Effectiveness Evaluation of PBL Teaching Method in the Course of "Business Data Intelligence Analysis"

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Abstract: *With the rapid development of information technology and the wide application of data science, the course of business data intelligence analysis has become increasingly important in higher education. Problem-Based Learning (PBL), as a student-centered teaching method, is widely welcomed for its emphasis on solving practical problems and cultivating independent learning ability. This study explores the application effect of PBL teaching method in the course of "Business Data Intelligence Analysis," focusing on evaluating its impact on students' learning effectiveness. Through a combination of quantitative and qualitative methods, this paper constructs evaluation indicators for learning effectiveness and analyzes students' performance in knowledge mastery, practical ability, and teamwork. The results show that PBL teaching method effectively improves students' comprehensive abilities, providing important reference for the teaching of business data intelligence analysis course.*

Keywords: *PBL teaching method, business data intelligence analysis, learning effectiveness, evaluation research*

1. Introduction

In the era of big data, business data intelligence analysis has become an important means for enterprise decision-making, making the demand for professionals in this field more urgent. Traditional teaching methods often focus on teacher lectures, and students passively receive knowledge, which is difficult to fully stimulate their initiative and innovation. Problem-Based Learning (PBL), as a student-centered teaching method, has been proven to have significant teaching effects in various disciplines by proposing practical problems to guide students' independent learning and problem-solving.

However, the specific application of PBL teaching method in the course of business data intelligence analysis and its effectiveness evaluation research are not sufficient. Therefore, this study aims to explore the application effect of PBL teaching method in the course of "Business Data Intelligence Analysis," analyze students' performance in knowledge mastery, practical ability, and teamwork through the construction of scientific evaluation indicators, and provide basis and reference for the teaching reform of this course.

2. PBL Teaching Method: Theoretical Foundation and Development

2.1 Origin and Definition of PBL Teaching Method

Problem-Based Learning (PBL) originated in the late 1960s, introduced by the Faculty of Medicine at McMaster University in Canada. Its initial goal was to improve the traditional medical education model, which was predominantly lecture-based, with students passively receiving knowledge. PBL emphasizes learning in real-world problem contexts, encouraging students to engage in self-directed exploration and collaborative teamwork, thereby developing their abilities to solve practical problems and enhance their self-directed learning skills. Since its introduction, this teaching method has rapidly gained global popularity and has been progressively applied in various fields including medicine, engineering, law, business, and social sciences.[1]

The core definition of PBL is a student-centered teaching method that involves presenting complex, open-ended problems to students, prompting them to actively seek solutions. Throughout this process, students not only need to acquire and apply new knowledge but also develop critical thinking, teamwork, and communication skills. The key to PBL is situating learning within real-world contexts, allowing

students to master subject knowledge and skills while solving actual problems. This method not only aids in academic capability enhancement but also prepares students for practical applications in the workplace, laying a solid foundation for their future professional development.

2.2 Theoretical Foundations of PBL Teaching Method

The theoretical foundations of PBL primarily include constructivist learning theory, self-directed learning theory, and cooperative learning theory.

Firstly, constructivist learning theory posits that knowledge is not passively received from teachers but actively constructed by students. Through interaction with their environment, students integrate new and existing knowledge, constructing their understanding of concepts. PBL teaching method aligns with this theory by presenting real-life problems, guiding students to actively construct knowledge through exploration and problem-solving. This process enables students to deeply comprehend the essence of knowledge and apply it in real-world contexts.

Secondly, self-directed learning theory emphasizes the proactivity and self-management capabilities of students in the learning process. PBL fosters these qualities by allowing students to autonomously choose learning resources and methods, sparking their interest and motivation, and cultivating their self-directed learning abilities. This autonomy not only helps students grasp the learning content but also enhances their self-management and time management skills, preparing them for self-directed tasks in future professional environments.

Lastly, cooperative learning theory highlights that students can achieve knowledge sharing and complementarity through teamwork. PBL encourages collaborative problem-solving, nurturing students' cooperative consciousness and team spirit while promoting knowledge exchange and mutual learning among students. Throughout this process, students learn to listen, communicate, and collaborate, improving their team cooperation skills and conflict resolution techniques.[2]

2.3 Key Characteristics and Principles of PBL Teaching Method

PBL teaching method has the following key characteristics and principles:

Problem-Centered Approach: The core of PBL lies in presenting a complex and meaningful problem that is challenging and closely related to real-life contexts. This problem serves as the starting point and driving force for students' learning, guiding them to conduct in-depth exploration and research. For instance, in medical education, a pathological case can be used as a problem to guide students in discussing diagnosis and treatment plans.

