors. In the future, efforts should be made to further deepen industry-education integration, optimize the project-based teaching model, and contribute to cultivating more high-quality talents who meet the development needs of the transportation field.

Disclosure statement

The authors declare no conflict of interest.

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