The Teaching Reform of Machine Learning Course Based on PBL Teaching Model

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Abstract: This paper aims to explore the application of Problem-Based Learning (PBL) teaching model in Machine Learning and its impact on teaching reform. By analyzing the theoretical basis, implementation strategy and empirical research of PBL teaching mode in machine learning teaching, this paper aims to propose a set of PBL teaching reform scheme suitable for machine learning courses, and evaluate its role in improving students' learning effect and innovation ability. Through empirical research, This paper compares and analyzes the changes of students' learning effect, learning attitude and innovation ability under PBL teaching mode and traditional teaching mode, which provides theoretical and practical basis for the teaching reform of Machine Learning course.

Keywords: PBL Teaching Model; Machine Learning; Teaching Reform; Problem-oriented Learning

1. Introduction

With the rapid development of artificial intelligence technology, machine learning, as one of its core branches, has been widely concerned in the field of education. The traditional teaching mode has been unable to meet the students' demand for deep understanding and innovative application. Problem-based learning (PBL) is a student-centered teaching model that emphasizes active learning and critical thinking skills through solving practical problems. This study will explore the application of PBL teaching mode in Machine Learning course, analyze its influence on teaching effect, and put forward corresponding teaching reform suggestions [1].

2. Theoretical Basis of PBL Teaching Model

The PBL teaching model originated in the field of medical education in the 1950s, and its core is to promote the knowledge integration and skill development of students by solving real-world problems. Through the process of students' active construction of knowledge meaning, group cooperation and communication, learning of real projects, students' independent exploration and discovery, multiple intelligence learning, teaching techniques and methods, PBL teaching mode is jointly supported, making it an effective teaching method that can promote students' active learning, critical thinking and problem-solving ability. Through PBL, students are able to achieve an in-depth understanding and application of knowledge in the process of solving practical problems, while developing teamwork and communication skills [2, 3].

In the field of machine learning, the application of PBL patterns can stimulate students' in-depth understanding of algorithm principles and promote their ability to solve practical problems. For example, through the selection of actual scientific research topics, guide students to search and read relevant cutting-edge literature, complete scientific research training projects, and share the training content in the blog log, so as to facilitate students to learn from each other, learn from each other and improve the ability of scientific research and innovation. [4, 5]

3. Implementation Strategy of PBL Teaching Model in Machine Learning Course

3.1 Course Design

Courses should be designed around the core concepts and algorithms of machine learning, designing a series of challenging problems and guiding students to explore solutions through group work. [6-10].

The teaching process is shown in Figure 1

below.

Figure 1. Machine Learning Course Teaching Process Based on PBL

3.2 Integration of Learning Resources

Integrate online and offline resources, including open source code libraries, online courses, academic papers, etc., to provide students with rich learning materials [11-13].

3.2.1 Integration concept of learning resources

PBL teaching mode emphasizes student-centered teaching and promotes students' active learning and deep understanding by integrating multi-dimensional learning resources. In the course of Machine Learning, the integration of learning resources should not only include traditional textbooks and academic papers, but also cover online courses, open source code libraries, real case studies, etc., to provide a comprehensive, multi-angle learning environment.

3.2.2 Integration of interdisciplinary resources

Machine learning is an interdisciplinary field, and the integration of its teaching resources should fully reflect this feature. By integrating the resources of computer science, statistics, applied mathematics and other disciplines, students can build a comprehensive knowledge point framework. For example, fundamentals of statistics and linear algebra are introduced to support the understanding of machine learning algorithms.

3.2.3 The combination of practical cases and theoretical learning

Practical cases are an indispensable part of PBL teaching model. By integrating practical cases from industry, students can apply theoretical knowledge to solve practical problems, enhancing the practicality and pertinence of their learning. For example, implementing machine learning algorithms by analyzing real data sets allows students to learn by doing.

3.2.4 Leverage online platforms and tools

Online platforms and tools provide a wealth of resources and interactive ways to teach PBL. Machine learning courses offered by online education platforms such as Coursera and edX, as well as code-sharing platforms such as GitHub, can be leveraged to provide students with real-time updated learning materials and practical tools.

3.2.5 Use of open resources

Open Educational Resources (OER) provide extensive support for the PBL teaching model. By integrating these open resources, the cost of education can be reduced while improving the accessibility of educational resources. For example, the use of open access academic papers and instructional videos to provide students with a wider range of learning materials.

3.2.6 Establishment of feedback and evaluation mechanism

Effective feedback and evaluation mechanisms are critical to the success of the PBL teaching model. By integrating peer review, self-assessment and teacher feedback, students can be provided with comprehensive learning feedback to promote self-reflection and learning improvement.

