

Influence of Metonymic Thinking on the Critical Thinking Ability of English Majors Based on Data Mining

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Abstract: English majors must enhance their critical thinking skills in order to keep up with the times. It is a constant and solid guarantee of national talent resources, although English majors' critical thinking capacity is still being explored. The purpose of this paper is to investigate the impact of metonymic thinking on English majors' critical thinking abilities. This research presents an improved analytic hierarchy technique based on data mining for evaluating the critical thinking skills of English majors for the purpose to provide students with a more accurate and clear understanding of themselves. It helps kids develop critical thinking abilities. The upgraded analytic hierarchy method has a greater accuracy rate of evaluation than the classic analytic hierarchy process. The experimental results of this paper show that in the test of metonymy ability before the experiment, only 30% of the students answered correctly. It shows that only 30% of the students have good metonymy ability, and the corresponding critical thinking ability is weak. But after the experiment, in the test of metonymy ability, 78% of the students in the experimental group answered the test questions correctly, while the correct rate in the control group was only 40%. It shows that the students' metonymy ability has been improved after the experiment, and their critical thinking ability has also become stronger. This shows that the relationship between the two is positively correlated.

1. Introduction

The rapid development of the information age, the multimediaization of learning content, the interactivity of the learning environment, the equality of teacher-student relationships, the diversification of learning evaluation, and the real-time nature of learning resources dissemination are all conducive to cultivating students' critical thinking ability. Contemporary education puts forward higher requirements for students' abilities in information screening, information processing, and information processing. In the face of complex information, to cultivate students through questioning, reasoning, judgment, interpretation and other thinking analysis, critical thinking has

become an indispensable basic thinking quality. Critical thinking is the core of thinking and the foundation of creative thinking. Critical thinking education will have a profound impact on students' long-term and life-long development. Carrying out the education of critical thinking in English majors is conducive to stimulating the spirit and courage of students to explore the truth, to develop good thinking habits, and to promote the comprehensive development of students' minds.

2. Related Work

The development of students' critical thinking is the essence of education. The development of students' thinking is like their physical development. Theoretical guidance, repeated training and timely feedback are all necessary. Critical thinking is an integral and important part of learning. Utami B's research aimed to describe the critical thinking skills of students. The goal of the Fuad N M study was to see if students with three different learning modalities had varied critical thinking abilities. Inferential statistics are then used to examine it [1]. Quattrucci J G provided a novel approach to problem solving that attempts to include students more in the laboratory experience and allow them to apply critical thinking skills. The response from students has been overwhelmingly positive [2]. Vital thinking training, according to Huang L Y, is critical for journalism students' professional development. To accomplish this, he studied and designed a gamification platform and blended learning program to help 32 journalism students improve their critical thinking skills and abilities [3]. The goal of Utami B's research was to describe the critical thinking abilities of women.

To achieve this, the researchers analyzed the test results of 200 students spread across six schools. The test results show that the critical thinking ability of the students is still very low [4]. The authors experimented with Aryani F's research aimed at investigating the impact of reflective learning models on students' critical thinking abilities. The participants were 32 college students who were randomly selected during the 2014 academic year. He used the Critical Thinking Skills Test to assess the critical thinking abilities of participants [5]. Scholars agree that critical thinking is important, but they don't explain how to increase critical thinking skills.

With the urgent need of the society for high-quality talents, especially innovative talents, critical thinking has set off a broad and in-depth research upsurge in the field of education. Stefanova S's research looked into the efficiency of teaching critical thinking abilities in the English classroom through literary texts. He wanted to look at critical thinking as a collection of processes. To evaluate the validity of the model, teachers and students completed teacher assessment and self-assessment questionnaires [6]. Hong H proposed a method to identify disaster-prone and vulnerable areas by building predictive models through data mining methods. Logistic regression (LR), random forest (RF), and support vector machines are all combined in the suggested strategy [7]. Lei discovered that classical statistical analysis has long dominated the field of traffic accident analysis, and using data mining and complicated network analysis techniques to traffic accident analysis has become the norm. He explored the potential to identify important accident characteristics using a modular optimization community detection algorithm and association rule learning algorithm [8]. By employing cloud computing services that hold the data, Marozzo F discovered that getting relevant information from data is typically a hard procedure. He outlined the Data Mining Cloud Framework (DMCFconcept)'s and implementation [9]. These scholars have found that data mining plays an important role in real life, and explained these methods, but their deficiency is that there is no specific experiment.

