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Teaching Reform and Practice of Safety Engineering Specialty from the Perspective of "Internet +"

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ABSTRACT

Against the background of the in-depth integration of "Internet +" with various industries, the field of safety engineering is facing the dual challenges of technological iteration and the upgrading of talent demand. The traditional teaching of safety engineering specialty has limitations in content, methods, practice, and evaluation, making it difficult to meet the industry's demand for high-quality and innovative safety talents. This paper analyzes the necessity of teaching reform in safety engineering specialty from three dimensions: industrial transformation and upgrading, the development of educational informatization, and the improvement of students' abilities. It systematically sorts out the current problems in teaching, such as outdated content, traditional methods, weak practice, and single resources and evaluation. Furthermore, it puts forward specific reform and practice paths from four aspects: the integration of teaching content with cutting-edge technologies, the innovation of diversified teaching methods, the construction of an intelligent practical platform, and the establishment of a whole-process and diversified evaluation system. By introducing new technology modules, building a dynamic resource database, promoting mixed teaching, developing virtual simulation systems, and constructing a school-enterprise collaboration platform, the reform promotes the innovation of the teaching model of safety engineering specialty, improves the quality of talent cultivation, and provides the industry with safety engineering professionals who possess Internet thinking and practical innovation capabilities.

KEYWORDS

Internet; Safety engineering specialty; Virtual simulation; School-enterprise collaboration

1 Introduction

With the rapid development of a new generation of information technology, "Internet +" has become the core driving force for promoting industrial transformation, and the field of safety engineering has also undergone profound changes. From intelligent mine safety monitoring to urban public safety emergency management, from industrial Internet security protection to big data risk early warning, the application of new technologies has continuously expanded the connotation and extension of safety engineering [1]. The teaching content is disconnected from the cutting-edge technologies of the industry, the teaching methods are difficult to stimulate students' awareness of active learning, the practical teaching is difficult to cover complex real scenarios, and the evaluation methods cannot fully reflect students' comprehensive abilities. These problems result in that after graduates enter the workplace, they need a long time to adapt to the job requirements and are difficult to quickly participate in industrial technological innovation and safety management practice. Therefore, based on the perspective of "Internet +", exploring the path of teaching reform in safety engineering specialty and reconstructing the teaching system has become an inevitable choice for colleges and universities to improve the quality of talent cultivation in safety engineering specialty and serve the development of the industry.

2 The necessity of teaching reform for safety engineering specialty from the perspective of "internet +"

2.1 The need for industrial transformation and upgrading

At present, industries related to safety engineering are accelerating their transformation and upgrading towards intelligence and digitalization, and the traditional safety management model can no longer meet the safety guarantee needs of the new era. In the process of industrial transformation and upgrading, the demand for safety engineering professionals is no longer limited to the traditional ability of risk identification and hidden danger investigation, but also emphasizes that talents have the ability to use Internet technology to solve complex safety problems. Therefore, promoting the teaching reform of safety engineering specialty and cultivating talents that meet the needs of industrial transformation and upgrading has become the primary task of professional development.

2.2 Driven by the development of educational informatization

Educational informatization is the core content of educational modernization, and "Internet + Education" has become an important direction of higher education reform. Under the background of "Internet +", the maturity of information-based teaching tools such as online course platforms, virtual simulation technology, and live teaching systems provides new possibilities for the teaching of safety engineering specialty [2]. By using information-based means, the boundaries of classrooms can be broken, and the efficient integration and sharing of teaching resources can be realized. It can simulate complex and dangerous safety scenarios to reduce the risks of practical teaching; it can record students' learning processes to achieve precise teaching and personalized guidance.

2.3 The key to improving students' innovation and practical abilities

The safety engineering specialty has distinct practicality and applicability, and students' innovative ability and practical ability are their core competitiveness. "Internet +" provides a new path for improving students' innovation and practical abilities. By introducing new technology modules such as big data and the Internet of Things, students' knowledge horizons can be expanded, and their innovative thinking of using new technologies to solve safety problems can be cultivated. Through online-offline mixed teaching, students can be guided to preview actively, conduct in-depth discussions, and improve their abilities of independent learning and collaborative learning. Through virtual simulation experiments and school-enterprise collaborative practice platforms, students can carry out practical operations in simulated or real scenarios and accumulate experience in solving practical problems.