3.2.7 Resources to promote self-directed learning

Under the PBL model, students need to find and integrate learning resources independently. A series of guiding questions and tasks can be designed to encourage students to actively explore and use resources such as libraries and online databases to cultivate their autonomous learning ability.

3.3 Evaluation Mechanism

Establish a diversified evaluation mechanism, including project reports, group discussions, individual presentations, etc., to comprehensively evaluate students' learning outcomes

The evaluation mechanism of PBL teaching model is the key link to ensure that teaching activities reach the expected learning objectives. In machine learning courses, the design of assessment mechanisms needs to take into account the student's learning process, learning outcomes, and individual and team development. Here are a few core components:

3.3.1 Problem design evaluation

The evaluation should first focus on the quality and effectiveness of the problem design.

Questions should be truthful, complex, and stimulate the curiosity and interest of the student. Questions need to be able to cover important concepts and skills in the machine learning course, ensuring that students are able to deeply understand and apply relevant knowledge in the process of solving problems.

3.3.2 Student Engagement assessment

The PBL model emphasizes student initiative and engagement. The assessment should look at the student's performance in group discussions, whether they actively participate, make constructive comments, and cooperate effectively with group members. Through this assessment, students can be motivated to become more engaged in the learning process.

3.3.3 Knowledge construction evaluation

To assess students' ability to construct knowledge in problem-solving and to integrate new knowledge with existing knowledge effectively. This assessment helps to understand how well students understand and internalize machine learning concepts.

3.3.4 Evaluation of problem-solving ability

Observe students' performance in the problem-solving process, whether they are able to apply their acquired knowledge and skills to solve practical problems and provide creative solutions. This is particularly important for machine learning courses, as the field emphasizes the application and innovation of algorithms.

3.3.5 Diversified evaluation methods

PBL assessment should adopt a variety of methods, including situational assessment, peer and self-assessment, learning log, team statement, electronic file and concept map. These methods can comprehensively assess students' performance in different areas, including practical problem solving, teamwork and personal reflection.

3.3.6 Continuous and phased evaluation

PBL assessment focuses not only on the end result, but also on the learning process. Continuous assessment focuses on student performance at the end of each session, while phased assessment is done at the end of each case study. This kind of evaluation is helpful to adjust teaching strategies in time and ensure the realization of teaching objectives.

3.3.7 Feedback and improvement

Evaluation results should be made available to students and teachers for self-reflection and teaching improvement based on feedback. This feedback mechanism is an integral part of the PBL teaching model, which helps to improve the teaching quality and the learning effect of students.

4. An Empirical Study of PBL Teaching Model in Machine Learning Curriculum

For example, the PBL teaching model is implemented in the machine learning course, by designing a series of projects related to practical problems, and having students work together in small groups to solve these problems. These problems deal with the core concepts and algorithms of machine learning and require students to not only understand theoretical knowledge, but also apply it to practical problem solving. The overall implementation process is shown in Figure 2:

Figure 2. PBL Teaching Model Implementation Process

Problem Design: Teachers design a series of unstructured questions that simulate real problems students may encounter in their future professional fields.

Group Cooperation: Students are divided into teams, and each team is responsible for a specific problem. Team members need to collaborate and work together to find solutions to problems.

Resource utilization: Students use libraries, online databases and other resources to independently find the knowledge and skills needed to solve problems.

Teacher Role: Teachers act as facilitators and facilitators, rather than direct providers of knowledge, providing necessary support and feedback to students.

At the same time, the experimental class of big data major in a university was used to conduct the experiment, and the experimental results are shown in Table 1:

Table 1. Front and Back Data Analysis

	Test Type	Number	Mean Value	Standard Deviation	t	df	p
Experimental Class	pretest	34	3.69	0.56	-3.205	33	0.003
	aftertest	34	3.69	0.55			

The pre-test and post-test data of the experimental class were analyzed, and the

paired sample T-test was carried out on the pre-test and post-test data of the class to determine whether there was basically a certain gap between the pre-test and post-test of the experimental class's computational learning effect, so as to test whether there was a significant difference between the experimental class's computational learning effect before and after the experiment.

This study evaluated the effectiveness of PBL by comparing the learning effect of students under PBL teaching mode and traditional teaching mode. The results show that PBL model can significantly improve students' active learning ability and problem solving ability.