Student-Centered Learning: In PBL, students are the primary agents of learning. The teacher's role shifts from being a knowledge transmitter to a facilitator and guide. Through self-directed learning and teamwork, students actively acquire knowledge, analyze problems, formulate hypotheses, and verify solutions. This approach not only enhances students' learning initiative but also strengthens their independent thinking and innovation skills.

Collaborative Team Learning: PBL emphasizes collaborative learning within teams. Through discussion and cooperation, students can share their perspectives and resources, collaboratively solving problems. This process not only aids in knowledge construction but also develops students' collaboration skills and communication techniques. During teamwork, students can learn from each other, complement each other's strengths, and form a more comprehensive knowledge system.

Reflection and Feedback: Reflection is a crucial component of PBL. As students solve problems, they continually reflect and self-assess to understand their progress and areas for improvement. Feedback from teachers and peers also helps students refine their learning strategies and enhance learning outcomes. Through reflection, students gain deeper insights into the learning content and can continuously improve in future learning and work.

Interdisciplinary Integration: PBL encourages students to integrate knowledge and skills from different disciplines to solve problems. This interdisciplinary learning approach helps cultivate students' comprehensive qualities and innovative abilities, enabling them to better tackle complex real-world issues. For example, in a comprehensive project, students might need to combine knowledge from engineering, management, and economics to propose a holistic solution.

2.4 Advantages and Challenges of PBL Teaching Method

PBL teaching method offers numerous unique advantages but also faces certain challenges in its implementation. Its advantages include:

Enhanced Learning Interest and Motivation: By guiding learning through real-life problems, PBL enables students to experience the joy of learning while solving practical issues, thereby stimulating their motivation to learn.

Devopment of Critical Thinking and Problem-Solving Skills: As students tackle complex problems, they continuously analyze, evaluate, and adjust their strategies, fostering critical thinking and problem-solving skills.

However, the implementation of PBL also presents challenges:

Difficulty in Shifting Teacher Roles: Teachers need to transition from traditional knowledge transmitters to learning facilitators and supporters, requiring them to possess high-level guidance skills and flexibility in managing the classroom.

Demand for Resources and Time: PBL requires significant teaching resources and time investment, with teachers needing to prepare comprehensive cases and materials, and students needing extended periods for discussion and research.

3. Application of PBL Teaching Method in the Course of "Business Data Intelligence Analysis"

3.1 Course Design and Teaching Objectives

In applying the PBL teaching method to the course of "Business Data Intelligence Analysis," the course design needs to be oriented towards real problems, integrating core knowledge and skills of business data analysis to construct real-world problem scenarios that students can solve. The course design should adhere to the following principles:

Firstly, the selection of problem scenarios must be meaningful and challenging, capable of stimulating students' interest and motivation for learning. Specifically, these problems should originate from real business data analysis cases, such as marketing data analysis, customer behavior prediction, supply chain optimization, etc.

Secondly, the teaching objectives of the course should be clear and specific, including knowledge objectives, skill objectives, and attitude objectives. Knowledge objectives refer to the basic theories and methods that students need to master, such as data mining techniques, machine learning algorithms, data visualization tools, etc. Skill objectives aim to cultivate students' ability to apply these knowledge to solve practical problems, such as data collection and cleaning, model construction and evaluation, result interpretation and reporting, etc. Attitude objectives include fostering students' critical thinking, teamwork spirit, and ability for continuous learning.

Finally, the course design should include multiple stages, each with clear tasks and assessment criteria, ensuring that students gradually delve into the knowledge and skills of business data intelligence analysis while solving problems.[3]

3.2 Teaching Resources and Technological Support

The effective implementation of the PBL teaching method in the course of "Business Data Intelligence Analysis" relies on rich teaching resources and advanced technological support. Specifically, several aspects are indispensable:

Firstly, provide diversified learning resources, including textbooks, case libraries, datasets, and relevant literature, etc. Textbooks should cover the basic theories and methods of business data analysis, case libraries should contain cases from different domains, datasets should be diversified to ensure that students can access various types of data analysis tasks. Relevant literature can help students understand the latest research progress and application examples.

