

Research on the strategy of improving the management ability of rational education based on Bayesian theory

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Abstract. In view of the complex diversity and dynamic variability of the research problems of rational education management at the present stage, this paper uses Bayesian theory combined with emerging educational technology to effectively improve the quality of data processing, the accuracy of the model and the limitation of computational resources. In the research paradigm, it focuses on the promotion strategy of rational education based on Bayesian theory to cope with the emerging trend in the field of education management. The case study method is used to explore in depth the specific problems in educational practice and to propose targeted solutions. At the same time, the quantitative research method is used to analyse the case data and reveal the rules and trends behind the data. By comparing and analyzing different data models, their applicability is evaluated and the optimal solution strategy is determined. Empirical research shows that Bayesian theory has significant application value in the promotion strategy of rational education, which can provide scientific decision support for education managers and promote the high-quality development of rational education .

Keywords: Bayesian theory, rational education, promotion strategy, empirical research.

1. Introduction

In education, the quality of managers' decision-making directly affects the quality of teaching and student learning outcomes. However, in the face of uncertainty and risk, the traditional deterministic decision-making model may not be able to deal effectively.

Bayesian theory is also known as a reliable, intuitive theory of verification. It mainly uses probability theory and graph theory as the theoretical basis to predict the combination of data, prior knowledge and probability reasoning in the process of uncertain conditions and reasoning judgement. It establishes a relational model, mines potential information, and obtains a more scientific and reasonable network topology model (including Conditional Probability Table, CPT) [1]. Different from the linear model function representation, it directly learns the appropriate weights of each feature through data samples [2], and makes decisions after weighting (as shown in Figure 1 below), which provides a framework for dealing with uncertainty and incomplete information, which is of great significance for educational management.

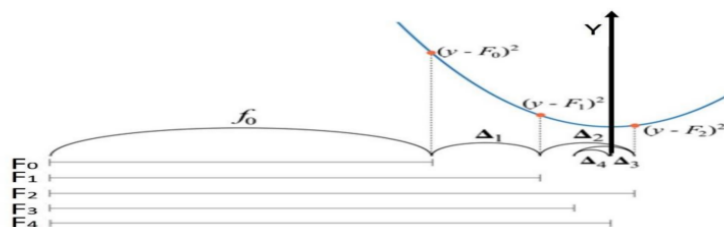


Figure 1. Bayesian theory functions distinguish linear functions

To further and intuitively demonstrate the application value of Bayesian theory in data distribution analysis, and in particular its ability to characterize the correlation between variables in real-world educational data, the corresponding scatter distribution characteristics of Bayesian theory in this context are presented in Figure 2.

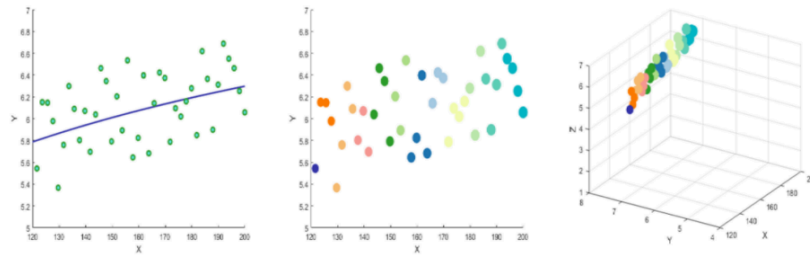


Figure 2. Scattered distributions with applications to Bayesian theory

2. Research methods

With the rapid development of AI technology, there are many emerging trends in the field of education management, such as education informatization (using information technology to optimize the process of education and teaching, improve the efficiency and quality of education and teaching) [3], personalized learning (designing teaching according to students' individual differences to meet the learning needs of different students), data-driven education decision making (using big data analysis technology to provide scientific decision support for education managers and improve the scientificity and effectiveness of education decision making). Through extensive reading of domestic and foreign literature, the existing research methods are sorted out one by one (as shown in Table 1), and the following three research methods are adopted.

