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Research on Teaching System Reconstruction for "Mobile Robot Localization and Navigation" Based on Industry-Education Integration

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Abstract

Aginst outdated teaching content and high proportion of theoretical knowledge in the "Mobile Robot Localization and Navigation" course, this paper proposes a teaching system reconstruction method based on the industry-education integration. The main research contents include the reconstruction of teaching content based on the industry-education integration, creation of immersive teaching environment with equal emphasis on knowledge and ability, construction of multi-teaching evaluation system based on the multiple intelligences theory. Through the research on the reconstruction of curriculum teaching system, students' theoretical knowledge and practical ability can be improved, which can be adapted to the demand of industrial development for professional high-level talents in the field of robotics.

Keywords

Project teaching content, robot engineering major, teaching system reconstruction, immersive teaching environment, new engineering major.

1. Introduction

In recent years, with the support of major national strategies such as "Made in China 2025", China's manufacturing industry has rapidly developed and upgraded. Then a large number of high-level applied technical talents are urgently needed [1]. To promote talent cultivation, China vigorously promotes the development strategy of industry education integration in applied undergraduate colleges. In 2019, the Development and Reform Commission of China issued the "Implementation Plan of the Pilot Construction for the National Industry-Education Integration" [2]. It can be seen that the integration of industry and education, as the guiding principle and development strategy of applied undergraduate colleges, has risen to a national strategy. Furthermore, restructuring the teaching system of the curriculum is one of the important ways to achieve the industry-education integration.

The reconstruction of the teaching system helps to break through outdated teaching concepts and cultivate high-level and high skilled talents who can adapt to the rapid development of the industry by new ways and methods. In response to the problems of the excessive teaching content, outdated teaching systems, and weak practical links, the Department of Chemistry of Tianjin University explored the reconstruction of the teaching system for the "College Chemistry" course [3]. Muhammad Odeh proposed a stepwise project teaching which is more conducive to learning results than classroom lectures [4]. Gao Rongli has carried out a preliminary reconstruction of the teaching system for the course "Physical Properties of Materials" from the aspects of teaching mode, teaching methods, and evaluation mechanism [5]. Starting from the micro level of industry education integration, Han Liying summarized four ways to achieve industry-education integration in professional courses for the reconstruction of the teaching system [6]. Taking typical work tasks as the main thread, Xu Ying reconstructs

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the teaching system according to the work process [7]. Deng Yeying has integrated the teaching concept of industry education integration into the innovative practical training curriculum teaching system of "two integrations and four synergies", which achieves two-way empowerment between schools and enterprises [8]. Xing Yan established the teaching method of "one core, multiple elements" and built a practical platform of "online and offline mixing", then explore d the teaching system under the industry-education integration [9].

The "Mobile Robot Positioning and Navigation" course is an important component of the curriculum system for the robotics engineering major. Through research and analysis, it was found that there are two main problems with the current teaching system. Firstly, proportion of theoretical knowledge is higher which makes students feel bored and uninspiring. Secondly, teaching content is relatively outdated which is unable to meet the needs of the industry. To solve the above teaching problems, this paper proposed the teaching system reconstruction for the "mobile robot localization and navigation" course based on the industry-education integration.

2. Construction Objects for Teaching System Reconstruction

Through the teaching system reconstruction for the "Mobile Robot Localization and Navigation" course, the following objects are to be achieved.

(1) Foundation based on the actual project cases, which can improve students' mastery and application ability of theoretical knowledge through task guidance.

(2) Guidance by the actual work process can cultivate students' professional knowledge, professional abilities, and professional attitudes, which meets the high-level requirements of talent cultivation.

(3) Evaluation system based on the evaluation subject, evaluation process, and evaluation content, which provides clearer and more accurate feedback on students' mastery of theoretical knowledge and practical operation ability.

3. Implementation Strategies for Teaching System Reconstruction

3.1. Reformulate Project Teaching Content

Reformulation of project teaching content based on industry-education integration includes four main contents. Firstly, through research on mobile robot companies, typical work tasks of mobile robots are summarized, and then the basic knowledge, practical abilities, work methods, and organizational preparation abilities required in actual work can be extracted. Integrating the professional abilities and qualities required in practical work into the course of "Mobile Robot Localization and Navigation" course enables students to quickly apply basic knowledge to projects, which can enhance the course's interest and deepen understanding of the knowledge. Secondly, frontline workers, enterprise experts, professional teachers, teaching and research experts, and graduates from mobile robot companies are invited to jointly develop project teaching course content. 8 projects and corresponding 16 tasks have been planned based on a total of 32 class hours, as shown in Table 1. In order to constantly track the cutting-edge technology of mobile robots and meet the real-time talent needs of enterprises, project teaching course content needs to be revised annually. Thirdly, graduates who participate in this course can provide feedback on practical problems, solutions, and work experiences encountered in their positions after graduation through online live streaming or recording, which as a reference for the next revision of teaching content. Lastly, the method of joint teaching between schools and enterprises is adopt. On campus professional teachers are mainly responsible for theoretical knowledge teaching, while enterprise technical backbones are mainly responsible for practical teaching.