Secondly, utilize modern educational technology tools to enhance the interactivity and effectiveness of teaching. For example, using online learning platforms, students can access learning resources, submit assignments, and participate in discussions anytime and anywhere. Using data analysis software and tools,

such as Python, R, Tableau, etc., students can conduct practical data analysis and visualization operations. Using virtual labs and simulation environments, students can conduct complex business data analysis experiments to enhance their practical abilities.

Finally, provide timely technological support and guidance. Teachers should regularly conduct technical training to help students become familiar with and master various data analysis tools and platforms. During the learning process, teachers should answer students' questions promptly, provide personalized guidance and feedback to ensure that students can successfully complete various learning tasks.

3.3 Student Participation and Team Cooperation

The PBL teaching method emphasizes students' active participation and teamwork, which is particularly important in the course of "Business Data Intelligence Analysis." Specifically, the following strategies can effectively promote student participation and cooperation:

Firstly, design classroom activities with strong interactivity, such as group discussions, case analysis, role-playing, etc., to stimulate students' learning interest and enthusiasm for participation. In the classroom, teachers can propose challenging problems to encourage students to seek solutions through discussion and collaboration.

Secondly, establish an efficient team cooperation mechanism. Divide students into several groups, each responsible for a specific business data analysis project. During the project, students need to collaborate, each performing their own duties, while regularly communicating and reporting progress and sharing experiences. This collaborative learning model can not only cultivate students' teamwork spirit but also enhance their ability to solve practical problems.

Additionally, adopt diversified assessment methods to motivate students to participate actively. In addition to traditional exams and assignments, various forms such as project reports, presentations, peer evaluations, etc., can be introduced to comprehensively assess students' learning outcomes and participation. Through this multidimensional assessment approach, students can have a more comprehensive understanding of their learning effectiveness, stimulating their motivation for continuous learning and improvement.

4. Evaluation of Learning Effectiveness in the Course of "Business Data Intelligence Analysis" Using PBL Teaching Method

4.1 Construction of Evaluation Indicators for Learning Effectiveness

After applying the PBL teaching method in the course of "Business Data Intelligence Analysis," in order to scientifically assess students' learning effectiveness, a comprehensive and operational set of evaluation indicators needs to be constructed. These indicators should cover various aspects of students' performance in terms of knowledge mastery, skill improvement, and attitude change. Specifically, the evaluation indicators for learning effectiveness can be divided into the following dimensions:

Knowledge Mastery: Evaluate students' understanding and mastery of the basic theories, methods, and tools of business data intelligence analysis. Assessment can be conducted through mid-term exams, final exams, knowledge quizzes, etc.

Practical Skills: Evaluate students' ability to apply the knowledge learned to solve problems in practical projects. This includes data collection and processing, model construction and evaluation, data visualization and report writing, etc. Assessment can be conducted through project reports, practical assignments, and lab experiments.

Problem-solving Ability: Evaluate students' comprehensive ability to analyze problems, formulate solutions, execute plans, and optimize results when facing complex data analysis tasks. Assessment can be conducted through case studies, simulation projects, and real-world exercises.

Teamwork and Communication Skills: Evaluate students' performance in teamwork, including division of labor, information sharing, conflict resolution, and effective communication. Assessment can be conducted through group projects, team presentations, and peer evaluations.

Autonomous Learning Ability: Evaluate students' initiative, thirst for knowledge, and ability for continuous learning during the learning process. Assessment can be conducted through learning journals,

reflection reports, and autonomous learning plans.[4]

4.2 Quantitative Analysis of Learning Effectiveness

Quantitative analysis includes the following steps:

Data Collection: Firstly, collect performance data of students on various evaluation indicators through mid-term exams, final exams, project report scores, practical assignment scores, team presentation scores, and questionnaires, etc. Mid-term and final exams mainly assess students' mastery of basic knowledge and theories; project report scores and practical assignment scores focus on students' practical operational ability and problem-solving ability; team presentation scores evaluate students' collaboration ability and communication skills; questionnaires collect information on students' learning attitudes, participation, and satisfaction. The data collection should cover various teaching activities throughout the semester to ensure the comprehensiveness and representativeness of the evaluation.[5]

Data Processing: After data collection is completed, preprocessing of the data is a crucial step. Preprocessing includes data cleaning, normalization, and outlier detection, etc. Data cleaning aims to remove or correct incomplete, inconsistent, or erroneous data to ensure data quality. Normalization standardizes the data to eliminate dimensional differences between different indicators, making the data comparable. Outlier detection is used to identify and handle outliers in the data to prevent them from adversely affecting the analysis results. Through these preprocessing steps, the accuracy and consistency of the data can be ensured, laying a solid foundation for subsequent statistical analysis.