Table 1. Journal resource statistics

No.	Title	Author/Editor -in-Chief	Source	Publication Date	Cit ed	Downl oads
1	Knowledge Tracking Research for Smart Education	Fei Liu	Hefei University of Technology	2023/10/1	0	169
2	Deep Cognitive Diagnosis Method for Adaptive Learning and Its Applications	Fei Wang	University of Science and Technology of China	2024/6/3	0	44
3	Research on Educational Application of Key Learning Analytics Technologies in the Context of Big Data	Xia Xiaona	QuFu Normal University	2022/3/31	2	1712
4-188					...	
189	Bayesian Evaluation of Students' Independent Learning in Network Environment	Tian Zide; Wang Guojun	Journal of Baicheng Normal College	2007/12/15	0	161

2.1. Literature review

By searching Yulin Development Library, online network resources, Chinese electronic academic journal database (such as CNKI, Wanfang Dat and Cqvip) and foreign language database (such as Web of Science, Sci-Hub, Google Scholar and Open Access Library), 189 literatures on Bayesian theory, sentiment analysis, rational education and so on are consulted to understand the application technology of Bayesian theory, online learning and other related knowledge. Clarify the development context and research status of education management [4]. The innovation points and shortcomings of the existing research are excavated, and the in-depth research is carried out on the basis of the previous research. The analysis shows that Figure 3 to Figure 6 provide ideas and references for improving the management ability strategy of rational education based on Bayesian theory.

