Research on the Application of Data Mining Technology in Teaching Management and Decision Support and Its Impact on Improving Teaching Quality

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Abstract. With the rapid development of information technology, the application of data mining technology in the field of education is becoming increasingly widespread. The article aims to provide an overview of the development of data mining technology and its application in teaching management and decision support, clarifying the importance of data mining technology in the field of education. Subsequently, the paper conducted an in-depth analysis of the data requirements and characteristics of data mining technology in teaching management and decision support, and proposed targeted application strategies. Through practical case analysis, the paper demonstrates the specific practice and effectiveness of data mining technology in optimizing teaching management and decision support processes. Finally, the shortcomings and limitations of the research were pointed out, and future research directions and improvement suggestions were proposed. This study not only enriches the application theory of data mining technology in the field of education, but also provides new perspectives and tools for teaching management and decision support, which has important practical significance for improving teaching quality.

Keywords: Data Mining Technology.Education.Teaching Management.Decision Support.Practical Application

1 Introduction

Data mining technology, as a powerful data analysis tool, has shown tremendous potential in multiple fields. In the field of education, teaching management and decision support are key links in improving teaching quality and effectiveness[1]. The application of data mining technology can not only help educators deeply understand and analyze various data in the teaching process, but also provide strong support for teaching management and decision-making.

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2.1 Overview of Data Mining Technology and Its Application Potential in the Teaching Field

With the continuous development of information technology, data mining technology, as an important tool for processing and analyzing large-scale data, has been widely applied in multiple fields such as finance, healthcare, and commerce. Data mining technology can reveal hidden patterns, association rules, and trends in data through the collection, cleaning, transformation, modeling, and analysis of data, providing strong data support for decision-making.

In the field of teaching, the application potential of data mining technology is enormous. Teaching management involves a large amount of student information, course data, teaching resources, etc., which contain rich teaching laws and potential value[2]. Through data mining techniques, educators can deeply analyze and mine these teaching data, identify problems in teaching, optimize teaching processes, and improve teaching efficiency. Meanwhile, data mining techniques can also help educators better understand the learning needs and characteristics of students, providing data support for personalized teaching.

2.2 The Data Requirements and Characteristics of Data Mining in Teaching Management and Decision Support

In teaching management and decision support, the application of data mining technology needs to fully consider the characteristics and needs of teaching data. Firstly, teaching data has diversity and complexity, including various types of data such as student grades, course arrangements, and teaching resources. These data have differences in format, structure, and quality, and require effective integration and cleaning[3]. Secondly, teaching data has timeliness and dynamism, and as teaching activities progress, the data will continuously update and change. Therefore, data mining techniques need to be able to process and analyze this data in real-time to provide timely decision support.

In response to these characteristics of teaching data, the application of data mining technology requires the adoption of appropriate methods and models. For example, clustering analysis can be used to identify the learning characteristics and needs of student groups, association rule mining can be used to discover the correlation between courses, and predictive models can be used to predict student academic performance. The application of these methods can help educators gain a deeper understanding of the teaching situation and provide scientific basis for decision-making.

2.3   Practical Case Analysis of Data Mining Technology in Optimizing Teaching Management and Decision Support Processes

In the teaching management practice of Hubei Vocational and Technical College of Industry, educators have used data mining techniques to conduct in-depth analysis of students' academic performance. Through mining and analyzing a large amount of data, they discovered some interesting phenomena and patterns. For example, there is a significant correlation between grades in certain courses, and the academic performance of certain students is greatly influenced by specific factors. Based on these findings, educators have adjusted and optimized curriculum arrangements and teaching methods, effectively improving teaching quality and student learning outcomes.

In addition, data mining technology has played an important role in teaching resource management, teaching quality evaluation, and other aspects. By mining and analyzing teaching resource data, educators can understand the utilization of teaching resources, optimize resource allocation, and improve resource utilization efficiency[4]. At the same time, by mining and analyzing data on teaching quality evaluation, educators can timely identify problems and shortcomings in teaching, providing strong data support for improving teaching. These practices fully demonstrate the practical application effect of data mining technology in optimizing teaching management and decision support processes. Through the application of data mining technology, educators can conduct teaching management and decision-making more scientifically and accurately[5], providing strong guarantees for improving teaching quality and efficiency.