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Table 1. Project and corresponding task

Project	Corresponding task
Project 1: Use of roslaunch	Task 1: Start a simple ROS node
	Task 2: Start multiple ROS nodes and set parameters
Project 2: ROS programming application based on C++ language	Task 3: Send and receive ROS messages
	Task 4: Request and Response ROS Service
	Task 5: Request and Response of ROS Action
Project 3: ROS programming application based on Python language	Task 6: Send and receive ROS messages
	Task 7: Request and Response ROS Service
	Task 8: Request and Response of ROS Action
Project 4: Motion Control of Robot	Task 9: record and playback data
	Task10: Motion Control of Robot by data
Project 5: Chassis calibration and functional usage	Task 11: Accuracy calibration of chassis
	Task 12: Usage of ultrasonic function
Project 6: Control mobile robot by voice	Task 13: Control mobile robot by voice
Project 7: Motion control of mechanical arm	Task 14: Motion control of mechanical arm
Project 8: ROS subscription and publishing based on Arduino	Task 15: ROS publisher based on Arduino
	Task 16: ROS Receiver based on Arduino

3.2. Create Immersive Teaching Environment

In the teaching process, an immersive teaching environment adapted to the teaching content is created. By integrating the resources of universities and enterprises, the limitations of previous teaching methods are broken, so that students can learn professional knowledge, develop professional ability and cultivate professional attitude in a variety of application scenarios, which can promote the achievement of goals of the reconstructing the teaching system. The implementation of immersive teaching environment for the "Mobile Robot Localization and Navigation" course under the industry-education integration is divided into 4 steps: determine the application environment, clarify the work position, cultivate the comprehensive ability and summarize the experience, as shown is Fig. 1.

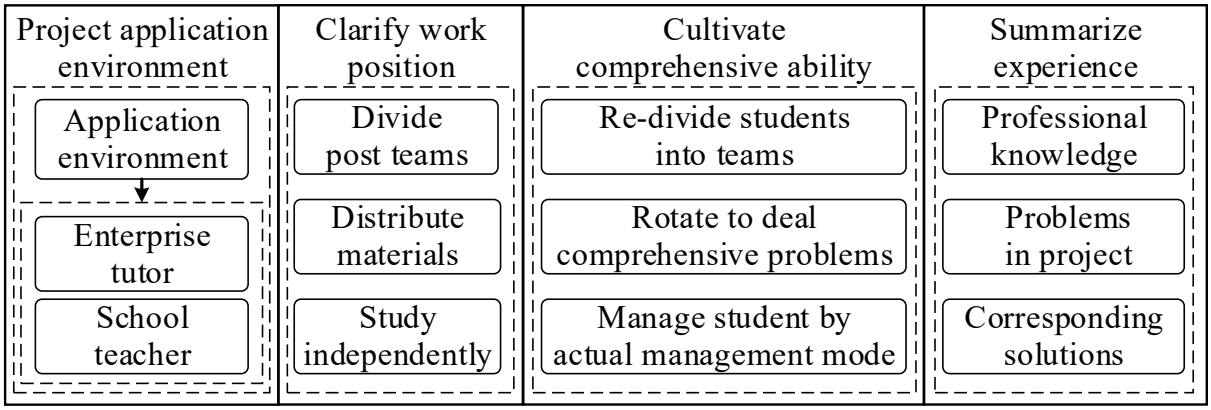

Figure 1. Implementation of immersive teaching environment

Firstly, according to the content of the project, the number of people required for the project, the application environment of the project is jointly determined by the enterprise tutor and the school teacher. Secondly, according to the application environment, the students are divided

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into post teams, and the job responsibilities of each member of the team are determined. Teachers distribute post task materials and supervise students to study independently. Thirdly, based on the actual project and task, the students are re-divided into teams and then rotated to cultivate the ability of each student to deal with comprehensive problems, and the students are managed by the actual management mode in the process of the project. Finally, after the end of the rotation, the students are guided to summarize the professional knowledge used in each position, and summarize the problems encountered in the project and the corresponding solutions in the project report.