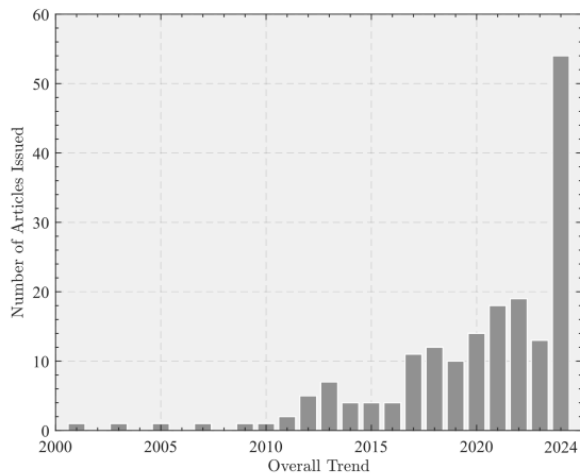


Figure 3. Number of publications in academic journals for the corresponding year



Figure 4. Word clouds

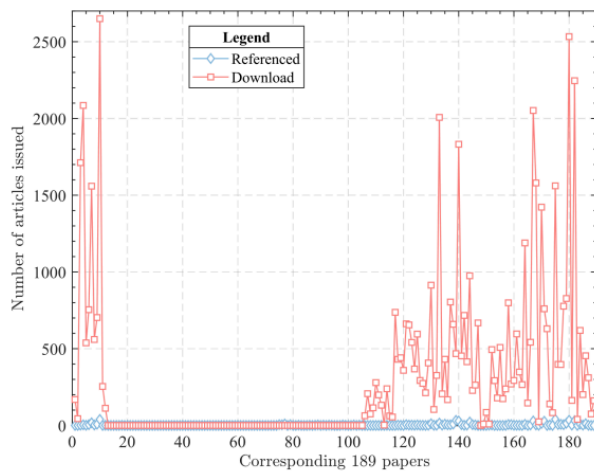


Figure 5. Citation and downloads of papers

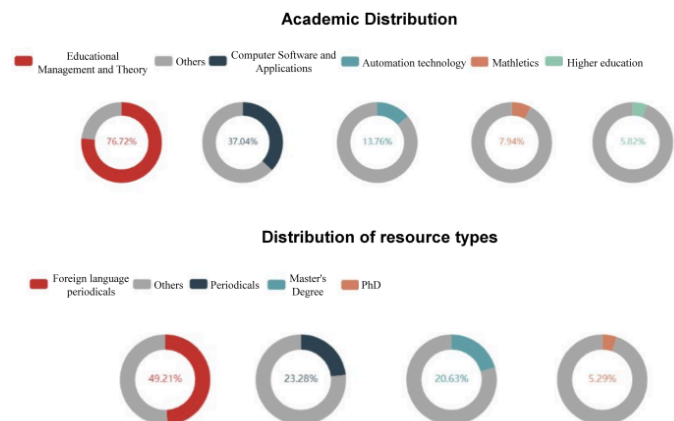


Figure 6. Distribution of disciplines and resource types

2.2. Sentiment analysis

Social Emotional Learning (SEL) is a technology that uses natural language processing technology to mine texts with emotional tendencies, and then summarises the mining results [5]. Some key findings from recent research show that students who take SEL courses have improved their academic performance by an average of 11 percentage points on the Academic Performance Test. Emotion recognition and feature extraction are performed on the obtained data. The vectorisation matrix of the text data is constructed using Bayesian theory probability statistics, and the emotion classification model is established [6]. The final results are comprehensively analysed and evaluated.

2.3. Interdisciplinary

Through the theory and computational method of statistics, combined with the cognitive emotion theory, affective computing theory and machine learning computational method in the field of education [7]. With the help of MATLAB to obtain the data or corpus used to build the model, the emotional calculation of online course reviews is carried out, and the emotional recognition method based on online course reviews is discussed by means of logistic regression, support vector machine and decision tree [8].

3. Field research and study

Rational education plays a vital role in cultivating the all-round quality of students. It involves not only the development of logical and critical thinking, but also decision-making, problem-solving and rational responses to uncertainty.

Table 2. Questionnaire design for the current status of sense of reason education based on Bayesian theory

(Data unit: number of persons)

I. Basic information

Gender:		Grade Level:					Ages:				
Male	Female	Elementary school 6th grade	First year of junior high school	First year of high school	Sophomore year of high school	First year of college	11-12	13-14	15-16	17-18	≥ 19
91	87	62	69	24	19	4	53	72	28	17	4

II. Knowledge of Sense of Reason Education

Q1. Do you understand what sense education is?					Q2. Do you think Sense of Reason education has helped you in your studies and life?				
Very well	Somewhat	Heard of it	Don't know much about it	Not at all	Very helpful	Somewhat helpful	Not very helpful	More than 60% helpful	Not at all
19	104	29	25	1	11	82	71	9	5

III. Rational Thinking

Q3. Which of the following approaches do you usually take when solving problems?					Q4. Are you able to remain calm and rational when facing complex problems?					Q5. Do you often use logical reasoning to analyze problems?				
Investigate	Analyze	Ask	Rely on	Relying	Always	Often	Sometimes	Rarely	Never	Always	Often	Sometimes	Rarely	Never
88	51	18	14	7	32	87	35	22	2	27	69	47	31	4

IV. Emotional Management

Q6. Which of the following ways do you usually respond to setbacks?					Q7. Are you able to manage your emotions effectively?					Q8. Which of the following do you usually do to resolve conflicts with others?				
Calmly	Confide	Release	frustrated	Avoiding	Always	Often	Sometimes	Rarely	Never	Communicate	Avoid	Argue	Seek help	Avoid or ignore
46	79	37	15	1	34	49	57	32	6	79	16	42	39	2

V. School Support

Q9. How well do you think the school is doing in teaching a sense of reason?					Q10. What improvements would you like to see made to the school's sense of reasoning education?									
Very good	Fairly well	Average	Not particularly good	Very poor	Increase the number of related courses		Increase the number of related courses		Train teachers to improve teaching quality		Provide psychological		Concerned by	
74	35	26	34	9	34		56		36		19		33	

Rational education is a broad concept that encompasses both cognitive and emotional aspects. It emphasises that in the process of education we should not only develop students' cognitive skills, but also cultivate their emotional and social skills. In this educational model, Bayesian theory can help managers to better understand and predict students' behaviour [9] in order to make more reasonable and effective decisions. By adopting a Bayesian perspective, educational managers can process information more flexibly, make more accurate risk assessments, and make more reasonable predictions in the face of

uncertainty. This method not only helps to improve the quality of educational decisions, but also promotes the overall improvement of educational management skills.

