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Reform and practice of diversified blended teaching of industrial robot programming and application under the background of new engineering

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Abstract. With the advancement of new engineering education, the course of Robot Programming and Application, as an important subject in the field of intelligent manufacturing, urgently needs teaching reform. This paper explores how to improve the teaching effect of the Robot Programming and Application course through a diversified and blended teaching mode under the background of new engineering. Based on the Chaoxing Learning Pass platform, this study combines online and offline teaching resources to construct a teaching mode of "independent learning before class, interactive exploration during class, and extension and improvement after class", and verifies its effectiveness through practice. The results show that the diversified and blended teaching mode can significantly enhance students' learning interest and practical ability, providing a beneficial reference for the teaching reform of related courses under the background of new engineering.

Keywords: new engineering education, robot programming and application, diversified blended teaching, teaching reform

1. Introduction

The course "Programming and Application of Industrial Robots" serves as a core compulsory course for the major of Robotics Engineering, shouldering the responsibility of cultivating students' key abilities and comprehensive qualities. This course aims to enable students to systematically master the basic knowledge, programming principles, and application methods of industrial robots, and to equip them with core capabilities such as system planning, programming and debugging, operation control, and fault diagnosis of industrial robots. At the same time, the course is dedicated to fostering students' practical innovation ability, teamwork spirit, and problem-solving skills, laying a solid foundation for their future careers in industrial robot research and development, design, application, maintenance, and related fields of intelligent manufacturing. In view of this, the teaching team of this course attaches great importance to its construction and initiated the exploration of online teaching as early as 2020. After several years of continuous teaching practice and optimization, the course has won multiple honors and recognitions such as the school-level special construction course, school-level ideological and political demonstration course, innovation and entrepreneurship demonstration course, and online open course, fully demonstrating its outstanding achievements and wide influence in the field of professional course construction.

The construction of new engineering disciplines is an important direction of higher education reform in China, aiming to cultivate high-quality engineering and technical talents who can adapt to the needs of emerging industries. As a core course in the field of intelligent manufacturing, the course of robot programming and application is of great significance for cultivating students' practical and innovative abilities [1]. However, the traditional teaching mode has many problems, such as a single teaching method, a disconnection between teaching content and practical application, and an incomplete assessment and evaluation system. Therefore, exploring a diversified and hybrid teaching mode to meet the requirements of new engineering discipline construction has become an important task of current teaching reform [2].

2. Related research

In the process of mixed teaching reform of robot-related courses, many researchers have actively introduced high-quality online course resources or independently built online teaching resources on the basis of traditional classroom teaching, and carried out

various mixed teaching practices [3]. For example, Wang et al. [4] explored mixed teaching in terms of course content, teaching platforms, and teaching modes; Zhang [5] improved the key and difficult points of the course and introduced virtual robot models for theoretical teaching; Bai [6] reformed the teaching content and methods of the course, and practiced teaching reform by setting up course experiments and strengthening enterprise practice internships; He [7] reconstructed the course content, built a teaching resource library, and designed a three-in-one flipped classroom model before, during, and after class; Liu [8] proposed a design method and idea for online and offline mixed teaching. Wu [9] analyzed the theory of blended learning, combined with domestic and foreign teaching practices, and constructed an "Internet + Education" teaching model based on blended learning, and conducted in-depth discussions on the mixed teaching method from both theoretical and practical aspects. Fan [10] based on the theory of blended learning, designed a mixed teaching model for comprehensive training in engineering disciplines, and detailedly explained it from aspects such as course design, teaching implementation, and teaching evaluation. In addition, many scholars have conducted in-depth discussions on the current mixed teaching mode, methods, and strategies.

However, although these studies and practices have achieved certain results in introducing new online teaching platforms and online teaching methods, how to comprehensively promote the diversified and hybrid teaching reform of the industrial robot course from multiple aspects, multiple angles, and in-depth levels, and achieve the comprehensive optimization of teaching methods, teaching content, and teaching evaluation, remains an important issue to be solved in the construction of new engineering disciplines.

3. Teaching status of the robot programming and application course under the background of new engineering disciplines

With the continuous deepening of the construction of new engineering disciplines, the robot programming and application course, as a key course in the field of intelligent manufacturing, has attracted much attention to its teaching status. This course is dedicated to enabling students to master the fundamental knowledge, programming theories and application skills of industrial robots, thereby enhancing their practical innovation capabilities and comprehensive qualities to meet the urgent demand of modern manufacturing for high-level engineering and technical talents [11]. However, the current teaching situation still faces many challenges, mainly reflected in the following aspects:

3.1. Limitations of traditional teaching models

The traditional teaching model centers on the one-way lecture by the teacher, with students mostly in a passive state of receiving knowledge and lacking opportunities for active participation and practical operation. This model not only leads to students' insufficient understanding of the course content and their difficulty in integrating theoretical knowledge with practical applications, but also restricts the improvement of their comprehensive abilities. Practical operation is an important part of the robot programming and application course, but the traditional teaching model often neglects students' participation in the practical stage, resulting in weak practical abilities of students and their inability to meet the high requirements of modern manufacturing for robot technology talents. Moreover, this one-way knowledge transmission method is difficult to stimulate students' learning interest and initiative, which is not conducive to cultivating students' innovative thinking and autonomous learning ability.