3   The Path and Mechanism of Data Mining Technology to Improve Teaching Quality and Its Empirical Evaluation

3.1   The Path and Mechanism of Data Mining Technology to Improve Teaching Quality

Data mining technology plays a crucial role in improving teaching quality, providing strong support for the improvement of teaching quality through a series of paths and mechanisms. On the one hand, data mining techniques can reveal the learning characteristics and needs of students by analyzing their learning data. By mining and analyzing data on students' academic performance, learning behavior, interests, and hobbies, teachers can more accurately grasp their learning situation, and thus tailor teaching to their individual needs, developing teaching plans and methods that are more in line with their characteristics. The formulation of this personalized teaching strategy can more effectively stimulate students' learning potential, enhance their learning interest and effectiveness. Secondly, data mining techniques can help teachers optimize the allocation of teaching resources. By mining and analyzing teaching resource data, teachers can understand the utilization of teaching resources and identify problems and deficiencies in resource allocation. Based on these data, teachers can allocate teaching resources more reasonably, improve resource utilization efficiency, and ensure the full utilization and maximum benefits of teaching resources[6].

In order to more accurately describe the application process of data mining technology in improving teaching quality, we can introduce some mathematical formulas and algorithms to assist in explanation. For example, in cluster analysis, we can use the K-means algorithm to partition the student population, and its objective function can be expressed as:

$[J=\sum_{i=1}^{k} \sum_{p \in C_i} ||p - m_i||^2]$

Among them, (C_i) represents the (ith) cluster, $(m1)$ is the mean (centroid) of (C_i), (p) is the point in (C_i), and $(||p - m1||)$ represents the Euclidean distance from point (p) to the centroid of its cluster. By minimizing the objective function (J), we can find the optimal clustering partition, thereby revealing the learning characteristics and needs of the student population.

In association rule mining, we can use the Apriori algorithm to discover the association relationships between courses. The Apriori algorithm is based on a fundamental assumption: if a certain itemset is frequent, then all its subsets are also frequent. By utilizing this property, we can effectively reduce the search space and improve mining efficiency.

3.2   The Actual Effect of Data Mining Technology in Improving Teaching Quality

In order to verify the practical effect of data mining technology in improving teaching quality, this study conducted empirical research.Firstly, we collected a large amount of teaching data, including student academic performance, learning behavior, and utilization of teaching resources. Then, we applied data mining techniques to conduct in-depth analysis and mining of these data. Through data processing and analysis, we have discovered some interesting phenomena and patterns, and based on this, we have proposed some targeted teaching improvement strategies., We applied these improvement strategies to practical teaching and conducted a comparative study of teaching effectiveness. The results show that after applying data mining technology, students' academic performance has significantly improved, and teaching effectiveness has also been significantly improved. Meanwhile, we also found that the application of data mining technology can improve the teaching efficiency and satisfaction of teachers, further promoting the improvement of teaching quality[7].

A predictive model was constructed using data mining techniques to predict student academic performance. This model is based on algorithms such as linear regression or decision trees, and establishes a model for predicting future grades of students by analyzing their historical grades, learning behaviors, and other characteristics. The mathematical expression of the model can be expressed as:

$[\text{Score}_{\text{predicted}}=f(\text{Features})]$

Among them, $(\text{Score}_{\text{predicted}})$ represents the predicted student grades, (f) is a mapping function obtained based on data mining algorithms, and (Features) represents the set of features that affect student grades.

In order to verify the accuracy of the model, we used methods such as cross validation to evaluate the model and calculated indicators such as accuracy and recall. By comparing the changes in student grades before and after using data mining techniques,

we found that the average grades of students were significantly improved after using data mining techniques, and the prediction accuracy of the model also reached a high level.