Through the random sampling of students in Yulin City, concluding primary school, middle school and university, the survey found that (the effective statistical results of 178 samples are shown in Table 2), the school has the following problems in rational education: First, the teaching content is single, lack of cultivation of students' rational thinking and emotion; second, the traditional teaching methods, lack of interactivity and professionalization; third, the education evaluation method is single, lack of comprehensive evaluation of students' comprehensive quality.

In view of these problems, first, we should optimize the teaching content and strengthen the cultivation of students' rational thinking and emotions; second, we should innovate teaching methods, adopt interactive and exploratory teaching methods, and improve students' participation and learning effect. Third, we must improve the educational evaluation system, adopt a diversified evaluation method, and comprehensively evaluate the comprehensive quality of students [10].

4. Empirical results

In order to avoid misapplication of the problem, it is necessary to classify the survey data. Due to the diversity of variables and the diversity of choices, the seven variable attributes of age, question 1, question 2, question 3, question 5, question 7 and question 10 are assigned according to the correct rate, corresponding to the number L1-L7. The number represents the digital distribution to achieve the effect of simplifying and quantifying the data. To facilitate accurate decision-making, the calculation formulae of empirical entropy (used to quantify the uncertainty of survey data) and Gini index (used to measure the purity of feature attributes) [8, 11] are adopted. Among them, the empirical entropy formula is shown in Equation (1), and the Gini index formula is shown in Equation (2); in both formulae, p_i refers to the probability under a particular choice attribute.

$$H(X) = - \sum_{i=1}^n p_i \log(p_i) \quad (1)$$

$$Gini(D) = \sum_{i=1}^n p_i(1 - p_i) \quad (2)$$

Step 1: Derive the 1-5 levels of L1 (age), corresponding probabilities P_1, P_2, P_3, P_4, P_5 , and the Gini index $Gini(D)$ (where D is the L1 feature data set). The specific probability values are as follows:

$$P_1 = \frac{53}{178}, P_2 = \frac{78}{178}, P_3 = \frac{26}{178}, P_4 = \frac{17}{178}, P_5 = \frac{4}{178}$$

Substitute the above probabilities into Equation (2) to calculate the Gini index of L1:

$$Gini(D) = 1 - \sum_{i=1}^5 P_i^2 = 1 - \left[\left(\frac{53}{178} \right)^2 + \left(\frac{78}{178} \right)^2 + \left(\frac{26}{178} \right)^2 + \left(\frac{17}{178} \right)^2 + \left(\frac{4}{178} \right)^2 \right] = 0.69$$

Step 2: Substitute each of the L2-L7 data in turn to calculate the Gini index of all branches. At this time, the branch Gini index calculation formula shown in Equation (3) is used (where D_i is the i -th sub-data set divided by feature a , and $|D_i|$ and $|D|$ represent the sample sizes of the sub-data set and the total data set, respectively):

$$Gini(D, a) = \sum_{i=1}^n \frac{|D_i|}{|D|} Gini(D_i) \quad (3)$$

Step 3: Calculate the characteristic Gini index of L2-L7. The smaller the Gini index value, the greater the purity of the feature attribute and the higher the reliability.

On this basis, Bayesian theory is introduced to further analyze the probability relationship between variables:

Conditional probability: It represents the probability of event B occurring under the premise of event A [12], and its calculation follows Equation (4):

$$P(B|A) = \frac{P(AB)}{P(A)} \quad (4)$$

Joint probability: If there are n events between two unrelated variables, the joint probability can be decomposed into the product of prior probabilities, as shown in Equation (5):

$$P(X_1, X_2, \dots, X_n) = \prod_{i=1}^n P(X_i | X_1, X_2, \dots, X_{i-1}) \quad (5)$$