3.2. Disconnection between course content and practical application

The existing course content mostly focuses on the explanation of theoretical knowledge and is not closely combined with practical engineering applications. The update speed of course content lags behind the rapid development of robot technology, resulting in outdated knowledge points and inability to meet the actual needs of modern manufacturing for robot technology. During the learning process, students often find it difficult to effectively apply the knowledge they have learned to solve practical problems, leading to poor learning outcomes. For example, in the course teaching, there is often a lack of in-depth explanation and sufficient practical operation opportunities for key contents such as robot system planning, programming debugging, operation control, and fault diagnosis that are common in actual engineering projects. This makes students feel at a loss when facing practical problems and unsure of how to apply the knowledge they have learned to solve practical difficulties. This disconnection between theory and practice not only greatly affects students' learning enthusiasm but also severely limits the improvement of their comprehensive abilities, making it difficult to meet the high requirements of modern manufacturing for robot technology talents.

3.3. Single assessment and evaluation method

The traditional assessment and evaluation system mainly focuses on the final exam, often neglecting students' performance during the learning process and the cultivation of practical abilities. This single assessment method is difficult to comprehensively reflect students' learning outcomes and is not conducive to the improvement of students' comprehensive qualities. The final exam usually focuses on the examination of theoretical knowledge and is insufficient in evaluating students' practical abilities and innovative thinking. In addition, the traditional assessment method lacks a dynamic evaluation mechanism for students' learning process,

making it difficult to timely discover problems in students' learning and provide targeted guidance. This assessment model not only fails to motivate students to actively participate in the learning process but also does not facilitate teachers to adjust teaching content and methods based on students' learning feedback, thereby improving teaching quality.

4. Construction of a multi-modal blended teaching model

4.1. Construction of a multi-modal blended teaching model

The multi-modal blended teaching model is proposed based on constructivist learning theory and blended learning theory. Constructivist learning theory emphasizes the active construction of students in the learning process, while blended learning theory emphasizes the organic combination of online and offline teaching resources. By combining the two, the leading role of teachers and the main role of students can be fully exerted to improve teaching effectiveness. The core concept of the blended teaching model reform lies in the deep integration of the advantages of traditional offline teaching and modern online teaching, rather than a simple superposition. On this basis, students and teachers should be organically combined to build a "student-centered, teacher-guided" online and offline blended teaching system. The construction of the blended teaching model is shown in Figure 1.