3 The current situation of teaching in safety engineering specialty

At present, the teaching of safety engineering specialty has limitations in many aspects: the update of teaching content lags behind the development of industrial technology, the curriculum system still focuses on traditional safety theories, and involves less about the new technologies related to "Internet + ". In addition, the publication cycle of teaching materials is long and the curriculum connection is insufficient, which cannot meet students' learning needs; the teaching method is mainly the traditional lecture-based method, teachers rely on PPT explanations, the case presentation lacks intuitiveness, it is difficult to achieve personalized guidance, and online teaching has not been organically integrated with offline teaching; the practical teaching link is weak, the laboratory lacks equipment for simulating complex safety scenarios, most off-campus internships are for observation and learning, and the guiding teachers have insufficient enterprise experience [3].

4 Teaching reform and practice of safety engineering specialty from the perspective of "internet +"

4.1 Promote the integration of teaching content with cutting-edge technologies

4.1.1 Introduce new technology application modules

In the curriculum system of safety engineering specialty, three core new technology modules, namely big data security analysis, intelligent emergency management, and Internet of Things security monitoring, are added in a targeted manner to realize the in-depth integration of "Internet +" technology with traditional safety engineering knowledge. In the course "Safety System Engineering", a chapter on the application of big data in safety risk assessment is added, which explains in detail how to collect safety data such as temperature and pressure in the production process of chemical enterprises using Python tools, construct a risk early warning model using machine learning algorithms, and demonstrate the model training and early warning effect combined with the actual data case of a petrochemical enterprise. In the course "Emergency Management", the practical operation content of the intelligent emergency management platform is integrated, introducing the full-process architecture of the platform including monitoring, early warning, disposal, and review. Taking the emergency disposal of a city's rainstorm and waterlogging as an example, it demonstrates how to integrate data from multiple departments such as meteorology, transportation, and fire protection through the platform to complete the scheduling of emergency resources and command decisions. At the same time, 2-3 industry technical experts are invited to participate in the design of the course modules every semester. According to the annual industry technological innovation trends (such as the new standards for industrial Internet security protection in 2024), the teaching focus is adjusted to ensure that the content is synchronized with industry practice.

4.1.2 Build a dynamically updated teaching resource database

Relying on the school's provincial online open course platform, a dynamic teaching resource database for the safety engineering specialty is built, covering four sub-databases: a case database, a technical information database, an expert lecture database, and a virtual simulation resource database. The case database is classified by industries such as chemical industry, construction, and mining, and collects typical safety accident cases in the past 5 years (such as a construction site collapse accident in 2023) and successful cases of intelligent safety management (such as the application case of an intelligent mine safety monitoring system). Each case includes complete materials such as accident scene videos, data analysis reports, and rectification plans; the technical information database updates industry standards, technical white papers, and core documents in the fields of big data security analysis and Internet of Things sensor technology in real time, and links to authoritative data sources such as the China Academy of Safety Science and Technology and the official website of the Ministry of Emergency Management; the expert lecture database updates 1-2 live lectures by industry experts every quarter, covering topics such as intelligent safety technology research and development and enterprise safety management practice. A resource update team composed of 3 college teachers and 2 enterprise technical backbones is established to sort out industry trends and supplement resources every month [4]. At the same time, a submission channel for teachers and students is opened to encourage teachers to share teaching cases and students to submit practical reports, forming a co-construction and sharing mechanism. Using the platform's data statistics function, the frequency and duration of students' resource access are analyzed, and high-attention resources are updated first to improve the efficiency of resource utilization.

4.2 Innovate diversified teaching methods and models

4.2.1 Promote online-offline mixed teaching

A closed-loop mixed teaching model of "online preview + offline discussion + online consolidation" is constructed, covering the entire teaching process relying on platforms such as Chaoxing Xuexitong. One week before class, teachers release fragmented teaching videos (each 10-15 minutes long), preview courseware, and targeted tasks on the platform. For example, in the preview stage of the course "Internet of Things Security Monitoring", students are required to design a simple workshop temperature and humidity monitoring scheme framework after watching the video on the working principle of sensors and upload it to the platform; teachers check the students' preview progress and the first draft of the scheme through the platform, and select 3-4 typical problems (such as improper sensor selection and incorrect data transmission protocol) as the focus of in-class discussion. In in-class teaching, the "problem-oriented + group collaboration" model is adopted. Students are divided into groups of 4-5 people to conduct 40-minute discussions around the typical problems in the preview. Each group selects a representative to present the solution. Combined with industry practical cases, such as the failure case of a sensor monitoring scheme in an electronics factory, teachers make comments and supplementary explanations; within 3 days after class, teachers release extended assignments on the platform, such as modifying and improving the monitoring scheme and virtual simulation experiment tasks. Students complete and submit reports online, and teachers provide feedback on the correction within 48 hours. For students with learning difficulties, one-on-one online tutoring is provided, which effectively breaks the time and space limitations of traditional classrooms and improves the pertinence of teaching.

