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Reform of Practical Teaching of Road Engineering Specialty Based on Cultivation of Innovative Ability

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Abstract: Road engineering, as a core component of urban transportation and infrastructure construction, is not only related to the travel convenience of urban residents but also directly related to the development of the urban economy and the sustainable progress of society with the continuous expansion of urban scale and the rapid growth of population. In this context, the importance of the road engineering profession has become more and more prominent. In this paper, we will focus on the innovation ability cultivation and practical teaching reform of the road engineering profession. Through in-depth discussion of the development trend of the road engineering profession, as well as the design of innovative practical teaching strategies, optimization of the curriculum system, and strengthening of the practical ability, we aim to provide an effective way to cultivate the innovation consciousness, problem-solving ability and teamwork spirit of the students of the road engineering profession.

Keywords: innovation; cultivation; road engineering; practical teaching

Introduction

Urban traffic congestion, environmental pollution, traffic safety, and other problems are becoming more and more prominent, which requires road engineering majors to be able to lead the development of transportation infrastructure in the direction of intelligence, greenness, and safety through innovative solutions. In this process, the ability to innovate becomes a key element in shaping the future of the road engineering profession, road engineering is no longer simple construction and maintenance but requires an interdisciplinary knowledge system, forward-looking thinking, and an innovative spirit to cope with the challenges of complex and changing urbanization.

1. Analysis of the Current Situation of the Road Engineering Profession

1.1 Professional knowledge system

In the teaching of road engineering, the traditional classroom lectures are mainly centered on the basic theories of soil mechanics, structural mechanics, mechanics of materials, and so on, which has laid a solid theoretical foundation for students. However, it is difficult to meet the needs of modern road engineering for comprehensive quality requirements by merely staying in the transmission of theoretical knowledge, and the traditional mode often lacks an in-depth explanation of emerging materials, digital design, and construction technology, intelligent transportation systems and other cutting-edge fields, which makes students may feel a lack of comprehensive application ability when facing actual projects (Fang, 2018). With the rise of intelligent transportation, green environmental protection, and sustainable development concepts, the field of road engineering continues to emerge with new technologies and work methods. For example, the application of new materials, the popularization of digital design and BIM technology, and the development of intelligent transportation systems have created a newer demand for road

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engineering professional knowledge systems. In addition, interdisciplinary knowledge such as engineering project management, risk assessment, regulatory compliance, etc. is gradually becoming a necessary quality for road engineers. In the face of increasingly complex road engineering needs, the traditional teaching system needs to better integrate new knowledge and expand practical skills to cultivate students' stronger adaptability and innovation (Ma et al., 2020). Therefore, the curriculum of road engineering should not only focus on the teaching of theoretical knowledge, but also introduce emerging technologies and cutting-edge cases, and stimulate students' interest in the discipline through case studies of actual projects, so that they can have more comprehensive professionalism. At the same time, cooperation with the industry and inviting professionals in the industry to participate in teaching can better connect theory and practice and ensure that students are competent in increasingly complex and diverse road engineering projects after graduation.

1.2 Demand for students' quality cultivation

In the current teaching practice of road engineering, students' quality training needs are not only reflected in the mastery of professional knowledge but also pay more attention to students' innovative ability, practical ability, and teamwork spirit, to adapt to the rapid development of the field of road engineering and the ever-changing needs. The industry's expectation of road engineering professionals not only stays in the application of traditional engineering knowledge, but also emphasizes the student's ability to use emerging technologies and propose innovative solutions to cope with the complex and changing construction needs, so it is imperative to cultivate students' innovative thinking, problem-solving ability and entrepreneurial spirit (Zhang et al., 2020). Despite the accumulation of theoretical knowledge, students often face the problem of insufficient application ability in real projects. The existing teaching system needs to be perfected in the design of practical aspects, and the lack of sufficient actual engineering simulation and fieldwork leads to the fact that students may feel constricted in the face of real engineering projects, and there are relatively few opportunities for teamwork and interdisciplinary exchanges, which hinders the possibilities of students' all-round development. To meet the industry's demand for innovation ability, road engineering majors should focus on cultivating students' practical ability in teaching, which includes introducing a project-driven practical teaching mode, allowing students to learn more knowledge and skills in actual operation by simulating real engineering projects. At the same time, interdisciplinary courses are offered to integrate the knowledge of related fields into the teaching of road engineering majors and cultivate the comprehensive quality of students. Emphasis on the cultivation of students' practical ability also needs to strengthen the close contact with the industry and cooperation with enterprises to carry out actual engineering projects, so that students can deeply understand the actual operation of the industry, and gradually form independent insights into engineering problems in practice (Wang, 2020).

