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International Journal of Earthquake Engineering
Anno XLIII - Num. 1 - 2026

Strategies for Enhancing Multicultural Understanding in College English Education

Xun Wang[1,*]

[1] School of Foreign Languages, Hubei University of Arts and Science, Xiangyang, Hubei, 441053, China

SUMMARY: *At a time of international trade friction, college teaching, especially English teaching, needs to shoulder the responsibility of enhancing students' multicultural comprehension ability, so as to send more tolerant talents to the society in the future. This study uses the LDA model to extract the multicultural understanding themes and other contents in students' English learning data to complete the students' ability portrait. A knowledge graph is constructed to deeply explore the association between learning data and comprehension ability. Students are classified by K-means clustering algorithm, and personalized enhancement resources are provided for different types of students by combining the intelligent recommendation of knowledge graph resources. Students are best classified when they are clustered into 4 categories according to their major learning achievements. Knowledge mapping provides 5 paths for different types of students, which can meet the competence enhancement needs of different types of students.*

KEYWORDS: *English language teaching; multicultural understanding; LDA model; knowledge graph; K-means clustering*

1 Introduction

In the context of economic globalization, cultural exchanges between countries are becoming closer, and in the process of mutual communication and interaction, students' multicultural understanding can be enhanced, students' social communication skills can be improved, thus enhancing the teaching quality and teaching efficiency of university English courses in colleges and universities [1-4]. It is also necessary to constantly optimize and innovate the teaching mode in order to cultivate excellent English talents for the development of socialist economic construction.

Multicultural comprehension is an important part of the four disciplinary core literacies of college students proposed in the 2021 English Curriculum Standards for Higher Education Specialties. Students' multicultural competence is multifaceted and three-dimensional. From the knowledge level, it seems that multicultural comprehension competence requires students to master the knowledge of English for accomplishing relevant foreign-related tasks in their future work, and to be able to use English to accomplish specific communication tasks in the workplace [5, 6]. From the skill level, it is important to have cross-cultural communication skills and communication abilities to be able to undertake foreign communication tasks independently [7]. From the literacy level, students are enabled to consciously disseminate the excellent traditional Chinese culture in foreign communication, cross the multicultural

*17396187399@163.com
https://doi.org/10.65102/is2026202
Published: 30 April, 2026

communication barriers, build up cultural self-confidence, be able to put China's development into the general pattern of the international situation, build up a global vision, and establish a sense of the community of human destiny [8-11].

At the same time, cultivating students' multicultural competence also responds to the current national call and requirements for the implementation of curriculum ideology in English teaching in colleges and universities, and is in line with the state's expectation and emphasis on the function of higher education in educating people [12-14]. However, more than 70% of the graduates in the current workplace have a significant lack of intercultural communication skills, leading to difficulties in advancing international cooperation [15, 16]. And contemporary students have stronger patriotic spirit and cultural subject consciousness, which makes it difficult for them to accept invasive and intensive cultural input, and the traditional basis for teaching cultural input exposes defects [17, 18]. Therefore, how to effectively improve students' multicultural comprehension in efficient English education has become a hot topic.

This study quantifies students' English multicultural comprehension ability by screening indicators. At the same time, combined with the LDA model, it intelligently analyzes the in-depth connection between students' learning data and multicultural comprehension ability, and builds a portrait of students' English multicultural comprehension ability. Based on this in-depth connection, the relationship between knowledge ontology and ability entities is built, and the knowledge graph is constructed to accurately realize ability scoring and resource recommendation. Through the K-means clustering algorithm, students with different English multicultural comprehension abilities are categorized according to their major grades and scoring results, and different enhancement paths are mined.

2 Analysis of Techniques for Improving English Multicultural Comprehension Skills of Higher Education Students

2.1 Indicator System for Portrait of English Multicultural Comprehension Skills

Quantitative modeling of English multicultural comprehension ability of college students is to use scoring methods on the basis of objectively obtaining the static basic information and dynamic behavioral information of college students, and to calculate a score that can characterize students' English multicultural comprehension ability by examining various factors affecting their English multicultural comprehension ability, and then to make a portrait of their English multicultural comprehension ability through this score. For this reason, it is crucial to establish a set of scientific and measurable evaluation index system for English multicultural comprehension ability. In this paper, the quantitative evaluation of college students' English multicultural comprehension ability under the perspective of core literacy is divided into two categories: static indicators note that they include position, gender, specialty, city of origin and parents' education; dynamic evaluation indicators are decomposed into four indicators according to the level of English mastery, English learning styles, the quality of thinking development, and the cognition of cultural literacy.

