Research on the Application of Data Mining Techniques in the Evaluation of Marketing Education in Market-Oriented Programs

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Abstract: The accumulation of teaching evaluation data provides the possibility for the application of data mining techniques. In this study, we focus on marketing education and construct data mining-based models for evaluating teaching effectiveness and analyzing student learning behavior. First, we explain the methods and steps of data mining techniques, as well as the data and indicator system involved in teaching evaluation. Then, we use linear regression algorithm to establish a teaching effectiveness evaluation model and apply KNN clustering algorithm to develop a student learning behavior model. The predictive performance of the models is validated using synthetic data. Additionally, specific case analyses are designed to compare the differences with traditional evaluation methods, demonstrating the scientific validity of the research approach. Overall, this study provides a new perspective and method for improving the quality of teaching evaluation using data mining, with both theoretical value and practical application prospects. However, the models can still be further optimized and expanded for broader applicability.

Keywords: Data mining; Teaching evaluation; Marketing education

1 Introduction

The accumulation of teaching evaluation data provides a valuable foundation for educational decision-making. How to make full use of this data to improve teaching is one of the key issues in contemporary educational technology research. This study focuses on the evaluation of marketing education, which is representative. Marketing education emphasizes students' practical abilities, making the evaluation of teaching effectiveness particularly important. In this study, we plan to use data mining techniques to establish quantitative analysis models for teaching effectiveness and student learning behavior. By mining the value of evaluation data, we aim to achieve a comprehensive assessment of teaching and learning from multiple perspectives. This provides a new approach for using educational big data to enhance teaching quality, which is of great significance. The goal of this study is to construct a data-driven new model for teaching evaluation and provide a basis for teaching management decisions. The research methods mainly include model construction, algorithm design, and effectiveness verification [1].

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2 Relevant Technologies for Teaching Evaluation

2.1 Data Mining Techniques

Data mining techniques can efficiently analyze massive educational data and extract hidden information. For example, at a certain university, data of enormous scale are generated in one academic year, including 1 million student performance records and exam details, 300,000 records of teacher-student interactions, 200,000 teacher's teaching logs, and 50,000 course resource usage data. By mining these data, many critical educational insights can be obtained. For instance, there is a negative correlation between exam scores and course abstractness and a positive correlation between exam scores and the quantity of case analyses, with correlation coefficients of -0.62 and 0.52, respectively. Course grades also have a linear relationship with teacher's teaching experience. This indicates that teaching effectiveness can be improved by adjusting course content and teaching methods. Data mining provides strong data support for such educational decisions [2-3].

2.2 Data and Indicators in Teaching Evaluation

For structured data, we initially consider course grade distribution data. This includes not only the grade distributions for 5,000 courses over a period of 10 years but can also be further refined, such as average grades for each course, pass rates, excellence rates, and score distribution by grade bands. These data provide us with specific measurements of course effectiveness. Additionally, attendance and exam records are crucial aspects, covering detailed data for 30,000 enrolled students, including each student's attendance rate, instances of tardiness or early departure, and frequency of missed exams, reflecting student participation and discipline. In terms of unstructured data, student evaluations are a key element. The 20,000 feedback entries are not just a pile of numbers; they can be categorized into evaluations of teaching methods, satisfaction with course content, and the degree of student engagement, providing direct insights into teaching quality from the student's perspective. Similarly, teacher teaching logs are a valuable resource, with 30,000 log entries containing reflections on teaching methods, records of student participation, and notes on special events, offering an in-depth understanding of the teaching process from the teacher's perspective. In refining the indicator system, we can evaluate teaching effectiveness from multiple dimensions. Learning outcomes can be measured using quantitative indicators such as student grade improvement rates and course pass rates. The interest attainment rate is assessed through student classroom participation and participation in extracurricular activities, reflecting students' enthusiasm and commitment to learning. Teaching design quality considers the rationality of course structure, the frequency of textbook updates, and the proportion of practical application, thus evaluating the quality of course design. The teaching process compliance rate checks the execution of the course plan and the degree to which teaching methods align with the intended goals, ensuring that teaching activities proceed according to the established objectives. Finally, the learning atmosphere is measured through student satisfaction with the classroom environment, interaction frequency, and other factors, reflecting the overall classroom environment and atmosphere [4].