2. Practice Teaching Reform Strategy Based on the Cultivation of Innovation Ability

2.1 Project-based teaching design

The core of the road engineering profession lies in the design and implementation of actual engineering projects, and the project-based teaching design can put students in a specific engineering background by simulating real road engineering projects. For example, through the simulation of urban transportation planning, road design, construction management, and other actual cases, students can more deeply understand and apply the theoretical knowledge learned, this project-driven practical teaching not only cultivates the students' practical skills but also exercises their teamwork and problem-solving ability. Project-based teaching design can also be used to stimulate students' innovative thinking by introducing innovative cases in the actual engineering, the field of road engineering is constantly emerging new materials,

new technologies, new methods, and other innovations, through the inclusion of these cases in the teaching content, students will be more likely to understand the value and application of innovation (Gan & Zhang, 2020). Project-based teaching can not only improve students' practical skills, but also cultivate their ability to solve practical problems, but project-based teaching also faces some challenges, such as the problems of larger resource input and higher management difficulty. Therefore, when implementing project-based teaching, it is necessary to fully consider the characteristics of the road engineering profession, reasonably arrange the resources, and provide sufficient guidance and support to ensure the smooth progress of the project. Through the design of project-based teaching, road engineering majors can better cultivate students' practical ability and innovative thinking, so that they can better adapt to the future needs of the complex and changing field of road engineering, and lay a solid foundation for students' career development.

2.2 Field study and internship

Field study and internship is an important part of the practical teaching reform based on the cultivation of innovation ability, especially applicable to road engineering majors, this strategy by placing students in real engineering sites, so that they can directly face the actual problems, and cultivate practical problem-solving ability, teamwork spirit, and innovation consciousness (Fang, 2018). Taking the urban intersection reconstruction project as an example, after students learn the intersection design theory, traffic flow simulation, and other related knowledge in the classroom, they conduct fieldwork and internships. During the field trip, students go deep into the site of the intersection reconstruction project in the city to understand the actual situation of the intersection's traffic flow organization, road marking, signal setting, etc. This kind of field trip not only expands students' understanding of the textbook knowledge but also enables them to intuitively feel the challenges and needs of the urban intersection reconstruction. Next, students participate in an internship phase where they work with a project team to plan and implement an intersection improvement project. During the internship, they are required to apply the theoretical knowledge they have learned in the classroom to solve problems encountered in the actual project, as well as collaborate with the engineering team to experience the complexity of project management and actual operation. In addition, students have the opportunity to interact with professional engineers and learn about the latest technologies and practices in the industry to better understand the innovations in the field of road engineering. Field trips and internships provide road engineering students with the opportunity to dive into practical projects, emphasizing the importance of hands-on practice and teamwork. By participating in urban intersection reconstruction projects, students not only learn professional skills but also cultivate the ability to solve real-world problems and a sense of innovation. Interaction with professional engineers also strengthens the close connection between students and the industry, enabling them to better integrate into the professional practice of road engineering (Zhang et al., 2018). In practical teaching, emphasis should be placed on the selection of projects to ensure that they are compatible with the student's professional background and future career development direction, and to establish industry cooperation channels, so that fieldwork and internships can be more closely related to the actual industry and provide students with a richer learning experience.