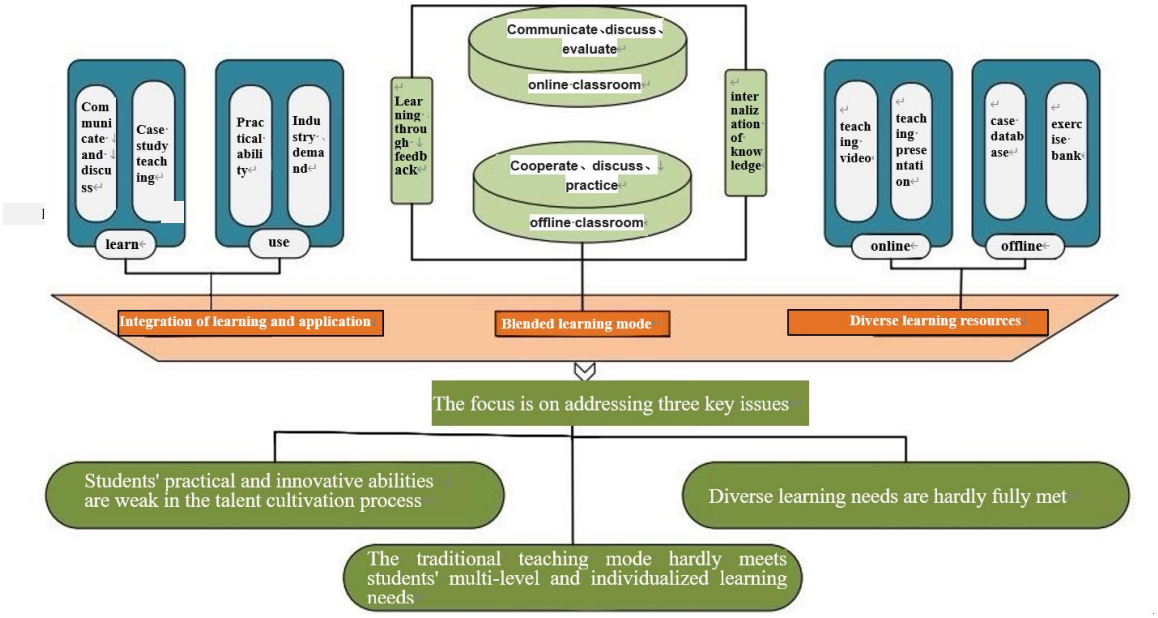

Figure 1. Reform ideas of blended teaching mode

4.2. Teaching mode design

1) Pre-class Autonomous Learning: Utilizing the Chaoxing Learning Pass platform, teachers release pre-class study materials in advance, including video explanations, case analyses, and online tests. Students, through autonomous learning, initially grasp the basic concepts and knowledge points of the course, preparing for in-class learning.

2) In-class Interactive Exploration: During classroom teaching, teachers guide students to deeply explore the course content through methods such as explaining key and difficult points, organizing group discussions, and conducting case analyses. At the same time, they use the interactive functions of the Learning Pass platform to carry out online Q&A sessions and real-time feedback activities, enhancing the interaction between teachers and students.

3) Post-class Extension and Enhancement: After class, teachers assign extension homework, requiring students to consolidate the learned knowledge through practical operations and project practices. Meanwhile, they release extension learning resources on the Learning Pass platform to guide students in autonomous learning and exploration.

Under the blended teaching mode, teachers release task lists and other guiding materials through online platforms to guide students in autonomous learning. Students discuss and exchange around the set tasks, gradually mastering new knowledge through thinking and interaction, and gradually cultivating the ability to solve complex problems. Teachers, based on the statistical analysis of students' learning data, carefully design in-class teaching plans, focusing on explaining and deeply solving common problems of students, emphasizing the improvement of students' practical programming application abilities, and conducting comprehensive evaluations and timely feedback on students' task implementation. After class, teachers collect student feedback through online

questionnaires and release extension learning materials, optimizing and adjusting teaching content based on the feedback to further consolidate and enhance students' learning effects. This blended teaching mode not only effectively expands the boundaries of teaching time and space but also deeply integrates personalized, autonomous, and comprehensive learning, providing students with a more flexible and efficient learning experience.

5. Teaching reform practice

(1) practice object and method

This study takes the professional course "Robot Programming and Application" in the Industrial Robotics direction of the Intelligent Manufacturing College of Geely University as the practice object. Through a comparative experiment, students were divided into an experimental group and a control group. The experimental group adopted a multi-hybrid teaching mode, while the control group adopted a traditional teaching mode, as shown in Table 1.

Table 1. Comparative analysis of teaching effects

Comparison Dimension	Experimental Group (Multi-hybrid Teaching)	Control Group (Traditional Teaching)	Significance Difference (p)
Sample Size	24	24	—
Teaching Mode	Online and offline hybrid teaching (Case teaching + Virtual simulation + Project practice)	Classroom lecture + Experiment operatio	—
Final Average Score	85.6	76.2	$p<0.05$
Practical Assessment Excellent Rate	73%	52%	$p<0.01$
Class Participation	93%	65%	$p<0.05$
Project Completion Quality	4.2/5.0	3.6/5.0	$p<0.01$
Teaching Satisfaction	90%	73%	$p<0.05$

By comparing the learning effects of the two groups of students, the effectiveness of the multi-hybrid teaching mode was verified.

(2) practice process

1) Teaching resource construction: The teaching team meticulously created a wealth of teaching resources, including video explanations, case analyses, online tests, and extended reading materials. These resources were released through the Chaoxing Learning Pass platform for students to study independently.

2) Implementation of Teaching Activities: In classroom teaching, teachers guide students to deeply explore the course content through explanations, discussions, case analyses, etc. Meanwhile, they utilize the interactive functions of the Learning Pass platform to conduct online Q&A sessions and real-time feedback activities, enhancing the interaction between teachers and students.

3) Assessment and Evaluation Methods: A diversified assessment and evaluation system is adopted to comprehensively assess students' learning outcomes. This system covers multiple dimensions including regular performance, experimental performance, and final exam scores. Regular performance is evaluated by assessing students' classroom participation, online learning performance, and contributions to group discussions, providing a comprehensive assessment of students' learning process and attitude. Experimental performance is evaluated by assessing students' practical operation skills and project completion quality, focusing on students' practical abilities and application levels. Final exam scores are determined by testing theoretical knowledge, evaluating students' mastery of the core content of the course. This diversified assessment and evaluation method can comprehensively and objectively reflect students' learning achievements and promote the improvement of students' comprehensive qualities.