5. Suggestions on Teaching Reform

Based on the empirical research results, this paper puts forward the following suggestions for teaching reform:

5.1 Course Design

Project-driven: Design a series of practical projects related to machine learning, allowing students to learn theoretical knowledge while solving practical problems.

Interdisciplinary integration: Students are encouraged to integrate machine learning with other disciplines (such as data science, statistics, software engineering, etc.) to develop integrated problem solving skills.

5.2 Teaching Content

Integrating theory with practice: ensuring that students understand machine learning theories while applying them through practical projects.

Case studies: Introduce industry cases to allow students to analyze and discuss the application of machine learning in different fields.

5.3 Teaching methods

Group work: Students are encouraged to work in small groups to promote the development of teamwork and communication skills.

Flipped classroom: Students teach themselves theoretical knowledge through online resources before class and focus on discussion, practice, and problem solving during class.

5.4 Evaluation Method

Project outcomes: Use student project outcomes as the primary basis for assessment, not just traditional tests and assignments.

Process assessment: Value students' performance during the project, including teamwork, problem solving and innovation.

5.5 Resources and Tools

Experimental platform: Provides a machine learning experimental platform for students to practice algorithms and models.

Open source tools: Students are encouraged to use open source tools and libraries, such as TensorFlow, PyTorch, etc., to improve their practical skills.

5.6 Teacher Role

Facilitators: Teachers should act as facilitators and facilitators rather than mere knowledge transmitters.

Feedback providers: Provide regular feedback to students to help them improve their projects and learning methods.

5.7 Student Ability Training

Critical thinking: Students are encouraged to critically analyze machine learning algorithms and results.

Lifelong learning: Develop students' ability to learn independently to adapt to the rapid development of the field of machine learning.

5.8 Industry Contacts

Corporate Partnerships: Work with businesses to provide students with internship and project opportunities so they can learn about industry needs.

Industry expert lectures: Regularly invite industry experts to give lectures to share the latest industry trends and practical experience.

5.9 Course Feedback and Iteration

Continuous improvement: Constantly adjust and optimize course content and teaching methods based on feedback from students and teachers.

5.10 Ethics and Social Responsibility

Ethical education: Include discussion of machine learning ethics and social responsibility in teaching to develop students' professional ethics.

In addition to the above, there is also a need to increase the proportion of experiments and project practice, so that students learn by solving real problems.

At the same time, students are encouraged to

combine machine learning with knowledge of other disciplines, broaden their knowledge horizons, and provide personalized learning resources and guidance according to students' interests and abilities.

Through these suggestions, the teaching effect of "Machine learning" course can be improved, so that students can master professional knowledge at the same time, but also develop the ability to solve practical problems.

6. Conclusion

The application of project-based learning (PBL) teaching model in Machine Learning courses has been proven to be effective in stimulating students' enthusiasm for learning and enhancing their ability to innovate. Looking forward to the future, the direction of teaching reform should deeply explore the localization implementation strategy of PBL model in order to better meet the learning needs and backgrounds of different students.

Design Machine Learning course projects with local characteristics based on cultural and educational background. Such a design can help students better understand and absorb the concepts of machine learning, while strengthening their identification with the content of the course.

Taking into account the different learning styles and needs of students, a variety of learning resources and project options are provided to enable students to choose the appropriate project according to their interests and abilities, thus improving their learning motivation.

Interdisciplinary elements are incorporated into PBL projects, such as combining machine learning with the fields of economics, sociology, psychology, etc., in order to cultivate students' comprehensive analytical ability and innovative thinking.

Strengthen the combination of theory and practice, so that students can deepen their understanding of machine learning theory in the process of solving practical problems, while improving the ability to solve complex problems.

Establish a dynamic assessment system that not only assesses students' mastery of knowledge, but also their ability to innovate, work in teams, and manage projects.

Teachers should change from traditional knowledge providers to learning facilitators and project coordinators, and become more involved in students' project guidance and feedback to help students succeed in the project.

Create a student-centered teaching environment that encourages students to actively explore, ask questions and solve problems, thereby enhancing their ability to learn independently and innovate.

Community and industry involvement is encouraged to provide students with real-world project backgrounds and resources that enable students to apply machine learning techniques in real-world Settings, enhancing the practicality and relevance of learning.

Establish a continuous feedback and improvement mechanism to continuously adjust and optimize the PBL teaching model based on the learning outcomes and feedback of students to ensure the effectiveness and adaptability of the teaching method.

Through these measures, the application of PBL teaching model in Machine learning courses will be more suitable for the local education environment, better meet the personalized learning needs of students, and more effectively enhance the learning motivation and innovation ability of students.

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