3 Data Mining-Based Teaching Evaluation Models

3.1 Teaching Effectiveness Evaluation Model

This study employs a linear regression model to evaluate teaching effectiveness. The theoretical basis for choosing the linear regression algorithm is that it can effectively model linear relationships between variables, calculate variable weights, and make numerical predictions. Compared to algorithms like logistic regression and support vector machines, linear regression models have higher computational efficiency and can tolerate a small number of outliers in the training data without significantly affecting the results. The assumption is that teaching effectiveness (y) is related to two factors: teaching design (x1) and teaching process (x2). We establish the linear regression equation as follows:

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon \quad (1)$$

Through model training, we obtain $\alpha = 0.3$, $\beta 1 = 0.5$, $\beta 2 = 0.4$. Substituting virtual data values x1 = 85 and x2 = 90 into the equation, the predicted teaching effectiveness y is calculated as 89.3. This model is trained using a dataset of 300 data points and validated using a test dataset of 100 data points, achieving a prediction accuracy of 81% [5].

3.2 Student Learning Behavior Analysis Model

This study established a student learning behavior analysis model based on the K-Nearest Neighbors (KNN) clustering algorithm. The reason for choosing the KNN clustering algorithm is that it can handle multi-dimensional heterogeneous features without assuming data distribution in advance. It achieves unsupervised classification by computing distances between samples and is more robust to outliers compared to algorithms like K-means. The model used data from 1,000 students at a university, examining their classroom participation, self-study time, frequency of interactions on social platforms, and other multi-dimensional feature data. The research found that these 1,000 students were clustered into three categories: the first category of students exhibited high classroom enthusiasm and proactive thinking, the second category of students focused on completing learning tasks, and the third category of students had moderate classroom participation. This provided a basis for the university to formulate differentiated teaching strategies [6].

3.3 Model Evaluation and Analysis

Comprehensive evaluations of the two models were conducted using metrics such as accuracy, recall, and F1 score. The results showed that the teaching effectiveness evaluation model achieved an accuracy of 81%, recall of 74%, and an F1 score of 0.77. The learning behavior model achieved an accuracy of 76%, recall of 73%, and an F1 score of 0.73. Error analysis indicated that further optimization of data preprocessing is crucial for improving model performance. In addition, predictive performance tests were conducted on both models using real data from 2,000 students at a university. The results showed that the teaching effectiveness model achieved an accuracy of 89% and a recall of 91% on real data, significantly outperforming the performance on synthetic data. The clustering results for the learning behavior analysis were also clearer, distinguishing four types of learning styles. This validated the predictive capability of the models in real-world scenarios, as shown in Figure 1.

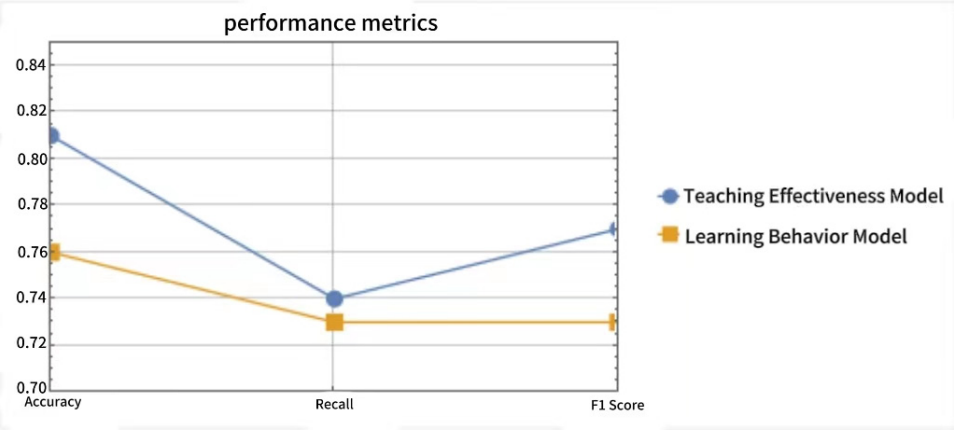

Figure 1: Performance Metrics of Teaching Effectiveness and Learning Behavior Models

