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Teaching Model and Organizational Strategy of Graduate Courses in Intelligent Manufacturing

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Abstract: With the rapid development of the field of intelligent manufacturing, the teaching mode and organizational strategy of graduate courses also need to be updated accordingly to adapt to new technology and market demands. This article analyzed the existing problems and explored improvement strategies and methods through the study of the current graduate education model in the field of intelligent manufacturing. After adopting the teaching mode and organizational strategy of graduate courses in intelligent manufacturing, the average score of students increased from 70 points at the beginning of the course to 87 points at the end. After the implementation of the course, students have shown good performance in project application and innovation. In the team collaboration ability experiment, the average scores for communication efficiency, role allocation, and conflict resolution were 33 points, 25 points, and 22 points, respectively. After adopting teaching modes and organizational strategies, the performance of teachers also received the highest evaluation. These experimental evaluation results comprehensively reflected the effectiveness of teaching strategies and potential room for improvement.

1. Introduction

With the advent of Industry 4.0, intelligent manufacturing has become the core driving force for global manufacturing transformation. This field is not only a technical challenge, but also heavily relies on talent cultivation. Therefore, graduate education in the field of intelligent manufacturing is particularly crucial, as its curriculum design and teaching methods can directly affect the operational skills and innovative abilities of future engineers. Nowadays, many educational practices still adopt traditional models and fail to effectively integrate the latest industry demands and technological advancements, which leads to a disconnect between educational achievements and industry demands. The purpose of this study is to systematically analyze and improve the curriculum and teaching strategies of graduate students majoring in intelligent manufacturing, in order to improve teaching quality and student satisfaction.

This article comprehensively tests the teaching mode of graduate courses in the field of intelligent manufacturing through four experiments. Research has found that project-based and collaborative learning teaching strategies can effectively enhance students' theoretical knowledge, project execution, and teamwork abilities. Students have received enthusiastic feedback on the adjustment of teaching modes, especially expressing great satisfaction with the teacher's performance and course content. This study not only demonstrates a successful framework for implementing teaching models, but also provides valuable empirical data for future teaching improvements.

The article first introduces the background of intelligent manufacturing and its importance in graduate education. In the methodology stage, the course content and industry technology integration, collaborative learning environment construction, and project driven practical teaching are introduced. During the experimental phase, the experimental data and analysis results are presented, and the effectiveness of various teaching strategies is systematically evaluated. The final conclusion section discusses the experimental results, proposes specific teaching improvement suggestions, and looks forward to future research directions.

2. Related Works

In recent years, many studies have focused on how to more effectively integrate information technology with educational practices to improve teaching quality and student engagement. For example, Bai Zhanjun combined the characteristics of classroom teaching and collected data on facial expressions, speech, and body movements to achieve multimodal data fusion for emotion calculation, and determined the optimal emotion calculation model. This study was based on multimodal data fusion sentiment computing technology, aiming to provide a reliable technical path for sentiment computing in VR (Virtual Reality) teaching [1]. Chen Zheng combined rich case studies and practical experience in VR teaching projects to summarize the six characteristics of VR teaching, and proposed a valuable application model for VR teaching construction [2]. Randles S demonstrated how the EPBL (Enquiry and problem-based learning pedagogy) supports curriculum design, providing learners with knowledge and skills to support organizations in effectively working within the context of MIP (Mission-Oriented Innovation Policy), particularly in addressing sustainability challenges [3]. Few studies have simultaneously explored the intersection of derivative relationships and observational learning, which may be a way for teachers to increase their total learning while saving teaching resources. Verdun V R investigated this intersection in the context of teaching third grade students grades, pictograms, and percentage equivalence courses [4]. In order to assist teachers and parents of students in the learning process, Maskati E developed a method that combines education and entertainment, and produced an effective teaching approach. The application proposed by Maskati E successfully supported general learning for students, especially those with reading disabilities [5]. The demand for scientific, technological, engineering, and mathematical skills is increasing, and theoretical knowledge and formulas alone are often insufficient to understand complex phenomena. Holly M hoped to promote the challenging task of designing educational VR platforms by describing the expectations of educators and students [6]. Although these studies demonstrate the potential of new technologies in education, they generally reflect a problem: the lack of a systematic approach to integrate these technologies into the specific teaching needs of intelligent manufacturing majors.

