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Teaching Reform and Practice Exploration of Graduation Practice Course of Automation Major Based on Industry-learning-research Integration Mode

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Abstract

Graduation practice is an important comprehensive practical teaching component for automation major. It represents the final stage of practical teaching course. This paper addresses issues such as superficial learning experiences and low-quality practice platforms under the "New Engineering" background. It explores the implementation of graduation internship courses based on the integration of industry-learning-research. The discussion focuses on two aspects: the integration of industry and education, and the integration of research and education. Specific measures are proposed to solve these issues and further improve the teaching effectiveness of graduation internship courses for automation majors.

Keywords

Graduation Practice, Integration of Industry-learning-research, Curriculum and teaching reform.

1. Introduction

The 20th National Congress of the Communist Party of China put forward the important thesis of "three firsts", emphasizing the great significance of science and technology, talent and innovation. China has established the world's largest higher engineering education system, and the integration of science and technology, industry and talent training tends to be obvious.

In the context of the development of "new engineering" by the Ministry of Education, the development of the industry has put forward new requirements for popular majors such as automation, artificial intelligence, and robotics education and teaching [1]. In the era of new industrial momentum, new development of science and technology and high-quality talent training, how to enable students to understand the various production links of enterprises related to automation information, how to expose students to the advanced management mode of modern enterprises, how to cultivate students' engineering project management and economic decision-making ability in multidisciplinary engineering practice teams, and how to improve students' self-learning and expansion ability to track cutting-edge knowledge and hot technologies have become important issues to be solved in the teaching of graduation internship courses and the direction of future training.

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2. Teaching Status

Currently, the implementation of graduation internship courses for automation majors primarily focuses on centralized internships, while allowing decentralized internships under certain conditions. The daily schedule for centralized internships is outlined in the internship plan. The internship methods, based on actual circumstances and requirements of the internship units, mainly combine themed lectures, site visits, understanding of process flows, and practical training. Decentralized internships refer to those arranged by students themselves according to their employment or further education needs. The current graduation internship courses face challenges such as outdated knowledge, superficial internship experiences, and low-quality internship platforms, which severely impact the effectiveness of course teaching [2].

3. Teaching Implementation of Graduation Practice Course in The Mode of Integration of Industry-learning-research

To address the challenges faced by current graduation internship courses in automation, the integration of industry, learning, and research has become a necessary choice for educational innovation and talent cultivation. It is essential to deepen the cooperation model among industry, academia, and research, moving toward a talent development approach that is guided by an innovation-driven strategy [3] [4].

3.1. Implementation of industry-education integration practice teaching

To comprehensively advance graduation internship teaching, improve practical teaching quality, and cultivate students' spirit of technological innovation, hands-on skills, and entrepreneurial awareness, it is important to promote close cooperation between educational institutions and enterprises. Following the principles of resource sharing, complementary advantages, and mutual collaboration, we aim to establish an off-campus internship teaching base in partnership with Shandong Aotai Electric Co., Ltd. This collaboration will enhance teaching, research, technological services, and talent exchange.

The implementation will proceed as follows. 1) Both parties will jointly develop the student internship outline, plan, and guidance document. Before each internship, the school and the company will discuss the internship plan and specific measures. 2)During the internship, responsible and experienced teachers will serve as internship supervisors. They will be in charge of guiding students, managing safety, and arranging living conditions. 3)The company will assign qualified engineering technicians or workers. These individuals will have good political qualities, rich practical experience, certain theoretical knowledge, and a strong sense of responsibility. They will be responsible for internship guidance, training, and consultation services. They will guide students in social internships and technological innovation activities. 4) Company technicians will conduct technical lectures and experience exchanges. This will help improve students' innovation and learning abilities. 5) After the internship, the company will evaluate the performance of the students. According to their annual hiring plan, they will prioritize selecting outstanding graduates from the internship base for employment. The internship schedule for the teaching process can be seen in Table 1.

To better meet the training and lecture needs of students, the base has added one smart training classroom. This classroom can accommodate 45 people at a time, allowing internship students to complete assessments and engage in technical exchanges. Additionally, several training devices have been added, including robotic vision equipment and line laser tracking devices, to meet the internship requirements. Currently, the internship base can accommodate over 200 students at a time, rotating through different workshops.

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Based on the internship requirements for the automation major, two training projects have been jointly developed: 1) an explanation of industrial robot internal mechanisms and practical maintenance of industrial robots; 2) assembly of standard robot systems and installation of standard system electrical cabinets. Through the internship at the base, students will achieve a close connection between theory and practice, as well as between their major and industry. They will apply their theoretical and practical knowledge to automate system design.

Table 1. Allocation of teaching hours for each teaching session

Serial number	Teaching content	Hours	Place
1	Explanation of the internship outline	2	Teaching and training classrooms
2	Internship base visit	4	Welding machine, photovoltaic inverter production workshop Robot production workshop R&D and testing center
3	Training on the management system of the internship base Safety education and training	2	Teaching and training classrooms
4	Project training 1	8	Robot production workshop
5	Lectures by engineering and technical personnel and experts	4	Teaching and training classrooms
6	Project training 2	8	Robot production workshop
7	Symposium at the end of the internship at the base	4	Teaching and training classrooms
8	Collect and organize internship materials	4	Teaching and training classrooms
9	Internship assessment	4	Teaching and training classrooms

Students will use software such as Protues and Python in real engineering projects. This experience will help them develop an initial sense of innovation and consider limiting factors. They will accumulate management knowledge and production technology, enabling them to apply theoretical knowledge to solve practical engineering problems. This process will also stimulate creative thinking and enhance their awareness of innovation.