3. Evaluation of Critical Thinking Ability Based on Improved AHP Based on Data Mining

3.1 Status of Educational Data Mining and Metonymic Thinking

It originated from statistics, combined with various theories and technologies such as computer science and pedagogy, and developed continuously. It then absorbed ideas from other fields, some of which played an important supporting role, such as database technology, visualization technology, etc. [10].

Educational Data Mining (EDM) provides services for educational researchers, students, parents and educational administration departments by researching and analyzing the educational system and student behavior patterns [11]. Therefore, educational data mining attracts more and more experts and scholars to study it, and has achieved considerable research results. The mining process is shown in Figure 1:

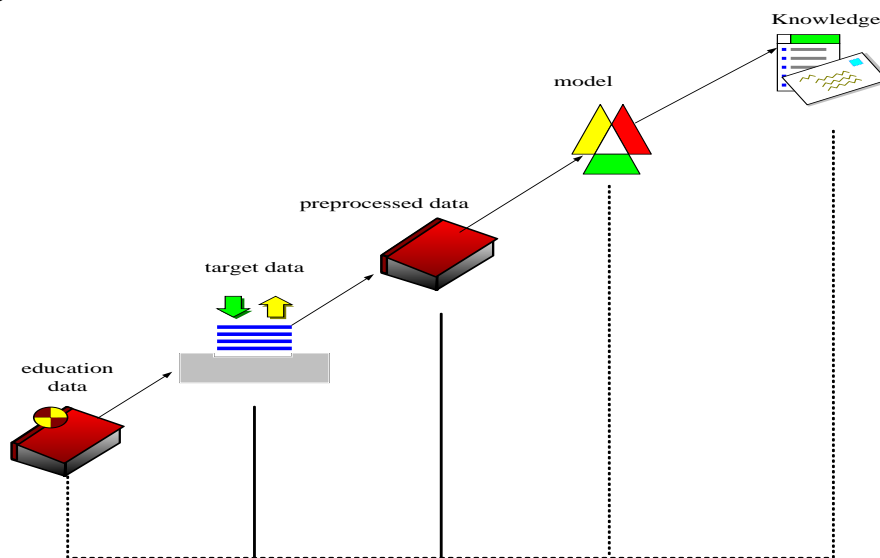


Figure 1: Educational data mining process diagram

As shown in Figure 1: The data of educational data mining comes from the data generated and stored by the educational system, structured data and unstructured data. Many educational institutions have large numbers of students and store terabytes of data, which increases the complexity of the data.

Traditional linguists believe that metonymy is a rhetorical device, which refers to substituting the name of one thing for the name of its neighbors. Cognitive linguists study metonymy from the perspective of ontology language and believe that metonymy is a universal language phenomenon [12]. Research in cognitive linguistics and psychology shows that metonymy is a useful tool for people to recognize and express abstract concepts. It is not only the carrier of language, but also the carrier of cognition and concept. People begin to recognize things by perceiving information. However, it is only through processing and organization that perceived things can be understood and remembered.

3.2 Analytic Hierarchy Process Based on Data Mining

Analytic Hierarchy Process (AHP) is a measurement method of pairwise comparison, in which decision makers can systematically evaluate various elements and obtain numerical weights for each element of the hierarchy. AHP transforms these assessments into weights that are processed and compared across the entire problem spectrum. These weights are the relative priorities of

achieving the decision objective in the overall alternative [13-14].

Consistency test is to check the coordination between the importance of each factor, and to avoid such inconsistency, it is necessary to test the consistency of the judgment matrix of each layer [15].