To address the aforementioned issues, some scholars have attempted to introduce project-based teaching methods into the curriculum. For example, Li Yuanbo believed that project-based teaching method, as a project-based practical teaching method, is an important way to promote the reform and innovation of ideological and political courses in universities. Further strengthening the theoretical exploration and practical application of project-based teaching method in the reform and innovation of ideological and political courses in universities can effectively enhance the vitality of ideological and political course construction in universities, and can effectively enhance the effectiveness and affinity of ideological and political courses in universities [7]. Yong L analyzed the characteristics of the course "Embedded Systems" based on the engineering education model, and explored issues such as the course system, textbook construction, and teaching method reform of "Embedded Systems" with engineering project development practice as the main idea [8]. Szab I hoped to improve the teaching quality of instructors by enhancing their skills in advanced technology usage. He also aimed to train instructors on how to combine specific teaching methods with specific technologies, providing guidance, best practices, and strategic concepts for instructors and universities [9]. Liu Liru analyzed the typical problems in the curriculum, course design, and graduation project of the Building Environment and Energy Application major at Guangdong University of Technology, taking it as an example. The project driven teaching method was adopted to optimize professional design and courses, aiming to promote the improvement of graduation design quality [10]. However, this method still faces problems such as insufficient resource allocation and insufficient alignment between teaching content and actual project requirements in practical applications. This article aims to optimize the project-based teaching model by combining collaborative learning theory and intelligent teaching systems, making it more suitable for the characteristics of intelligent manufacturing majors.

3. Methods

3.1 Course Content and Industry Technology Integration

In the process of graduate education in the field of intelligent manufacturing, it is extremely important to highly integrate course content with the latest industry technologies. This article discusses a teaching method that emphasizes the deep integration of advanced industrial technology in curriculum design, enabling students to deeply understand and master the latest trends in market demand and technological development. Taking technologies such as artificial intelligence, the Internet of Things, and machine learning as examples, it is necessary to continuously update the curriculum to ensure that it includes core concepts, practical cases, and operational exercises in these fields [11-12].

In order to achieve teaching objectives, numerous industry experts are worked closely to continuously review and update teaching content. For example, multiple experts with rich experience in the industry are invited to serve as guest lecturers, so that students can not only understand the application of these technologies in practical work through textbooks, but also through on-site communication. Students are able to participate in real-life enterprise projects, such as improving production line operations, which provides practical opportunities for them to apply theoretical knowledge to practical problem-solving. Combining practical learning methods greatly enhances the attractiveness and effectiveness of teaching, making learning more practical and significantly enhancing students' competitiveness in employment.

3.2 Construction of Collaborative Learning Environment

The advantage of collaborative learning lies in complementary abilities, where each learner can contribute a unique role based on their own strengths, promoting better learning outcomes. In addition, interaction and communication between individuals are crucial in collaborative learning, requiring the participation of each member. Collaborative learning not only enhances knowledge innovation, but also enhances learners' social and self-management abilities. Teachers need to provide reasonable guidance and a suitable learning environment [13].

The course design enhances the effectiveness of collaborative learning through various interactive processes. A team video conference is arranged once a week to use a shared online platform for project management and document editing. The mutual evaluation mechanism enables students to evaluate each other's work progress and quality. Through course design, students can share ideas in real-time and solve challenges in projects. In addition, as project mentors, teachers review the work of each team every two weeks, and provide professional advice and necessary additional resources to ensure that each project can effectively move forward according to predetermined goals.

Collaborative learning not only enhances students' technical skills, but more importantly, enhances their skills in communication, teamwork, and leadership. For example, in classroom practice classes, students are asked to play the role of project managers or team leaders, which allows them to experience and learn how to effectively communicate and lead teams to solve problems within a team. This teaching arrangement helps students prepare adequately for their future careers in the intelligent manufacturing industry.

3.3 Project-driven Practical Teaching

Project-driven practical teaching allows students to deeply understand and apply the knowledge they have learned in the field of intelligent manufacturing by constructing a simulated industrial environment. Students need to participate in designing an automation system aimed at optimizing the production process of the factory. In this project, students not only need to utilize the theoretical knowledge they acquire from the classroom, but also use their creativity to integrate the latest technologies, such as introducing robotics or artificial intelligence to improve efficiency [14].

In the teaching mode implemented in this article, students gain profound insights into the field of intelligent manufacturing through specific projects. Taking designing an automated assembly line as an example, students need to comprehensively apply knowledge of mechanical design, electronic control, software programming, and system integration. In this process, teachers are not only educators, but also project consultants, responsible for regularly checking the progress of each team, providing necessary technical support and strategic advice. The evaluation method is also very comprehensive, not only to check whether the final product works properly according to its functions, but also to evaluate the team's collaborative process, innovation level, and how they present the entire project. This evaluation quantification can be expressed using Formula (1):

$$\mathrm{TES} = \mathrm{w}_1 \times \mathrm{TS} + \mathrm{w}_2 \times \mathrm{IS} + \mathrm{w}_3 \times \mathrm{TCS} \quad (1)$$

In Formula (1), w_1, w_2, and w_3 represent weighting factors, representing the importance of technology application, innovation contribution, and team collaboration, respectively. Project-driven practical teaching methods can enhance students' technical skills, while also exercising their teamwork and project management abilities.