To meet engineering education accreditation requirements, we aim to further standardize the internship process. We will refine the internship management and supervision system to ensure quality in the graduation internship teaching segment. This will help improve the teaching quality of school-enterprise cooperation and maintain high standards for internship quality. For the internship, the training base will evaluate various aspects such as students' attitudes, their skill levels in practical operations, their grasp of professional knowledge, and their responses to work tasks and challenges. Meanwhile, practice base formulated the " Evaluation form of the internship unit on the internship situation" .

The enterprise and the automation major work together to train undergraduate professionals who can serve the regional economy. They actively participate in research and statistics related to training objectives. They provide effective evaluation results to form opinions and analysis reports on the reasonableness of these objectives. This collaboration has positively influenced

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revisions of the training program, especially regarding career fields, career positioning, and professional abilities.

In response to the school's focus on "applied research" talent cultivation, the collaboration between the school and enterprise has been put into practice. This has created an integrated talent training model that combines industry, academia, research, and application. Enterprise experts and technical engineers are strengthening their cooperation with the automation major. A complete training system and assessment method have been established. They participate in revising the professional training program and jointly guide the undergraduate graduation design under a dual mentor system with automation faculty.

3.2. Implementation of research-education integration practice teaching

The concept of "research feeding back into teaching" was put forward in the document titled "Opinions on Deepening the Reform of Undergraduate Education and Teaching to Comprehensively Improve the Quality of Talent Cultivation" (No. 6 [2019] of the Ministry of Education) issued in September 2019. It aims to fully promote the implementation of bringing scientific research achievements into classrooms, enhance the learning interest of contemporary university students, facilitate the opening of university research platforms to undergraduates, and encourage university students to enter laboratories and participate in research projects. This, in turn, cultivates their sense of innovation and improves their innovative capabilities [5].

To better support graduation internships, the automation major offers courses such as "Principles and Control of Robots" and "Digital Image Processing and Machine Vision." These courses lay a solid foundation for the successful implementation of internship projects. They are taught by associate professors or higher who have research experience in robotics and machine vision. The teaching content and methods emphasize the combination of theory and practice. This approach allows students to learn fundamental theories of robotics while encouraging independent innovation and practice. It aims to cultivate students' innovative spirit and improve their practical skills.

The integration of research and education in the courses related to graduation internships in the automation major is a mutually beneficial process [6]. Teachers deepen their understanding of professional knowledge during the teaching process. At the same time, students gradually apply theoretical knowledge in practical operations as they participate in teachers' research activities. The spirit of exploration and innovation during research is crucial for stimulating students' curiosity and creativity. This approach helps to cultivate students' overall quality.

4. Effectiveness of Teaching Reform

By integrating industry-education collaboration and research-education collaboration into the graduation internship courses of the automation major, we have established a high-level internship base. This approach overcomes the drawbacks of observational learning and improves the effectiveness of the internship courses. Through these teaching activities, we cultivate students' abilities in project management and economic decision-making within multidisciplinary engineering teams. Students also enhance their self-learning and expansion skills related to cutting-edge knowledge and emerging technologies. This helps to broaden their international perspective. The specific outcomes are reflected in several areas.

1) In the past five years, 19 graduates from our school have been hired by companies. They mainly hold important positions in the Robotics Division, New Energy Division, Intelligent Research and Development Center, and Human Resources Department.

2) Teachers take part in internships at companies. By collaborating closely with industry experts and engineers, they can understand the needs of businesses firsthand. This helps clarify

research directions and teaching content to better align with regional economic needs and company demands. It provides valuable feedback for refining the professional training goals and course system. This approach supports the development of application-oriented research talents in the field.

3) Both parties work closely together to address the issue of outdated university courses. This collaboration helps eliminate students' feeling that their learning is not applicable.

4) Through student and teacher satisfaction surveys, companies can quickly summarize and identify issues. They adjust internship content while maintaining a student-centered and output-oriented focus. This leads to continuous improvement in teaching effectiveness and enhances the quality of talent training. The satisfaction survey results for students and teachers in the 2023 graduation internship are shown in Table 2 and Table 3

Table 2. Some of the results of the students' survey on graduation internship

Do you think the internship content arranged by the graduation internship unit is rich?		How do you think your graduation internship will affect your future career plans?	
Options	Number	Options	Number
The content is very substantial	17	Clear career plans can be established	27
The content is relatively substantial	73	Basically have a clear career plan	58
The content is not substantial	0	Career planning is still vague	6
The content is very insubstantial	2	Nothing helps	1
Total	92	Total	92

Table 3. Partial results of teachers' research on graduation practice

Are you satisfied with students' knowledge and understanding of technical indicators, intellectual property rights, industrial policies and laws and regulations related to automation engineering during the graduation internship		Do you think graduation internship is helpful for students' future career orientation	
Options	Number	Options	Number
Very satisfied	6	Very helpful	4
Basically satisfied	9	More helpful	9
Generally satisfied	0	Helpful	2
Total	15	Total	15

5. Conclusion

This paper discusses issues in the teaching of graduation internships for automation majors, such as observational learning and low-quality internship platforms. It proposes integrating industry with education and research with education to improve the effectiveness of internship courses. This integration aligns industry, technology, and talent, providing clear direction for the reform of graduation internship teaching.

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