Posterior probability basis formula: Under the condition that event Y occurs, the probability of event X occurring can be expressed by Equation (6):

$$P(X|Y) = \frac{P(Y|X) \cdot P(X)}{P(Y)} \quad (6)$$

Posterior probability of n independent events: For n independent events, the probability of event X_i occurring when event Y occurs is called the posterior probability [13], and its calculation formula is shown in Equation (7):

$$P(X_i|Y) = \frac{P(X_i) \cdot P(Y|X_i)}{\sum_{j=1}^n P(X_j) \cdot P(Y|X_j) P(Y)} \quad (7)$$

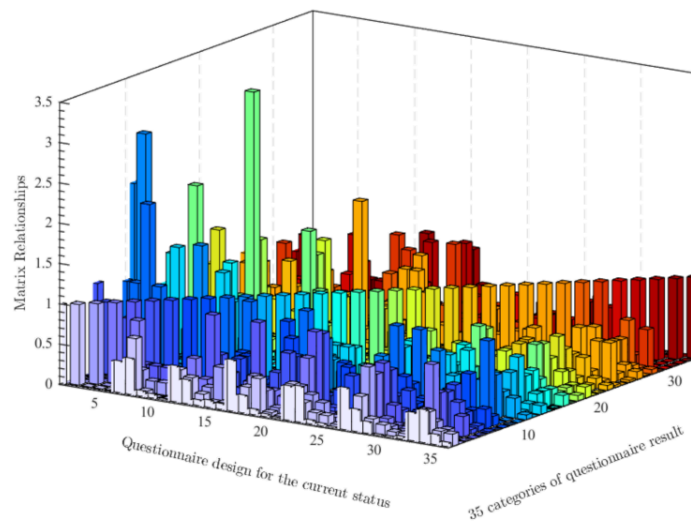


Figure 7. Matrix relationships in three dimensions

Through the quantitative analysis of the case data, the formula operation is substituted, and the three-dimensional histogram of the data matrix relationship (as shown in Figure 7) is obtained. After using the Bayesian network model to optimize the teaching strategy, the students' test scores and classroom performance are significantly improved, indicating that the Bayesian theory has significant application value in the promotion strategy of rational education [14]. In addition, by comparing and analyzing different data models, it is found that the Bayesian network model is superior to the linear regression model in terms of predictive effect and applicability, and it is determined to be the optimal data model.

5. Discussion

5.1. The application value of Bayesian theory in rational education

A Bayesian network model is constructed, which is dynamically updated according to prior knowledge and new evidence, to provide a scientific basis for educational decision-making. By modelling and analyzing the students' learning process, the teaching content and methods can be dynamically adjusted according to the students' knowledge, thus improving the teaching effect. In addition, Bayesian theory can also be used for educational evaluation and educational decision support system, for educational managers [15], to promote the high-quality development of rational education.

5.2. The Impact of emerging trends in education management on rational education

Educational informatization provides rich teaching resources and convenient teaching methods for rational education, and promotes the innovation and reform of teaching methods. The individualized learning of our times emphasizes that teaching

should be carried out according to the individual differences of students, so as to meet the learning needs of different students, provide more accurate teaching support for rational education, improve the scientificity and effectiveness of educational decision-making [16], and provide a strong guarantee for the development of rational education.

5.3. Research limitations and prospects

Firstly, the sample size of the case study is small (178 samples selected by reliability and validity), and the universality of the research findings needs further verification. Secondly, in quantitative research, there may be some errors in data collection and analysis, which may affect the accuracy of the research findings. Future research can expand the sample size and use a variety of research methods for comprehensive analysis to further verify the universality and accuracy of the research results. In addition, AI technologies such as ChatGPT, KIMI, and Deep Seek can also be combined to explore more intelligent and personalised strategies for improving rational education [17], thus providing more powerful support for emerging trends in education management.

6. Conclusion

Emerging trends in education management have had a profound impact on rational education. Emerging trends such as educational informatization, personalized learning, and data-driven educational decision-making have provided new opportunities and challenges for the development of rational education. Bayesian theory has significant application value in the promotion strategy of rational education, which can provide scientific decision support for education managers and promote the high-quality development of rational education. Future research can further expand the sample size, use a variety of research methods for comprehensive analysis, and explore more intelligent and personalized strategies for improving rational education.

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