Statistical Analysis: Utilize statistical software (such as SPSS, R, etc.) to conduct descriptive statistical analysis and inferential statistical analysis on the processed data. Descriptive statistical analysis includes calculating the mean, standard deviation, frequency distribution, etc., aiming to reveal the basic characteristics and overall trends of the data. For example, by calculating the mean and standard deviation, one can understand the overall performance and dispersion of students on various evaluation indicators. Inferential statistical analysis includes t-tests, analysis of variance (ANOVA), correlation analysis, etc., used to test significant differences and relationships between different teaching methods or student groups. For example, t-tests can compare the differences in mid-term and final exam scores to evaluate students' progress in knowledge mastery; ANOVA can explore the impact of different teaching modules on student learning effectiveness; correlation analysis can investigate the relationship between autonomous learning ability and problem-solving ability.[6]

4.3 Qualitative Analysis of Learning Outcomes

Qualitative analysis includes the following aspects:

Interviews and Discussion Sessions: By conducting semi-structured interviews with students, we can gain insights into their perceptions and evaluations of the PBL teaching method, collect information about the difficulties they encountered during the learning process and their strategies for overcoming these difficulties, as well as their suggestions for course design and teaching methods. Interview questions should cover multiple aspects, such as students' overall experience with the PBL teaching method, the difficulty of project tasks, the effectiveness of team collaboration, and the utilization of learning resources. Discussion sessions allow students to freely discuss and share their learning experiences and insights. Through these methods, teachers can obtain firsthand student feedback, understand students' genuine feelings and specific needs in PBL teaching, and use this information to improve teaching design and methods.

Classroom Observation and Documentation: Teachers observe and document students' performance in the classroom, focusing on their participation, interaction, and team collaboration. These observation records provide direct behavioral evidence for qualitative analysis, helping evaluate students' actual performance in learning activities. Specifically, teachers can observe the frequency and quality of students' contributions during discussions, their roles and cooperation in team tasks, their strategies for overcoming difficulties, and their overall learning attitude and enthusiasm. Through systematic classroom observation, teachers can gain a direct understanding of students' learning dynamics and team interactions, providing a reliable basis for further analysis.

Peer Evaluation and Teacher Feedback: Collecting peer evaluations and teacher feedback on individual and team performance provides a comprehensive assessment of students' learning outcomes. These evaluations not only reflect students' learning achievements but also highlight strengths and weaknesses in team collaboration and communication. Peer evaluation allows students to view their performance from different perspectives, understand their roles and contributions within the team, and

develop their assessment skills and sense of responsibility. For example, students can evaluate their peers' contributions, communication skills, and cooperation attitudes in team tasks. Teacher feedback, from a professional standpoint, offers specific guidance and comments, highlighting students' strengths and areas for improvement. For instance, teachers can assess students' depth of thinking, the innovation of proposed solutions, leadership abilities, and cooperative spirit within projects. Combining peer evaluations and teacher feedback forms a comprehensive assessment of student performance, promoting their overall development.

By employing these qualitative analysis methods, educators can systematically assess the effectiveness of the PBL teaching method, identify areas for improvement, and make informed decisions to enhance the learning experience and outcomes for students.

5. Conclusion

This study systematically analyzed the application of PBL teaching method in the course of "Business Data Intelligence Analysis" and found that PBL teaching method has significant advantages in improving students' learning effectiveness. The results of quantitative analysis show that students' scores in knowledge mastery, practical skills, and teamwork have significantly improved; the results of qualitative analysis indicate that students' autonomous learning ability and ability to solve practical problems have been effectively enhanced. At the same time, student feedback shows that they are generally satisfied with the PBL teaching method, believing that this method can better stimulate their interest in learning and improve their comprehensive abilities.

In the future, the application prospects of PBL teaching method in the course of business data intelligence analysis are promising. It is recommended to further optimize the PBL teaching mode in teaching practice, combined with the latest educational technologies and tools, such as virtual reality (VR) and augmented reality (AR), to improve the interactivity and practicality of teaching. Additionally, it is suggested to conduct more empirical studies to explore the application effects of PBL teaching method in different courses and student groups, providing richer theoretical and practical support for the promotion and application of PBL teaching method.

Acknowledgement

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