4.2.2 Explore project-driven and case-based teaching

With real enterprise safety projects and typical cases as the dual core, the practice-oriented teaching process is reconstructed. In terms of project-driven teaching, cooperation is established with 3 local chemical enterprises and 2 construction enterprises to obtain the annual safety project needs of the enterprises. The projects are decomposed into three stages of tasks: demand research, scheme design, and result acceptance. Students undertake the projects in groups of 5 people and complete the work within a 12-week teaching cycle. For example, after a group undertakes a risk assessment project of a chemical enterprise, they first communicate with the enterprise's safety director through online meetings to clarify the needs, then conduct on-site research on the enterprise's production workshop, identify 23 risk factors using the knowledge they have learned, and finally form an assessment report including risk level classification and rectification measures. The enterprise's safety director participates in the result acceptance and puts forward revision suggestions. In terms of case-based teaching, 8 types of typical cases such as mine water inrush, chemical explosion, and high-rise building fire are carefully selected, and teaching is carried out in four steps: case presentation, problem decomposition, scheme design, and review summary. For example, in the case teaching of mine water inrush, the accident simulation animation and rescue documentary are played first, guiding students to decompose three core issues: the cause of water inrush, personnel evacuation, and rescue plan. Then, groups are organized to design targeted prevention and rescue plans. Finally, the feasibility of the plans is evaluated with reference to industry standards, so as to comprehensively improve students' ability to solve practical problems.

4.3 Construct an intelligent practical teaching platform

4.3.1 Develop a virtual simulation experiment system

By cooperating with professional technology companies and investing special funds, a safety engineering virtual simulation experiment system is developed, covering three functional modules: accident simulation, risk operation experience, and emergency drill, which is suitable for VR equipment and computer operation. The accident simulation module can simulate 12 types of typical safety accidents such as chemical explosion, building collapse, and mine water inrush. Through the system, students can adjust the accident trigger conditions, observe the accident spread speed, damage range, and impact on personnel under different conditions, and generate an accident cause analysis report simultaneously; the risk operation experience module includes 8 types of high-risk operation scenarios such as high-altitude operation, confined space operation, and hot work. After wearing VR equipment, students can simulate the processes of wearing safety protective equipment, inspecting the operation environment, and operating equipment in a standardized manner. The system prompts operation errors in real time and deducts points; the emergency drill module sets 6 types of emergency scenarios such as fire, earthquake, and flood. Students can play roles such as emergency commander, rescuer, and medical staff, and complete tasks such as personnel evacuation, casualty treatment, and resource scheduling within a specified time. The system generates a drill score and improvement suggestions according to the task completion degree. The system sets three difficulty levels: basic, advanced, and challenging. Students can choose independently according to their learning progress. Teachers can view students' experimental data through the background and provide special guidance for weak links in operation, which effectively breaks the time and space limitations and safety risks of traditional practical teaching.

4.3.2 Build a school-enterprise collaborative practice platform

With the help of Internet technology, a school-enterprise collaborative practice platform is co-built with 10 enterprises related to safety engineering, realizing a three-in-one practical teaching model of "remote observation + online internship + joint guidance". In terms of the construction of remote practice bases, high-definition cameras and data acquisition terminals are installed in the enterprise's production workshops, safety monitoring centers, and emergency command rooms. The enterprise's real-time safety data and on-site images are transmitted to the university's practice platform through 5G network. Students can observe the enterprise's daily safety management process online through the platform, ask questions in real time, and get answers from enterprise tutors online. Four fixed observation periods are arranged every month, each lasting 2 hours. In terms of online internship projects, enterprises release internship tasks such as safety scheme design, safety data statistics, and safety training courseware production according to the production plan. Students apply independently through the platform. Enterprise tutors form internship groups after online screening, conduct task guidance once a week through Tencent Meeting, students submit internship results as required, and enterprise tutors provide feedback on revision suggestions within 72 hours. After the internship, an enterprise-certified internship certificate is issued. The platform sets up a school-enterprise joint guidance module, where college teachers and enterprise tutors jointly formulate internship plans, correct internship reports, and hold regular online exchange meetings to solve problems encountered by students during the internship, realizing the in-depth integration of school-enterprise resources and the improvement of practical teaching quality.

5 Conclusion

"Internet +" provides technical support and an innovative path for the teaching reform of safety engineering specialty. Through the in-depth integration of teaching content with cutting-edge technologies, the innovative application of diversified teaching methods, the construction of an intelligent practical platform, and the improvement of the whole-process evaluation system, the problems of outdated content, single method, and weak practice in traditional teaching have been effectively solved, and students' technical application ability and innovative practical ability have been significantly improved.

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