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Exploration and practice of blended teaching of Robot Programming and Application based on Learning Pass and BOPPPS Model

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Abstract. With the continuous advancement of new engineering education, the course of Robot Programming and Application, as a core course in the field of intelligent manufacturing, has an urgent need for teaching reform. This study focuses on the application practice of a blended teaching model based on the Learning Pass platform and the BOPPPS teaching model in this course. By constructing a teaching system covering "pre-class autonomous learning, in-class interactive exploration, and post-class extension and improvement", and deeply integrating the six key links of the BOPPPS model, this study has achieved comprehensive optimization in teaching methods, teaching content, and teaching evaluation. The practical results show that the application of this blended teaching model can effectively break through the time and space limitations of traditional classrooms, enabling students to learn anytime and anywhere in fragmented time, and promoting interaction and communication between teachers and students. This has a significant promoting effect on stimulating students' learning initiative and improving teaching quality, and is highly feasible. In addition, this blended teaching model has performed outstandingly in significantly enhancing students' learning interest and practical ability, providing a valuable reference and inspiration for the teaching reform of related courses under the background of new engineering education.

Keywords: new engineering education, blended teaching, Learning Pass, BOPPPS Model

1. Introduction

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 meet the demands of emerging industries. The course of "Robot Programming and Application" is a core course in the field of intelligent manufacturing and plays a significant role in fostering students' practical and innovative abilities. However, the traditional teaching mode has many problems, such as a single teaching method, a disconnection between teaching content and practical application, and an insufficiently comprehensive assessment system [1]. In recent years, the continuous progress of Internet technology and the wide popularity of mobile terminals have strongly promoted the rapid development of online education platforms. Online courses provide rich online teaching resources for teachers and students, greatly facilitating learners to break through the limitations of time and space to carry out learning activities. However, classroom teaching activities cannot be completely replaced by online courses. To achieve the deep integration of online and offline teaching and enhance the interaction between teachers and students, it is necessary to rationally utilize online resources and mobile terminals and adopt appropriate teaching methods to organize teaching activities [2]. Therefore, exploring a blended teaching mode based on the Learning Pass platform and the BOPPPS teaching model to meet the requirements of new engineering discipline construction has become an important task of current teaching reform.

2. Teaching status of the "Robot Programming and Application" course under the background of new engineering disciplines

2.1. Current implementation status of the course

Table 1. Assessment methods of the course

Score Composition	Composition Item	Proportion	Assessment Requirements
Usual performance	Online Learning	20%	Online learning videos (30%) + Online tests/assignments (30%) + Online interaction/discussion (30%) + Participation in other online activities (10%)
	Classroom Performance	10%	Lateness, early departure, and participation in the content that students must attend as required
	Offline Assignments	10%	Assignment completion status and accuracy rate
	Experiment	10%	Based on the assessment standards of the experimental projects in the experimental guidebook
Final exam grades	Final Exam	50%	Closed-book written test.
Total Evaluation Score		100%	

The "Robot Programming and Application" course is highly comprehensive and challenging, with both theoretical depth and practical breadth. Due to significant differences among students in terms of learning motivation, cultural foundation, learning ability, understanding level, and practical skills, the traditional lecture-based teaching mode is difficult to achieve ideal teaching results. Currently, the assessment methods of this course mainly include classroom performance, online tasks, offline assignments, and final exams, as shown in Table 1. From the perspective of teaching practice, the current course is insufficient in creating a positive classroom atmosphere, making it difficult to effectively ensure students' learning efficiency and effectiveness. Students face certain challenges in understanding and applying knowledge [3]. For instance, some students only scratch the surface when completing online tasks and assignments, lacking in-depth thinking and practical operation, resulting in poor mastery of theoretical knowledge and insufficient practical application ability in the final exam. In addition, the traditional assessment method overly focuses on results and neglects students' performance and progress during the learning process, which is not conducive to stimulating students' learning enthusiasm and initiative [4]. Therefore, it is urgent to reform the teaching mode and assessment method of this course to enhance students' learning interest and practical ability and improve teaching quality.

2.2. Teaching issues of the course

At the current stage, the teaching of the "Robot Programming and Application" course faces the following challenges.

2.2.1. Limitations of traditional teaching mode

The traditional teaching mode mainly relies on teachers' lectures, leaving students in a passive state of knowledge acquisition and lacking opportunities for active participation and practical operation. This results in students' insufficient understanding of the course content and weak practical abilities, which cannot meet the demands of modern manufacturing for robot technology talents.

2.2.2. Disconnection between course content and practical application

The existing course content mostly focuses on theoretical knowledge explanation and is not closely integrated with practical engineering applications. For instance, the course lacks in-depth explanations and practical operations on common robot system planning, programming debugging, operation control, and fault diagnosis in actual engineering projects. This leads to students being at a loss when facing practical problems and poor learning outcomes.

2.2.3. Single evaluation method

The traditional evaluation method mainly relies on the final exam, neglecting students' performance during the learning process and the cultivation of practical abilities. The final exam usually focuses on theoretical knowledge assessment, insufficiently

evaluating students' practical abilities and innovative thinking, and lacks dynamic evaluation of the learning process, making it difficult to promptly identify and solve problems students encounter during learning.