4. Results and Discussion

4.1 Theoretical Knowledge Mastery Test Experiment

The theoretical knowledge mastery test experiment evaluates the effectiveness of the graduate course reform in the field of intelligent manufacturing. The experiment involves conducting theoretical knowledge tests on students at the beginning and end of the course, and collecting and comparing the results of the two tests. The testing content includes the basic theory and application technology of intelligent manufacturing. Then, the grade results are visualized to visually demonstrate the progress of students and the effectiveness of teaching strategies.

From Figure 1, it can be seen that at the beginning of the course, the average score of the students is 70 points, while at the end of the course, the average score increases to 87 points, an average increase of 17 points. The highest score increases from 95 at the beginning of the course to 100 at the end of the course, and the lowest score also increases from 45 to 65. From the data conclusion, it can be seen that the teaching mode and organizational strategy adopted effectively enhance students' mastery of theoretical knowledge in the field of manufacturing technology, as shown in Figure 1:

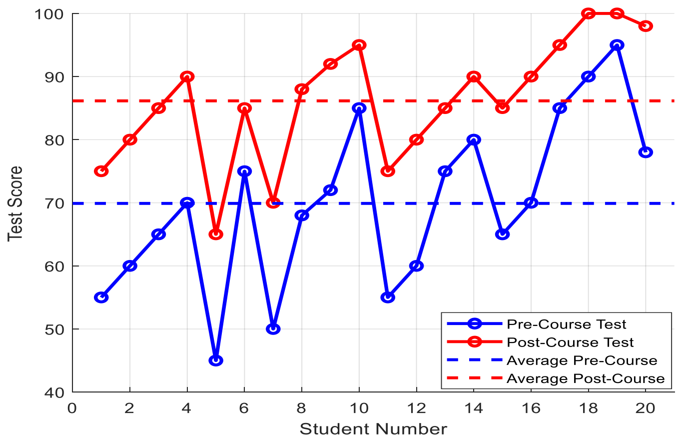

Figure 1: Evaluation of theoretical knowledge mastery

4.2 Evaluation of Project Implementation Effectiveness

To evaluate the project implementation effectiveness of graduate students majoring in intelligent manufacturing, a project implementation effectiveness evaluation experiment is designed. The experiment involves completing specific intelligent manufacturing projects through group division of labor. The project evaluation of the experiment focuses on two indicators: practicality and innovation. After the experiment, the project results of each group are scored through expert and teacher evaluations. The specific score is plotted in a bar chart. The score of the group is shown in Figure 2:

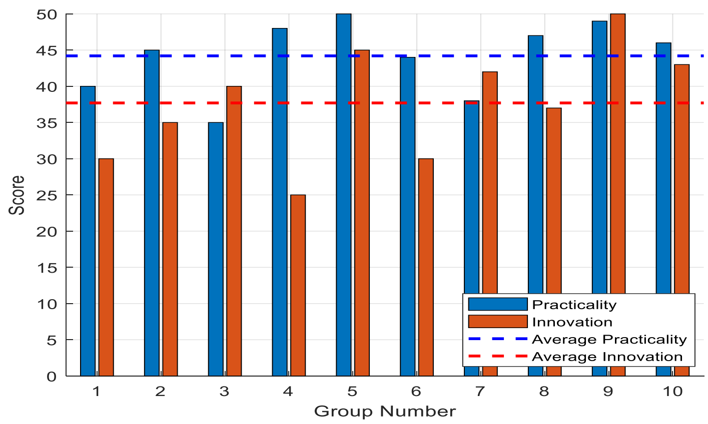

Figure 2: Evaluation of project implementation effectiveness

From Figure 2, it can be seen that in terms of practicality indicators, the average practicality score is 44.2 points, reaching a maximum of 50 points. In terms of innovation indicators, the average score of innovation is 37.9 points, with the highest being 50 points. From the data conclusion, it can be seen that there may be a need to emphasize the cultivation of innovative thinking in future teaching, in order to promote students' innovative ability in technology application.

4.3 Team Collaboration Ability Assessment

The team collaboration ability evaluation experiment evaluates the team collaboration ability of graduate students majoring in intelligent manufacturing. The evaluation indicators in the experiment include communication efficiency, reasonable role allocation, and conflict resolution ability. Before starting, students are assigned to different groups to carry out a semester long design and manufacturing project. Among them, the evaluation of team collaboration ability can be expressed by Formula (2):

$$\mathrm{TE} = \frac{\mathrm{TC}}{\mathrm{TN} \times \mathrm{TH}} \tag{2}$$

Among them, in Formula (2), TE represents team efficiency; TC is the number of completed tasks; TN is the number of team members; TH is the total working hours.