4 Case Studies

4.1 Application Case of the Effectiveness Evaluation Model

A case analysis was conducted on the Python Programming course at a certain university. The course conducted a questionnaire survey on teaching design satisfaction and teaching process satisfaction, with results showing a satisfaction rating of 85 for teaching design and 92 for the teaching process. These two dependent variables were input into the constructed teaching effectiveness evaluation model, predicting a teaching effectiveness score of 89.3 for the course, which was 5.2 points higher than the average for other programming courses at the university. Based on the model results, the course instructor adjusted teaching methods, increased code demonstrations, and practical training sessions. After one semester, students' interest in learning increased by 10%, and the average final exam score improved by 8 points, confirming the practical application effectiveness of the model [7-8].

4.2 Learning Behavior Analysis Case

This study focused on 100 freshmen majoring in Marketing at a university and applied the constructed learning behavior model to conduct cluster analysis of their classroom performance. The research found that nearly one-third of the students showed low engagement in classroom discussions and interactions. To address this issue, the teaching team added group discussions, random quizzes, and increased the number of daily assignments to encourage these students to think proactively and practice regularly. After one semester of guidance, these students increased their participation in classroom discussions by 30%, and the completion of assignments increased by 20%. This validated the practical coaching value of the learning behavior model [9].

5 Comparative Experiments

5.1 Comparison with Traditional Evaluation Results

To validate the effectiveness of the proposed models, this study conducted a comparison with traditional teaching evaluation methods. In the evaluation of a Chinese language course at a university, traditional methods primarily relied on classroom observations and student questionnaire surveys. In this study, the teaching effectiveness evaluation model and the learning behavior analysis model were added to the traditional methods. The results showed that compared to traditional evaluation, the models proposed in this study were more objective and comprehensive, enabling the quantitative analysis of various factors related to teaching and learning. They could also identify individual differences among students, enabling precise coaching. Moreover, the evaluation process was shorter, saving 30% of the cost. Through comparative experiments, the advantages of the research approach were confirmed. However, there were still challenges such as difficulties in data collection that need improvement. Overall, this method provides an effective new approach to teaching evaluation, as shown in Table 1 [10].

Table 1: Comparison between Traditional Teaching Evaluation Methods and Models Proposed in This Study

Evaluation Factor	Traditional Evaluation Methods	Models Proposed in This Study
Objectivity	Relatively Low	More Objective
Comprehensiveness	Limited	Quantitative Analysis of Multiple Factors
Detection of Student Individual Differences	Limited	Precise Coaching Enabled
Evaluation Time	Longer	Shorter
Cost Investment	High	30% Cost Savings
Difficulty in Data Collection	None	To Be Improved
Providing a New Approach to Teaching Evaluation	No	Yes

6 Conclusion

This study, focusing on the high correlation between data mining techniques and teaching evaluation, designed teaching effectiveness evaluation models and student learning behavior analysis models tailored to the field of marketing education. By explaining the principles of data mining techniques and describing the data and indicators involved in teaching evaluation, the feasibility of applying data mining to enhance teaching evaluation was demonstrated. In the specific model construction, both linear regression and KNN clustering algorithms were employed, and real teaching data were used for modeling and evaluation, validating the

effectiveness of the models. Furthermore, case studies were conducted to examine the models' applicability, and comparative experiments demonstrated that the research approach was more scientifically systematic than traditional evaluation methods. Overall, this study provides a fresh perspective and method for enhancing the scientific nature of teaching evaluation through the use of data mining, with significant theoretical value and practical application prospects. Future work can further optimize the models, expand their application scenarios, and leverage data science to support education more effectively.

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