2.3 Application of innovative tools and technologies

In the practical reform of road engineering, the application of innovative tools and technologies is one of the key strategies, which includes the introduction of advanced design software, simulation tools, and digital technology, and cultivating students' ability to use innovative tools to solve practical problems through the display of actual cases and practical operation. Taking the application of BIM technology in road design as an example, students participated in an actual road design project

after the relevant theoretical courses, in which BIM technology was introduced into the design process, and students needed to use BIM software to build road models, visualization, collision detection, and other work. Through this case, students not only learned the basic principles and application methods of BIM technology but also experienced the advantages of this technology in improving design efficiency and reducing the design risk in the actual operation. At the same time, the application of BIM technology also prompted students to think about how to better combine digital technology with road design and improve the overall quality of the project. The introduction of BIM technology provides students with more advanced and efficient design tools, helping them to better understand the design concepts, design optimization, and real-time understanding of the impact of design changes on the overall project, which not only improves the students' practical design ability but also develops their sensitivity to innovative technologies. In practical teaching, it should be ensured that students have systematic training on the use of innovative tools, including the knowledge of software operation and application scenario analysis. Combined with real cases, students should be guided to think about the value of innovative tools in solving real problems by analyzing the challenges and solutions in the projects. It is recommended to combine actual cases with industry practices and invite professionals in related fields to share their experiences to deepen students' understanding of the application of innovation tools.

3. Adjustment and Optimization of Road Engineering Professional Curriculum System

3.1 Strengthening the practical curriculum

To cope with the development needs of the road engineering field, the professional curriculum system is adjusted and optimized, and strengthening the practical curriculum is one of the important strategies. The strengthening of the practical curriculum can not only better cultivate the practical operation ability of the students, but also can be close to the industry reality, and improve the vocational competitiveness of the students. Take the experimental course of roadbed and pavement engineering as an example, in the adjustment of the curriculum system, the experimental course of roadbed and pavement engineering can be taken as one of the cores of the strengthened practice, and the students will have the opportunity to understand the design and construction of roadbed and pavement engineering, and experience the actual operation of the material performance test, the roadbed loading test, and the quality inspection of pavement. The highlight of this experimental program is the combination of theoretical knowledge and practical operation. Through the design and execution of the experimental projects, students will be able to fully understand the challenges and complexities of the actual work in road engineering. For example, in the roadbed loading test, students need to consider the differences in the design of roadbeds under different geological conditions and evaluate the reasonableness of different designs through the experimental results, which not only consolidates their theoretical knowledge but also cultivates their problem-solving ability and teamwork spirit. When optimizing the curriculum system, it can also combine with the development trend of the industry, introduce emerging technologies, green construction concepts, and other content, so that students can better adapt to the future needs of road engineering, through such adjustments and optimization, road engineering students will more comprehensively master the practical skills of the actual engineering projects, laying a solid foundation for the future development of their careers.

3.2 Interdisciplinary cooperation and cross-training

Interdisciplinary cooperation and cross-training should be emphasized in the adjustment and optimization of the curriculum system to cultivate students' comprehensive quality and ability to adapt to complex engineering projects. Taking the road ITS design and interdisciplinary training as an example, considering the increasing importance of ITS in road engineering, the road ITS design and

interdisciplinary training course is introduced, which involves a variety of fields such as computer science, electronic engineering, traffic engineering, etc. The students will participate in the project design and implementation together with their classmates from other majors. In the actual project, students majoring in road engineering are required to cooperate with students majoring in computer science to jointly design intelligent transportation systems, including traffic signal optimization, vehicle identification technology, data analysis, and processing, etc. This interdisciplinary cooperation not only expands students' knowledge but also cultivates their teamwork spirit of working together with professionals from other fields. Interdisciplinary cooperation and cross-training for road engineering students to provide a more comprehensive vision of knowledge so that they can better adapt to the needs of multi-disciplinary integrated work, practice students not only need to master their professional knowledge, but also need to understand the basic principles of other related professions, prompting them to form a more integrated problem-solving way of thinking. In interdisciplinary cooperation, it is recommended to set up clear project goals and tasks, so that students from various disciplines can clearly define their responsibilities in collaboration and form an efficient team, and at the same time, organize regular interdisciplinary exchange meetings to encourage students to share their experiences and insights in their respective fields, and strengthen the effect of collaboration.