2.2 Capacity Diagnostic LDA Model

At present, there are two most common topic models, LDA model is one of the very mature and heavily used topic model, LDA model is a Bayesian probability model that integrates the three-

layer structure of words, topics and documents. When we need to analyze the theme of an article or a series of articles, we usually need to analyze each word in the article first, because in general, a text or a paragraph repeated many times in the article, then it shows that this paragraph or text may play a role in illuminating the theme of the theme, and there must be some kind of correlation relationship between the words and the theme. The LDA model can represent the indirect correlation between different words in a document, and generate different topic vectors based on different documents, and finally calculate the probability of the topic through the model. For each document in the corpus, the process of generating document topics by LDA is as follows:

1) Extract a topic from the topic distribution of each document.

2) Repeat the above process until every word in all document sets is traversed.

In corpus D, each document is denoted as d. Suppose there are n words in document d, each of which is notated as w_i. The entire corpus is represented by the set of topics T. All the different words in the corpus can form a set, denoted as β. Two result vectors are obtained by LDA by training the corpus D as follows:

1) For each document d, the set of all topic probabilities it contains is denoted as $\theta_d = \{P_{t1}, P_{t2}, \cdots, P_{tk}\}$, where P_{ti} denotes the probability of d corresponding to the ith topic in T. The calculation formula is shown in equation (1).

$$P_{ti} = \frac{n_{ti}}{n} \tag{1}$$

where n_{ti} denotes the number of words corresponding to the ith topic in document d, and n is the total number of words in d.

(2) For each topic in t, the probability of generating different words $\varphi_t = \{P_{w1}, P_{w2}, \cdots, P_{wm}\}$, and P_{wi} denotes the probability that t generates the ith word in β. The calculation formula is shown in (2).

$$P_{wi} = \frac{N_{wi}}{N} \tag{2}$$

where N_{wi} denotes the one corresponding to the ith word in β, and N denotes the total number of all words in topic t.

Each topic is denoted as t, then the probability of w in d is calculated as shown in Equation (3).

$$P(w|d) = P(w|t) \times P(t|d) \tag{3}$$

The LDA model, which uses topics as an intermediate layer, can be used to give the probability of occurrence of word w in document d through θ_d and φ_t.

2.3 Intelligent Knowledge Graph Design Based on Ability Profiling

2.3.1 Methods of Constructing a Portrait of Intelligent Students' Multicultural Comprehension Skills

The construction method of intelligent students' English multicultural comprehension proficiency portrait is based on big data and artificial intelligence technology, through collecting, analyzing and mining all kinds of data of students, to construct a model that can comprehensively and dynamically reflect students' English multicultural comprehension proficiency. First of all, in the demand analysis of proficiency portrait construction, the goal and core demand of the portrait need to be clarified. The English multicultural comprehension competence portrait of college students should focus on three core dimensions: professional competence, practical competence and comprehensive quality. Professional competence reflects students' knowledge and skills in specific professional fields; practical competence mainly reflects students' hands-on ability and ability to solve practical problems; comprehensive quality covers students' non-academic qualities such as innovation, teamwork and communication skills.

Data collection is the basis for constructing the portrait of students' English multicultural comprehension ability, and the students' ability data mainly come from various aspects such as academic performance, practical activities and extracurricular activities. Academic performance reflects students' ability in knowledge mastery, practical activities can better reflect students' hands-on ability and ability to solve practical problems, and extracurricular activities provide an important basis for assessing students' comprehensive quality. In the data processing stage, it is first necessary to pre-process and clean the collected data, remove the noise data and irrelevant information, so as to make the data more accurate and complete. It is assumed that the data of students' English multicultural comprehension ability is $X = \{x1, x2, \cdots, x_n\}$. In further data analysis, the various types of proficiency data can be fused using the weighted average method, assuming that $W = \{w1, w2, \cdots, w_k\}$ is the vector of weights for each dimension, the students' composite proficiency scores S can be expressed as equation (4).

$$S = \sum_{i=1}^{k} w_i \cdot x_i' \tag{4}$$

where w_i is the weight of the ability dimension i, and x_i' is the processed data of this dimension. Through such a weighted fusion method, a multidimensional and accurate competency portrait can be constructed for students, which in turn provides a basis for educational decision-making.