3.3. Construct Multi-teaching Evaluation System

The evaluation system of the course is an important way to evaluate the teaching content and teaching methods, which is helpful to improve the teaching quality. The theory of multiple intelligences believes that human intelligence is composed of different parts [10]. Therefore, the diversified evaluation system is constructed based on the theory of multiple intelligences is more objective. The constructing process of the diversified evaluation system for the "Mobile Robot Localization and Navigation" course is shown in Fig. 2, which mainly includes three aspects: evaluation subject, evaluation process, and evaluation content. According to the construction objects for teaching system reconstruction, the evaluation subject will be transformed from a single teacher evaluation to a diversified evaluation system consisting of student self-evaluation, student peer evaluation, enterprise mentor evaluation, and on campus teacher evaluation. The evaluation process adopts a dynamic evaluation approach. At the end of each project, the diversified evaluation subjects conduct comprehensive real-time evaluations of each student's daily behavior, work ability, learning ability, and collaboration ability. The evaluation content is mainly based on project assessment, supplemented by paper exam. The reject assessment accounts for 60%, and paper exam accounts for 40%. Project assessment includes both regular performance and job performance. The project assessment results are composed of 30% and 70% of the regular performance and job performance.

Regular performance is mainly comprehensively evaluated based on learning ability, proficiency level, work discipline, cooperation ability. Job performance is evaluated for each student based on job indicators and project reports. The job indicators are jointly determined by enterprise mentors and on campus teachers.

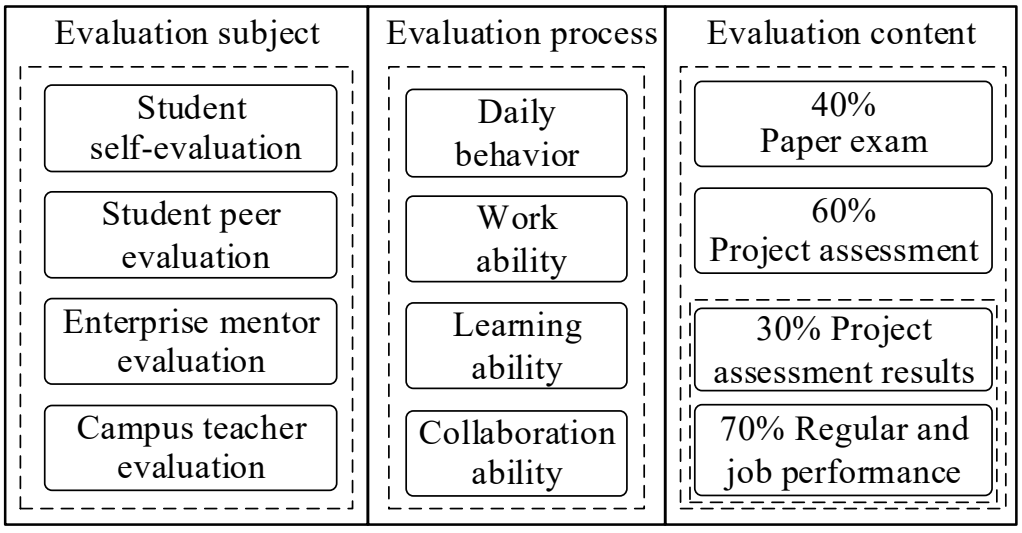

Figure 2. Diversified evaluation system

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4. Conclusion

Through multiple investigations and analyses for “Mobile Robot Localization and Navigation” course, there are two major problems: outdated teaching content and high proportion of theoretical knowledge. To address the two major issues above mentioned, this paper proposes a teaching system reconstruction method based on the industry-education integration. The main research contents include the reconstruction of teaching content based on the industry-education integration, creation of immersive teaching environment with equal emphasis on knowledge and ability, construction of multi-teaching evaluation system based on the multiple intelligences theory. Through the teaching system reconstruction, the integration of enterprise resources and university resources can be applied to talent cultivation in universities, which can achieve the industry-education integration and engineering-knowledge integration. the teaching system reconstruction can improve students' knowledge level, practical ability, and comprehensive literacy, then effectively promote students meet the demand for high-quality talents in the mobile robot industry. This study provides an effective path and case for the teaching system reconstruction of the robotics engineering major, which has important theoretical significance and practical guidance value.

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