It first finds the maximum eigenvalue of the matrix by formula 1:

$$\lambda_{\max} = \sum_{i=1}^n \frac{\sum_{j=1}^n a_{ij} w_j}{n w_i} \quad (1)$$

The judgment consistency index CI is formula 2:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (2)$$

Among them, n is the order of the judgment matrix. The random consistency ratio CR is expressed as formula 3:

$$CR = \frac{CI}{RI} \quad (3)$$

Among them, RI is the average random consistency index, and according to the average random consistency index value table, the RI value of the corresponding n -order matrix can be viewed.

The correlation between users u_1 and u_2 is calculated by computing the sine of the angle between the two vectors as formula 4:

$$sim(u_1, u_2) = \cos\left(\overset{\rightarrow}{u_1}, \overset{\rightarrow}{u_2}\right) \quad (4)$$

This measure is used to express the degree of difference between two individuals, focusing on the similarities and differences of vectors in direction.

3.3 Improved AHP-IAHP_SP Method

In view of the current problems in evaluating students' critical thinking ability, this paper improves the AHP method based on the perspective of stakeholders.

The IAHP_SP method is used to assign weights to the evaluation system. The comprehensive evaluation value of all the evaluators is calculated from the evaluation value matrix, and the evaluation weight of the evaluator obtained by weighting is averaged with the index weight obtained by the previous AHP. It obtains students' comprehensive quality scores.

The scores of n evaluators u_1, u_2, \dots, u_n to m -item indicators a_1, a_2, \dots, a_m form an index evaluation matrix, which is expressed as formula 5.

$$X = [a_{ij}]_{m \times n} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \quad (5)$$

Among them, a_{ij} represents the value of a_j by the rater u_i . Let m indicators be maximal, and X be the normalized data. The interest correlation coefficient r_{ik} of rater u_i and a_j can be

expressed as formula 6:

$$r_{ik} = \frac{a_i \bullet a_k}{\|a_i\| * \|a_k\|} \quad (6)$$

a_k is called the net benefit coefficient between evaluators. In order to maximize their own advantages, evaluators will highlight their own advantages, so there is formula 7:

$$H = \max \sum_{k=1}^n c_{ik} \sum_{j=1}^m a_{kj} w_j^{(i)} \quad (7)$$

Among them, $w_j^{(i)}$ is the weight value of each index from the evaluator's u_i perspective. Due to the non-dictatorship of the weight value, restrictions are added:

$$0.5^{m-1} \leq w_j^{(i)} \leq 0.5 \quad (8)$$

This chapter first expounds the importance of constructing the evaluation model of college students' critical thinking ability, and proposes the solution (IAHP_SP) studied in this paper for the evaluator similarity problem. This paper also introduces the calculation process of the weights of each evaluator based on this method in detail.

In this paper, the BP neural network is a comprehensive quality assessment model for students, consisting of an input layer, a hidden layer, and an output layer. The method uses the quality score of each student as input and the comprehensive score as output, with 15 nodes in the input layer and 1 node in the output layer. The number j of hidden layer neurons can be determined using the following methods:

$$j = \sqrt{n+m} + a \quad (9)$$

n is the number of neurons in the input layer, and m is the number of neurons in the output layer.

3.4 Evaluation Model of College Students' Critical Thinking Ability Based on IAHP_SP Method

Under the current educational model, traditional cultural thought and teaching evaluation system in China, the cultivation of critical thinking has not been really valued and fully promoted in English major education. The cultivation of critical thinking of English majors still lacks the support of special courses.

(1) Evaluation indicators

This paper starts from the eight evaluation indicators of the four stages of "discovery-analysis-optimization-evaluation" in the thinking process of problem solving. The eight evaluation indicators are logic, clarity, relevance and depth of thinking, development, flexibility and breadth of thinking. It combines teacher evaluation, student self-evaluation and teacher-student mutual evaluation, and integrates evaluation into the whole process of teachers' teaching and students' learning.