3.3 Summary of the Key Role of Data Mining Technology in Improving Teaching Quality

Through in-depth research on the paths, mechanisms, and empirical effects of data mining technology in improving teaching quality, we can summarize the key role of data mining technology in improving teaching quality. Firstly, data mining technology provides scientific data support for teaching decision-making. By mining and analyzing student learning data, teaching resource data, etc., we can obtain more accurate and comprehensive information, providing strong basis for teaching decision-making. This makes teaching decisions more scientific and precise, which helps to improve teaching quality and efficiency.

Secondly, data mining technology has promoted the implementation of personalized teaching. By mining and analyzing student learning data, we can understand the learning characteristics and needs of each student, and thus develop personalized teaching plans and methods. This personalized teaching strategy can better meet the needs of students, stimulate their learning interest and potential, and further improve the quality of teaching. In addition, data mining techniques can also help optimize the allocation of teaching resources and improve teaching efficiency. By mining and analyzing teaching resource data, we can understand the utilization of resources, optimize resource allocation, and improve resource utilization efficiency. At the same time, data mining technology can also help teachers better manage teaching progress and classroom order, and improve teaching efficiency.

4   Shortcomings, Limitations, and Future Prospects in the Research

4.1   Shortcomings and Limitations in Research

Although the study has delved into the paths and mechanisms of data mining technology in improving teaching quality and conducted empirical evaluations, there are still some shortcomings and limitations. Firstly, in terms of data collection, due to limitations in data sources and uneven data quality, there may be some bias in the analysis results. Future research needs to collect data more widely and conduct stricter screening and cleaning of the data to improve the accuracy and reliability of the analysis. Secondly, in the selection of data mining algorithms, although this study used some commonly used algorithms, it did not attempt and compare all possible algorithms one by one. Different algorithms may be applicable to different datasets and scenarios, and future research can further explore the application of more algorithms to find the optimal combination of algorithms. In addition, in terms of empirical research, the sample size of this study is relatively small and may not fully represent all situa-

tions. Future research can expand the sample size, increase the diversity of research subjects, and improve the universality and reliability of research. Finally, this study mainly focuses on the application of data mining techniques in improving teaching quality, but does not involve the influence of other related factors, such as teachers' teaching experience and students' learning attitudes. Future research can comprehensively consider more factors to reveal the influencing factors and mechanisms of improving teaching quality more comprehensively.

4.2 Future Research Directions

Future research can be carried out from the following aspects. Firstly, future research can further expand the application scope of data mining technology and explore more possibilities for application in teaching scenarios. For example, data mining technology can be applied to course design, teaching evaluation, and other aspects to further tap into the potential of data mining technology in improving teaching quality. Secondly, future research can focus on the combination and application of data mining technology with other technologies. For example, data mining technology can be combined with artificial intelligence technology to develop intelligent teaching assistance systems, providing students with more personalized and accurate learning support. In addition, future research can further explore the mechanism of data mining technology in improving teaching quality. Through in-depth analysis of the specific application process of data mining technology in the teaching process, the inherent logic and laws of improving teaching quality are revealed, providing more in-depth theoretical guidance for teaching practice. Finally, future research can also focus on the long-term impact of data mining techniques in the field of education. By mining and analyzing teaching data over a long period of time, the long-term effects and impacts of data mining techniques in improving teaching quality can be revealed, providing more comprehensive data support for educational decision-making.

4.3 Improvement Suggestions

To improve the above issues, first, strengthen data collection and organization work. In subsequent research, more attention should be paid to the source and quality of data to ensure its accuracy and completeness. At the same time, stricter screening and cleaning of the data are carried out to eliminate the impact of noise and outliers on the analysis results. Secondly, optimize the selection and application of data mining algorithms. In subsequent research, more types of data mining algorithms can be attempted, and algorithm combinations and optimizations can be made according to actual needs. By comparing the effects and performance of different algorithms, find the most suitable algorithm combination for a specific dataset and scenario. In addition, expanding the sample size and improving the diversity of research subjects. In subsequent research, the sample size can be expanded to include more students and teachers from schools and classes, in order to improve the universality and reliability of the study. At the same time, attention can be paid to student groups from different disciplines and grades to reveal the application effects of data mining technology in different teaching scenarios.