From Figure 3, it can be seen that in terms of communication efficiency indicators, the team's average score is 33 points; the highest score is 40 points; the lowest score is 28 points. On the opposite side of the role allocation indicator, the average score for role allocation is 25 points, with the highest score reaching 30 points. In terms of conflict resolution ability, the average score for conflict resolution ability is 22 points, with the highest being 27 points. The data conclusion shows the strengths and weaknesses of the team in the collaborative process, providing a basis for further team building and teaching optimization. The specific data situation is shown in Figure 3:

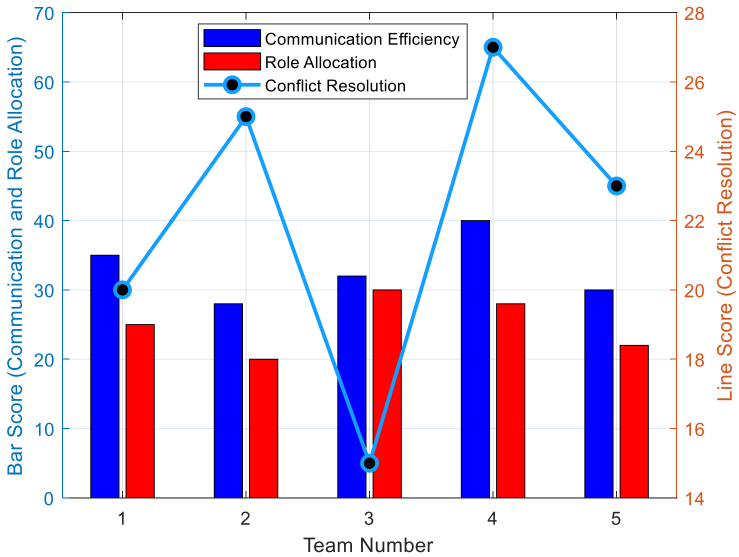

Figure 3: Team collaboration capability assessment

4.4 Student Satisfaction and Teaching Feedback Experiment

The purpose of designing an experiment on student satisfaction and teaching feedback is to evaluate the teaching mode and strategy of graduate courses in intelligent manufacturing through student satisfaction surveys and teaching feedback. For this purpose, a survey questionnaire containing multiple questions is distributed to collect student satisfaction feedback on course content, teaching methods, course resources, and teacher performance, with a maximum score of 5 points. The student satisfaction index can be expressed using Formula (3):

$$M = \frac{\sum_{i=1}^{n}(s_i \times r_i)}{n} \tag{3}$$

Among them, in Formula (3), s_i represents the satisfaction rating of the i-th student; r_i is the corresponding weight; n is the total number of students participating in the rating. The specific data details are shown in Table 1:

Table 1: Analysis of student satisfaction and teaching feedback

Student Number	Course Content Satisfaction	Teaching Method Satisfaction	Resource Availability Satisfaction	Teacher Performance Satisfaction
1	4	4	3	5
2	3	3	4	4
3	5	4	5	5
4	4	4	4	4
5	3	3	3	3

From the data in Table 1, it can be seen that according to the collected data, students generally expressed satisfaction with the course content, teaching methods, and teacher performance, with an average score of over 3.5, especially with the highest evaluation of teacher performance, averaging 4.2 points. However, the satisfaction with resource availability is slightly lower, with an average score of 3.8. From the data in the table, it can be seen that there may be a need to improve the provision of learning resources, and these feedbacks provide valuable information for further improvement of curriculum and teaching resources.

5. Conclusion

In this study, the course teaching mode and organizational strategy of graduate students majoring in intelligent manufacturing were comprehensively analyzed and evaluated, and teaching reforms centered on project-based and collaborative learning were implemented. In the experimental stage, four experiments were designed: theoretical knowledge testing, project implementation effect evaluation, team collaboration ability evaluation, and student satisfaction survey, verifying the effectiveness of this teaching model in improving students' theoretical knowledge, practical operation ability, and team collaboration ability. The experimental results show that students' theoretical knowledge and project implementation ability have significantly improved, and their satisfaction has also improved. Although this study has achieved some positive results, there are also some limitations, such as limited sample size and lack of long-term tracking data. Future research can consider expanding the sample size, studying the impact of different teaching methods on students with various learning styles, and conducting long-term evaluations to further validate the sustained effectiveness and universal applicability of these teaching strategies. In addition, it is also possible to explore the application of technology assisted teaching tools in intelligent manufacturing education to promote innovation and optimization of teaching modes.

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