This paper invites six evaluators to rate each student's quality in the evaluation system of students' critical thinking ability. Two of them are teaching staff of a university, two are academic administrators, and two are students. This paper performs extreme value processing on the collected scoring data:

$$a_{ij} = \frac{a_{ij} - m_j}{M_j - m_j} \quad (10)$$

Each evaluator used the 1-9 degree method to evaluate each evaluation index. Taking evaluator A as an example, its first-level judgment matrix is shown in Table 1:

Table 1: Rater A's first-level judgment matrix

A	A_1	A_2	A_3	A_4	Weights
A_1	1	1/5	1/3	1/2	0.0752
A_2	5	1	3	2	0.3808
A_3	3	1/3	1	1/2	0.2372
A_4	2	1/2	2	1	0.1634

As shown in Table 1: It solves the matrix to obtain the largest feature $\lambda_{\max} = 4.1063$, its corresponding feature vector $w_A = (0.0752, 0.3808, 0.2372, 0.1634)^T$, and performs a consistency check on w_A :

$$CI = \frac{\lambda_{\max} - n}{n - 1} = 0.0347 \quad (11)$$

When $n=4$, $RI = 0.9$, there is a relative consistency index:

$$CR = \frac{CI}{RI} = 0.0387 < 0.1 \quad (12)$$

This matrix has satisfactory consistency, that is, the weight w_A is objective and acceptable. Similarly, this paper uses the above method to solve other matrices.

(2) Implementation recommendations

Paying attention to the performance of students at both ends: In the implementation of the evaluation, teachers are suggested to focus on the differences in students' personality, and record the students' special performance and unique thinking. It records the students' bright points in learning in the critical thinking evaluation scale in time, and records the behavior of students with outstanding performance. Of course, teachers also need to pay special attention to students who are particularly suboptimal in performance. For example, students who rarely ask questions, answer questions, are silent, express no ideas, etc., or students who are very quick in thinking, feasible and stable, and perform very well. It provides more real and reliable evidence for the final comprehensive evaluation.

4. Experiment of Metonymic Thinking and Critical Thinking Ability Based on Data Mining

4.1 Investigation on Critical Thinking Ability of English Majors

The test's reliability is a crucial factor to consider while assessing its quality. The dependability coefficient indicates that the test results are consistent, steady, and dependable. This paper used SPSS to assess the validity of the collected data.

This paper evaluates the critical thinking ability of the respondents. The total score is 420 points, 280 points are considered as the dividing line between positive performance and neutral performance, and the critical thinking tendency is in the range of weak neutrality. The status quo of students' critical thinking tendency is generally in the middle state, as shown in Figure 2:

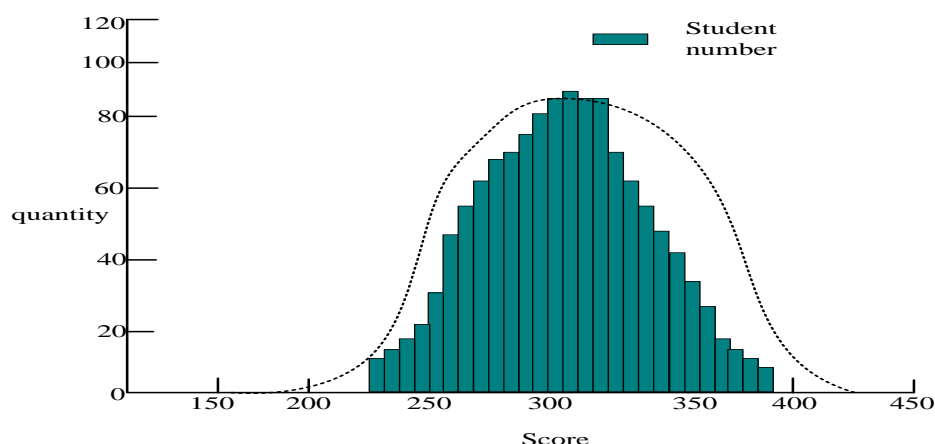


Figure 2: Overall Score Distribution of Students with Critical Thinking Tendency

As shown in Figure 2: From the overall point of view, there are many students with a score higher than 350, and the students' critical thinking tendency is in a state of "very few at both ends, clustering in the middle", and the overall distribution is uneven. In particular, it is worth paying close attention to the fact that the proportion of students with "strong" critical thinking inclination is very small, indicating that there are relatively few students who really have a strong critical thinking inclination.

Scores for each trait range from 10 to 60, with 40 being considered the dividing line between positive and negative performance, and scores <40 indicating weaker critical thinking tendencies. Scores > 50 indicate a strong tendency to think critically, as shown in Table 2.