6. Analysis of the effects of teaching reform

Through the exploration and practice of the blended teaching reform, the blended teaching mode reform of the "Robot Programming and Application" course has achieved phased results. Feedback from enterprise surveys shows that the direction of the blended teaching reform of the "Robot Programming and Application" course is correct; students are relatively adapted to the teaching mode and have given positive feedback; the operation and maintenance capabilities of industrial robot systems of students under the blended teaching mode have also been affirmed by enterprises. Compared with the previous teaching effect, the teaching

effect of the blended teaching mode has been greatly improved. The comparison of the teaching effects between the blended teaching and the traditional teaching is shown in Table 2.

Table 2. Teaching effect

Content	Content Traditional Teaching Effect	Blended Teaching Effect
learning goal	Obtain credits	Complete tasks
Teaching Mode	Parrot-style	Project-based teaching, online teaching, second classroom
Teacher's Activity (Role)	Lecture	Coach, practice partner, referee
Student's Activity	Passive learning	Autonomous learning, teamwork, task completion
Classroom Atmosphere	Dull	Active, frequent interaction between teachers and students
Teaching Effect	Low learning interest	Enhanced learning interest and innovation ability

Table 1 compares the teaching effects of traditional teaching and blended teaching. Traditional teaching aims to obtain credits and adopts a “parrot-style” teaching mode, where teachers mainly lecture and students passively learn, resulting in a dull classroom atmosphere and low student learning interest. In contrast, blended teaching emphasizes task completion and adopts various teaching modes such as project-based teaching, online teaching, etc. Teachers play roles such as coach, practice partner, and referee, while students engage in autonomous learning, teamwork, and task completion. The classroom atmosphere is active and there is frequent interaction between teachers and students, thereby enhancing students' learning interest and innovation ability. Blended teaching shows significant advantages in multiple dimensions.

The statistics of examination scores of blended teaching and traditional teaching are shown in Figure 2. Compared with the traditional teaching mode, the number of students in the high-score range has significantly increased under the blended teaching mode. This indicates that the implementation of the “Robot Programming and Application” course teaching through the blended teaching mode can effectively promote the deep integration of information-based teaching methods and task-driven teaching methods. Throughout the teaching process, learning resources have been utilized more effectively, students' learning initiative has significantly improved, and the teaching quality has been significantly enhanced, resulting in a very significant teaching effect.

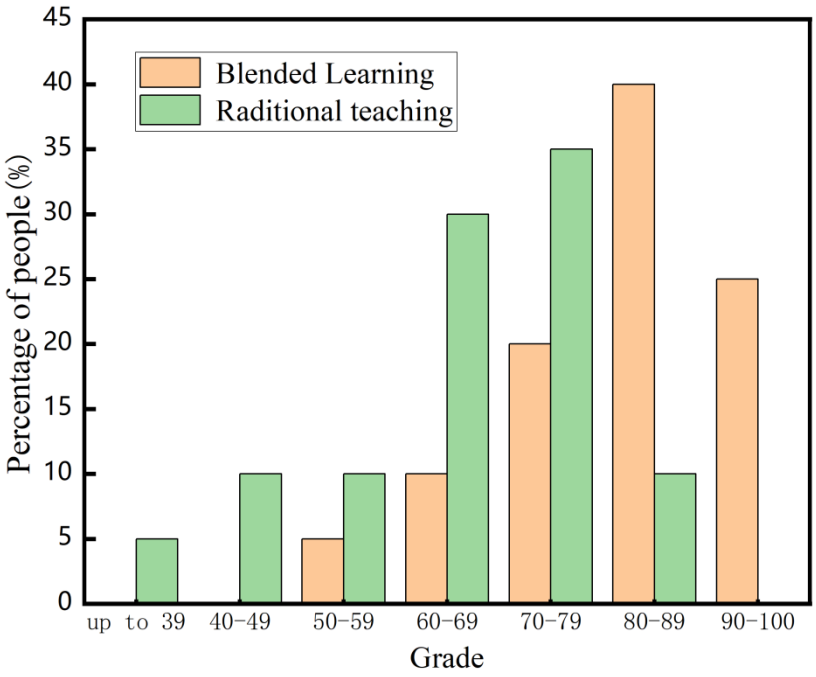

Figure 2. Statistics of examination scores of blended teaching and traditional teaching

7. Conclusion and outlook

This study has carried out teaching reform practice on the course of Robot Programming and Application by constructing a diversified and hybrid teaching model. The results show that this teaching model can significantly enhance students' learning interest and practical ability, providing a beneficial reference for the teaching reform of related courses under the background of new engineering. However, there are still some deficiencies in the teaching reform, such as the construction of teaching resources is not yet perfect, and the organization and implementation of teaching activities are not yet refined. In the future, we will further optimize teaching resources, improve the design of teaching activities, and explore more effective teaching methods to better meet the requirements of new engineering construction.

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