Finally, comprehensively consider more influencing factors and conduct in-depth theoretical discussions. In subsequent research, more factors related to teaching quality can be comprehensively considered, such as teachers' teaching experience, students' learning attitudes, etc., to more comprehensively reveal the influencing factors and mechanisms of improving teaching quality. At the same time, it is possible to strengthen theoretical exploration and model construction, providing more in-depth theoretical support for the application of data mining technology in improving teaching quality.The associated logical architecture is shown in Figure 1
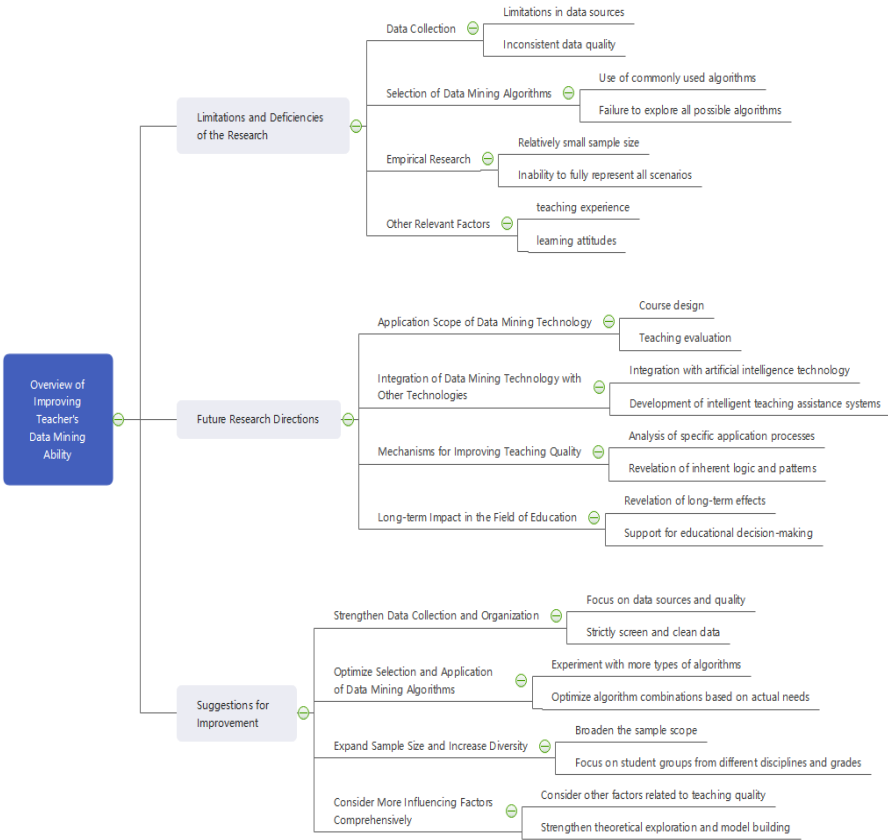
Fig. 1. Overview of Improving Teacher's Data Mining Ability

5   Conclusion

Data mining technology, as a powerful tool for processing and analyzing large-scale data, plays an increasingly important role in teaching management and decision support. With the rapid development of information technology, the teaching field has accumulated a large amount of student information, course data, teaching resources, etc., which contain rich teaching laws and potential value. Through the application of

data mining technology, educators can deeply analyze and mine these teaching data, discover problems in teaching, optimize the teaching process, and improve teaching efficiency.

In teaching management and decision support, the application of data mining technology needs to fully consider the characteristics and needs of teaching data. Teaching data has diversity and complexity, including various types of data, which require effective integration and cleaning. Meanwhile, teaching data has timeliness and dynamism, and data mining techniques need to be able to process and analyze this data in real time to provide timely support for decision-making.

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