As shown in Table 2: It can be seen from the table that the highest score in the sub-item is 45.35 points for intellectual curiosity, and the lowest is 38.04 points. The seven sub-indices are generally close and belong to the middle level, and the number of students near the junction of strong and weak is relatively concentrated, indicating that the seven sub-items are not significantly different.

Table 2: Average scores of all students on each trait

	A	B	C
seek truth	38.21	38.81	38.04
open mind	39.43	40.52	41.24
Skills of analyze	43.86	44.01	44.17
Systematization ability	39.44	38.69	39.84
critical thinking self-confidence	42.46	42.89	42.52
curiosity	45.21	45.21	45.35
cognitive maturity	38.59	39.02	38.86

4.2 Experiment on the Correlation between Metonymic Ability and Critical Thinking Ability

In this study, some students were selected to carry out a questionnaire, and two classes of English majors were selected for the research on critical thinking tendency. Pre-tests were conducted on metonymy ability and reading comprehension. Then, the authors conducted an experimental teaching period for 12 weeks. Independent sample test and paired sample test were performed on the subjects' pre-test and post-test scores by SPSS16.0. It is randomly divided into experimental group and control group, 30 people in each group.

So the next step is to verify whether there is a relationship between the two by improving their metonymy ability. On the basis of the same difficulty of this test, the students were tested. The

results are shown in Table 3:

Table 3: Metonymy ability and critical thinking ability of students in experimental group and control group before the experiment

group	control group	test group	critical thinking skills
No reaction	34%	29%	/
mistake	36%	41%	/
correct	30%	30%	/
Total	100%	100%	weaker

As shown in Table 3: In the pre-test of metonymy ability, only 30% of the questions were answered correctly by the students. And 36% of the questions in the control group were answered incorrectly by the students, while 41% of the students in the experimental group answered incorrectly. In addition, 34% of the questions were not answered by the students in the experimental group, and 29% of the questions were not answered by the students in the control group. The above data show that the students of the experimental group and the control group have the same level of metonymy ability, but the level of metonymy ability of the students in both groups is very low. Although about one-third of metonymic expressions were not explained, this suggests that when students encounter some words or expressions they do not recognize, they tend to give up guessing the meaning of the word.

After 12 weeks of teaching, the results are shown in Table 4:

Table 4: Metonymy ability and critical thinking ability of students in experimental group and control group after the experiment

group	control group	test group	critical thinking skills
No reaction	34%	12%	/
mistake	26%	10%	/
correct	40%	78%	/
Total	100%	100%	strong

As shown in Table 4: The following conclusions can be drawn: By imparting metonymic knowledge, students' metonymic ability and interest in English and reading can be improved; at the same time, students' reading ability can also be improved. Therefore, metonymic thinking can improve students' critical thinking ability.

In this paper, the post-test score data of the two groups of students are input into SPSS19.0, as shown in Figure 3:

As shown in Figure 3: Metonymic thinking is significantly positively correlated with critical thinking ability, which means that improving students' critical thinking requires continuous efforts to develop their metonymic thinking while practicing cognitive skills. Therefore, systematic and dynamic teaching is needed to improve students' metonymic thinking. In addition, more emphasis should be placed on developing students' inclination to seek truth, logic, systematicness and self-confidence, as well as their critical thinking skills.

This paper takes the students in the table 4 as an example, and imports their quality scores in various aspects into the radar chart, as shown in Figure 4.