2.2.4. Insufficient teaching resources

Currently, the teaching resources for the "Robot Programming and Application" course are relatively limited, mainly relying on a few textbooks and a small amount of online resources, which cannot meet students' personalized learning needs. Textbook content is updated slowly and fails to reflect the latest progress in robot technology, making it difficult for students to access cutting-edge knowledge. Although online resources provide some supplementation, they mostly consist of theoretical explanations and lack interactive learning modules and virtual simulation platforms closely integrated with practical operations, which is not conducive to the cultivation of students' practical abilities. Additionally, practical teaching resources are insufficient, with outdated and limited laboratory equipment, unable to meet students' needs for sufficient practice. Moreover, there is a lack of practical projects and internship opportunities in collaboration with enterprises, making it difficult for students to apply theoretical knowledge to solve practical engineering problems. The scarcity of these resources restricts the depth and breadth of students' learning and hinders the improvement of teaching effectiveness [5].

2.3. Countermeasures

For the "post-2000s" generation of college students, teaching activities should fully utilize modern and diverse teaching resources and place students at the core of teaching. Based on this, our teaching team has carried out a series of teaching practices and proposed the following suggestions:

(1) Adopt a Blended Teaching Mode. Through the Learning Pass platform, release task lists, video explanations, case analyses, and other guiding materials to encourage students to learn independently. In the classroom, use group discussions, project practices, and other methods to enhance students' participation and practical abilities.

(2) Reconstruct the Course Content. Reconstruct the course content system, adding case analyses and practical operations of actual engineering projects. Design project-driven teaching content based on enterprise demands, closely integrating theoretical knowledge with practical applications. For example, introduce virtual simulation platforms to allow students to conduct practical operations such as robot system planning, programming debugging, and fault diagnosis in a virtual environment. At the same time, invite enterprise engineers to participate in teaching and share practical engineering experiences to enhance students' practical abilities and problem-solving skills [6].

(3) Diversify Evaluation Methods. Adopt diversified evaluation methods, including regular performance, experimental performance, and final exam performance. Regular performance mainly assesses students' classroom performance, online learning situation, and group discussion performance; experimental performance mainly assesses students' practical operation abilities and project completion; final exam performance mainly assesses students' mastery of theoretical knowledge. At the same time, introduce process evaluation, recording students' learning process through the Learning Pass platform to promptly identify and solve problems students encounter during learning [7]. In addition, students are encouraged to participate in robot-related competitions and projects, and their competition results and project achievements are incorporated into the assessment and evaluation system to comprehensively reflect their learning outcomes.

(4) Enrich teaching resources and build an online and offline integrated resource library. Online resources include video explanations, case analyses, online tests, and extended reading materials, which are released through the Learning Pass platform for students' self-study. Offline resources include experimental equipment, project tasks, and enterprise practice cases, providing students with abundant practical operation opportunities. Meanwhile, teachers and students are encouraged to jointly participate in the construction of teaching resources, and students' works and project achievements are included in the resource library to enhance their sense of participation and achievement. Additionally, cooperation with enterprises is sought to introduce actual projects and cases from enterprises, enriching teaching resources and meeting students' personalized learning needs.

To enhance teaching effectiveness, this study attempts to apply the BOPPPS model-based blended teaching mode on the Learning Pass platform to the course of Robot Programming and Application. Relying on the Learning Pass online learning platform, it aims to improve the quality of classroom teaching and students' learning outcomes.

3. Blended teaching design based on Learning Pass + BOPPPS model

The blended teaching mode combines the advantages of traditional offline teaching and modern online teaching, effectively enhancing teaching effectiveness. The BOPPPS (Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, Summary) teaching model is a student-centered teaching design framework that emphasizes the completeness and interactivity of the teaching process. The design of the blended teaching mode based on Learning Pass + BOPPPS model.

3.1. Teaching design

The following takes "Teaching Device Usage" as the theme to elaborate on the blended teaching design based on Learning Pass and BOPPPS model in detail.

3.1.1. Bridge-in

- Objective: Stimulate students' interest in learning and guide them into the learning state.
- Method: Release a video about the application of teaching devices in industrial scenarios through the Learning Pass platform, demonstrating their importance and practical operation cases.
- Activity: After watching the video, students post their opinions and questions in the discussion area, and the teacher provides timely feedback.

3.1.2. Objective

- Objective: Clarify the learning goals of this class and understand the basic functions and operation methods of teaching devices.
- Method: The teacher releases the learning goals on the Learning Pass platform, including theoretical knowledge and practical skills.
- Activity: After reading, students confirm their understanding of the learning goals through the sign-in function.

3.1.3. Pre-assessment

- Objective: Understand students' existing knowledge and skill levels to provide a basis for subsequent teaching.
- Method: Release a pre-assessment questionnaire on the Learning Pass platform, covering the basic functions and operation methods of teaching devices.
- Activity: Students complete the questionnaire, and the teacher analyzes the results in class, pointing out common problems.