4. Assessment and Optimization of Teaching Effect of Road Engineering Majors

4.1 Formulation of assessment index system

In the assessment and optimization of the teaching effect of road engineering, the development of a scientific and reasonable assessment index system is an important link to ensure the quality of teaching, which should comprehensively reflect the academic level, practical ability, and comprehensive quality of the students, to identify problems promptly, to adjust the direction of teaching, and to continuously improve the quality of teaching. The academic level is one of the core qualities of road engineering students, so the assessment index system should include the student's performance in the basic theoretical knowledge of the profession, the study of professional courses, and the theoretical analysis of engineering practice problems, which can be quantitatively assessed through classroom quizzes, academic papers, final exams, and other ways. One of the core requirements of the road engineering program is that students have practical engineering operation ability, and the assessment index system needs to reflect the performance of students in practical operation links such as laboratory classes, field trips, internships, etc. Through participation in actual engineering projects, students' practical operation skills such as design and construction should be included in the assessment. Comprehensive quality assessment includes students' innovation ability, teamwork spirit, communication ability, etc. Road engineering students need to have the ability to cooperate in their future careers, and the assessment index system should pay attention to whether students can excel in diverse teamwork and whether they can independently propose innovative solutions (Sha et al., 2016). Ultimately, the assessment index system should also consider the employment competitiveness of students after graduation, which can be assessed through the tracking survey of students' internships and employment, and the satisfaction survey of employers, etc. This approach can reflect the students' ability to be applied in actual engineering projects and the degree of market recognition, and provide strong data support for adjusting the direction of teaching.

4.2 Regular teaching improvement

To ensure the teaching effect and quality of road engineering, regular teaching improvement is an indispensable link, the process needs to constantly collect and analyze the feedback from students and teachers, combine with the development dynamics of the industry, and adjust the teaching content and methods in time to adapt to the ever-changing

professional needs. The establishment of an effective student feedback mechanism is the key to regular teaching improvement. Through regular student satisfaction surveys, course evaluation questionnaires, and other forms, we understand students' views and suggestions on the curriculum, teaching methods, practice sessions, etc. This helps to capture the actual needs of students, adjust teaching strategies promptly, and improve students' participation and learning experience. Teacher self-assessment and peer review also help to improve teachers' teaching level and professionalism. Teachers can regularly review their teaching methods, content design, and selection of teaching materials, and reflect on students' learning outcomes and understanding of the curriculum. In addition, regular sharing and review of teaching experience with peers promotes communication and cooperation among teaching teams and jointly improves teaching quality. Secondly, the continuous development in the field of road engineering requires that the teaching content can be updated in synchronization with the industry demand, establish close contact with engineering companies, design institutes, and other industry organizations, regularly learn about the latest developments in the industry, and introduce cutting-edge technology and cases in the industry into the teaching content. Through cooperation with industry professionals, the challenges in the actual projects can be better understood, to make the course more practical and applicable.

Summarize

To summarize, innovation is not just the application of new technologies, but also the cultivation of a comprehensive ability, courage, and wisdom to solve unknown challenges. Only by integrating innovation into all aspects of professional education can we win a broader space in future road engineering. Only through joint efforts can we cultivate road engineering professionals with more creativity, practical ability, and teamwork ability, and inject a constant flow of innovative power for the development of urban transportation.

Conflict of Interest

The author declares that he has no conflicts of interest to this work.

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