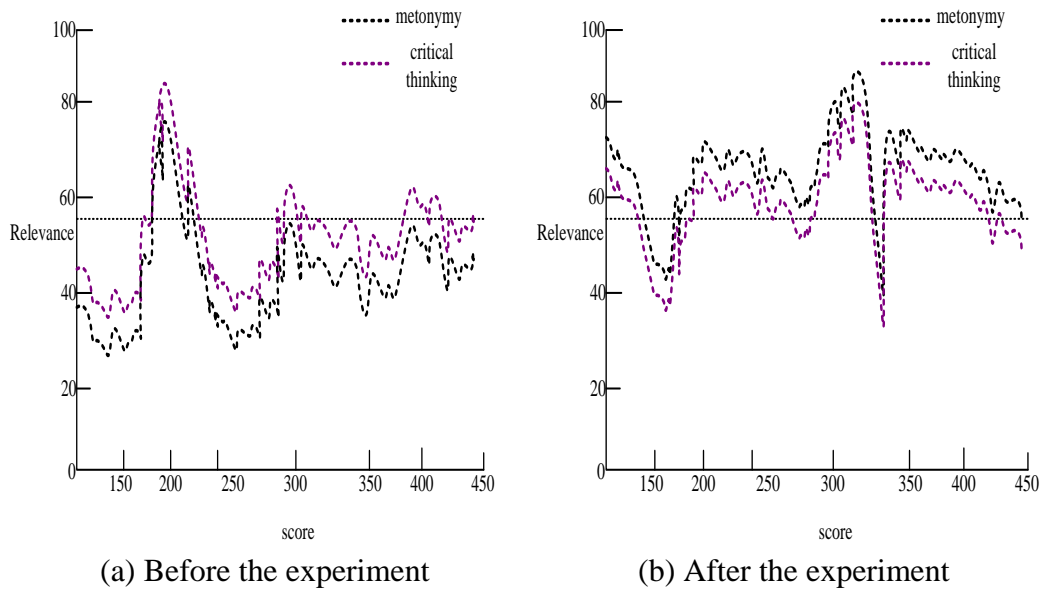


Figure 3: Correlation between metonymic thinking and critical thinking skills before and after the experiment

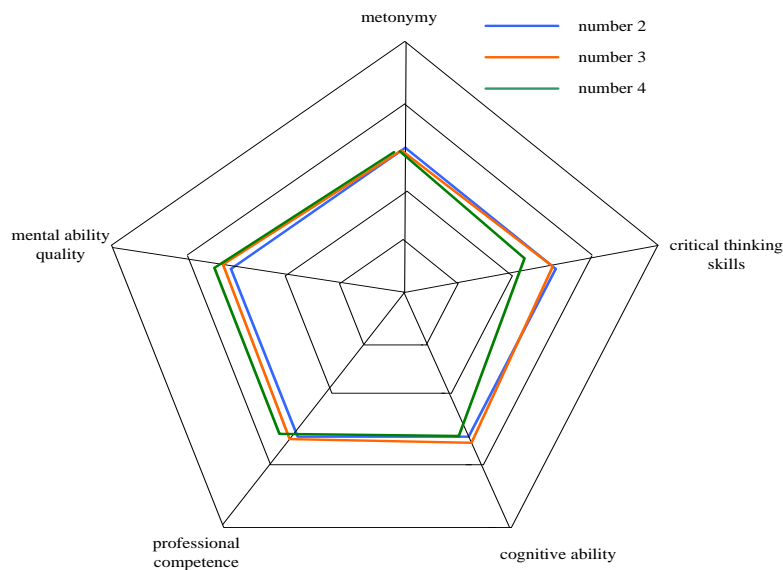


Figure 4: Radar chart of college students' critical thinking ability assessment

As shown in Figure 4: It can be seen from the figure that the metonymic thinking ability and critical thinking ability of the student numbered 2 are better than the other two students. On the radar chart for the assessment of college students' critical thinking ability, students can examine their own qualities and gaps with other students in various aspects. It identifies its own possibilities and strengths and improves its own weaknesses. Relevant educators formulate reasonable training programs to improve the quality of students.

5. Conclusion

Strengthening the cultivation of critical thinking of English majors has theoretical and practical guiding value for students' overall development and comprehensive quality improvement, creative

ability and personality development, deepening school education reform and cultivating high-quality talents. This paper analyzes the relationship between metonymic thinking and English majors' critical thinking ability. Based on data mining, AHP is proposed. This paper analyzes its shortcomings and proposes an improved AHP. In the method part, this paper introduces the analytic hierarchy process in detail. In the experiment, this paper conducts an experiment on the students majoring in English in colleges and universities. It conducted an investigation and analysis on the critical thinking ability of the experimental subjects, and found that the critical thinking ability of English majors is generally low.

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