3.1.4. Participatory learning

- Objective: Enhance students' practical abilities and innovative thinking through interaction and practice.
- Method: (1) Group discussion: Students discuss issues related to the use of teaching devices in groups, recording the discussion results. (2) Practical operation: Students complete tasks using teaching devices in the laboratory, with the teacher providing guidance and releasing operation videos. (3) Case analysis: Students analyze actual engineering cases in groups and submit analysis reports.
- Activity: The teacher provides real-time feedback and online answers through the Learning Pass platform to guide students' learning.

3.1.5. Post-assessment

- Objective: Evaluate students' learning outcomes and understand their mastery level.
- Method: Release a post-assessment questionnaire on the Learning Pass platform, including multiple-choice questions, short-answer questions, and operation questions.
- Activity: Students complete the questionnaire, and the teacher summarizes and provides improvement suggestions.

3.1.6. Summary and feedback

- Objective: Summarize key points, review the achievement of teaching goals, and evaluate students' performance.
- Method: The teacher releases a summary on the Learning Pass platform, evaluates students' performance, and provides improvement suggestions.
- Activity: Students post their learning experiences in the feedback area, and the teacher replies promptly.

3.2. Teaching process design

The blended teaching process design based on Learning Pass and BOPPPS model is as follows.

3.2.1. Pre-class autonomous learning

- Release guiding materials: The teacher releases task sheets, video explanations, case analyses, and online tests through the Learning Pass platform to guide students' autonomous learning.
- Student autonomous learning: Students initially master the basic functions and operation methods of teaching devices through watching videos, reading materials, and completing online tests.
- Online interactive communication: Students interact and communicate through the discussion area and question-and-answer area on the Learning Pass platform, raise questions and discuss them, and the teacher provides timely feedback.

3.2.2. In-class interactive exploration

- Bridge-in: The teacher releases a video about the application of teaching devices in actual industrial scenarios through the Learning Pass platform to stimulate students' interest in learning and guide them into the learning state.
- Objective: The teacher releases the learning goals of this class on the Learning Pass platform, covering both theoretical knowledge and practical skills. After reading the learning goals, students confirm their understanding through the sign-in function on the Learning Pass platform.
- Pre-assessment: A brief pre-assessment questionnaire is released through the Learning Pass platform to understand students' existing knowledge and skill levels regarding the teaching device. Students complete the questionnaire before class, and the teacher views their answers through the statistics function of the Learning Pass platform.
- Participatory Learning:
  (1) Group Discussion: Students are divided into groups of 5-6 people. The teacher releases discussion topics on the Learning Pass platform, and students discuss within their groups and record the discussion results in the discussion area of the Learning Pass platform.
  (2) Practical Operation: In the laboratory, students use the teaching device to perform practical operations and complete tasks assigned by the teacher. The teacher patrols the laboratory, promptly answers students' questions, and releases operation guidance videos and precautions on the Learning Pass platform.
  (3) Case Analysis: The teacher releases actual engineering cases on the Learning Pass platform, and students analyze the cases in groups, discussing how to use the teaching device to solve practical problems. Each group submits a case analysis report on the Learning Pass platform.
- Post-assessment: A post-assessment questionnaire is released through the Learning Pass platform to evaluate students' learning outcomes. Students complete the questionnaire in class, and the teacher views their answers through the statistics function of the Learning Pass platform to analyze students' learning outcomes.
- Summary: The teacher releases a summary of the key points of the lesson on the Learning Pass platform, reviewing the achievement of teaching objectives. At the same time, the teacher evaluates students' performance in class, praises outstanding groups and individuals, points out problems in students' learning process, and provides improvement suggestions.

3.2.3. After-class extension and enhancement

- Release of Extended Materials: The teacher releases extended learning materials, such as extended reading materials, project tasks, and experimental guidance, on the Learning Pass platform to guide students in self-study and practical operations.
- Online Questionnaire Survey: The teacher releases an online questionnaire on the Learning Pass platform to collect students' feedback on the course, understand their learning needs and suggestions.
- Optimization of Teaching Content: The teacher optimizes and adjusts the teaching content based on students' feedback to further consolidate and enhance students' learning outcomes.

4. Analysis of teaching reform effects

4.1. Enhancement of students' learning interest

Through questionnaires and interviews, it was found that students who adopted the blended teaching mode showed a significant increase in their interest in the course. Students generally believed that this teaching mode enabled them to better understand and master the course content, and also improved their self-study and practical abilities.

4.2. Enhancement of students' comprehensive quality

The blended teaching mode not only enhanced students' learning interest and practical abilities but also promoted the improvement of their comprehensive quality. Through activities such as group discussions and project practices, students' teamwork skills, communication skills, and self-study abilities were significantly improved.

5. Conclusion and outlook

This study conducted teaching reform practice on the Robot Programming and Application course by constructing a blended teaching mode based on the Learning Pass platform and the BOPPPS teaching model. The results showed that this teaching mode could significantly enhance students' learning interest and practical abilities, providing a useful reference for the teaching reform of related courses in the context of new engineering. However, there are still some deficiencies in the teaching reform, such as the incomplete construction of teaching resources and the insufficient refinement of the organization and implementation of teaching activities. 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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