2.3.2 Application of Knowledge Mapping in Portrait of Students' Multicultural Comprehension Skills

In the process of knowledge mapping construction, ontology construction, entity relationship extraction and other methods are key steps.

1) Ontology construction is the foundation of knowledge mapping construction, which involves the design of knowledge system and the construction of conceptual model in the field of students' English multicultural comprehension ability in colleges and universities. By analyzing the related domains of students' English multicultural comprehension ability, such as subject knowledge, practical ability, professionalism, etc., the ontology model defines the

dimensions of students' English multicultural comprehension ability and their interrelationships.

2) Entity-relationship extraction is to identify the entities related to students' multicultural comprehension of English and their relationships from the data, and the entities include students, courses, programs, competencies, etc., while the relationships include learning, participation, mastery, and assessment. Based on these entities and relationships, a knowledge map of students' multicultural comprehension of English is constructed.

The ability analysis and accurate recommendation method based on knowledge graph can be used to realize the deep mining and personalized teaching of students' English multicultural comprehension ability by constructing a complex mathematical model. For example, let the students' ability score be F, and the weights of their dimensional abilities are $w1, w2, w3$ corresponding to academic performance, practical ability, comprehensive quality, etc. respectively. The students' English multicultural comprehension score F can be expressed as equation (5).

$$F = w_1 \cdot \sum_{i=1}^{n} S_i + w_2 \cdot \sum_{j=1}^{m} P_j + w_3 \cdot \sum_{k=1}^{p} C_k \tag{5}$$

where S_i denotes academic performance, P_j denotes practical ability score, and C_k denotes comprehensive quality score. Based on students' scores in different dimensions, the knowledge graph can deduce their ability weaknesses and provide data support for accurate recommendation. In addition, the deep learning model based on students' English multicultural comprehension proficiency mapping can identify students' potential learning paths and make predictions for proficiency development. Assuming that the nodes in the competency graph represent the various types of students' competencies and the edges represent the relationship between them, the node embedding can be performed using graph convolution network (GCN) to obtain the vector representation of students' English multicultural comprehension competencies, V_{student}, which is denoted as Eq. (6).

$$V_{student} = \sigma\left(\sum_{i=1}^{N} A_{ij} W_j \cdot V_j \right) \tag{6}$$

where A_{ij} is the adjacency matrix between nodes in the students' English multicultural comprehension proficiency map, W_j is the weight matrix, V_j is the initial eigenvector of the proficiency node, N is the number of neighboring nodes, and σ is the activation function.

2.4 K-means based clustering of students' multicultural comprehension skills

The purpose of this experiment is to use the k-means clustering algorithm to reasonably cluster 80 senior students majoring in Business English in S colleges and universities according to the indicators of English multicultural comprehension ability of college students, to analyze the overall trend of students' graduation, to compare the differences in the indicators of multicultural comprehension ability of students in each cluster, and to study the relationship between different clusters and graduation destinations of the students.

For the parameters of the k-means clustering algorithm used, the selection of the appropriate number of clusters (k value) is the most important step in the experiment, only to determine the optimal number of clusters, in order to reasonably divide the group, and ultimately to

maximize the clustering results of the same class within the similarity is high, the difference between different classes of the degree of obviousness of the group divided into clear in order to better analyze the object of different clusters.

In this experiment, we use the contour coefficient method (SC) to select the optimal number of clusters for the clustering algorithm, the k value that can make the contour coefficient larger is the optimal number of clusters to be found (k value), the contour coefficient method combines the concepts of cohesion and separation. Cohesion and separation are not independent of each other, and the sum of the two is a constant. Let there be a current sample point x, whose profile coefficient is defined as follows:

$$S = \frac{b-a}{\max(a,b)} \tag{7}$$

where the value of a indicates the average distance from the calculated sample x to the data points of other samples within the same cluster, which is called cohesion, and the smaller the value of a obtained from the calculation means that the more the sample x should be categorized into this cluster class; the value of b indicates the average distance from the calculated sample x to all the samples within the different clusters, which is called the separation, and the smaller the value of b, the less the sample x should be categorized in other cluster classes. All the profile coefficients are calculated according to the profile coefficient definition equation and then averaged, i.e., the formula is as follows:

$$S_k = \frac{1}{n}\sum_{i=1}^{n} S_i \tag{8}$$

where S_k denotes the average profile coefficient, n value denotes the number of samples, and k value denotes the number of clusters. From the definition of equation (7) and equation (8), it can be seen that the calculated average profile coefficient has a range of values between -1.0 and 1.0, the closer the value of S_k is to 1.0, the more reasonable it means that the samples x are classified in the clusters of the clusters; in contrast, the closer the value of S_k is to -1.0, it means that the more the samples x should be grouped into the clusters of the other classes; and if S_k tends to 0.0, it represents the current number of clusters of n. 0.0, it means that the current position of sample x is on the boundary of two class clusters. Therefore, the value of the largest average profile coefficient of k is the optimal number of clusters.

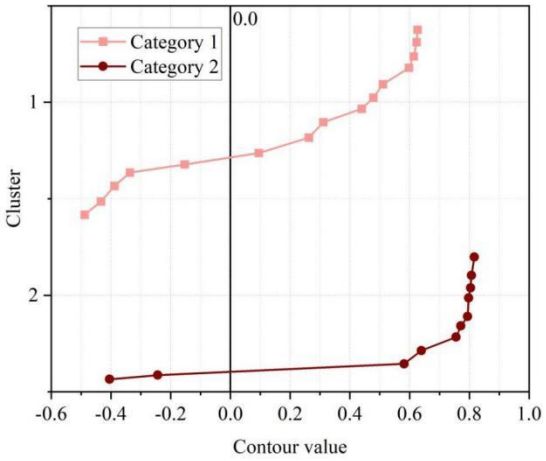
3 Practices for improving English multicultural comprehension of higher education students

3.1 K-means optimal clustering number determination

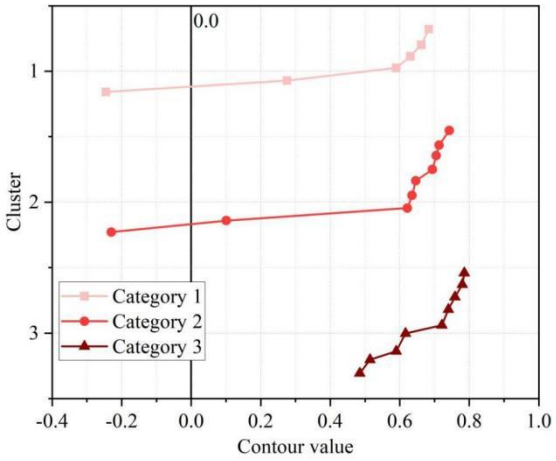
3.1.1 Comparison of contour distribution under different number of clusters

In the clustering process, the number of categories into which the sample data are classified needs to be given, i.e., in the cluster analysis of the students, it is first necessary to determine the number of categories into which the students are divided in total. The grades of the courses taken by 80 students in the fourth year of Business English at S University were taken as the sample for analysis and classified using the K-means clustering algorithm.

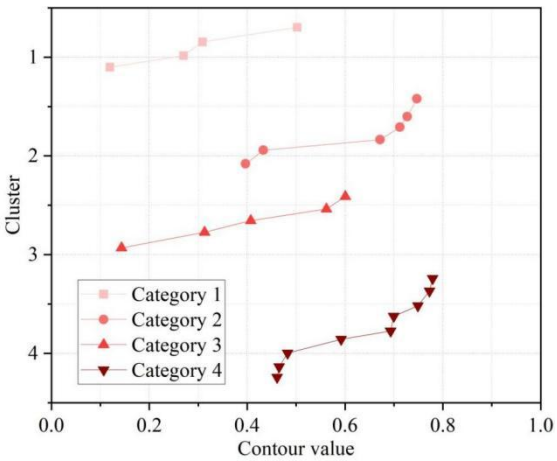
Figure 1 shows the distribution of contours for each category when the number of categories is 2, 3 and 4. When the number of clusters is 2 and 3, the contour value of each category exists less than 0.0 close to -1.0, which indicates that when students are clustered into 2 or 3 categories according to their academic performance, some of the students who do not belong to the corresponding category are misclassified into that category. And when clustering students into 4 classes, the contour value of each class is above 0.0 close to 1.0, there is no misclassification, and the classification effect is better. Figure 2 shows the dynamic clustering process of K-means clustering algorithm in classification. From the clustering process, it can be seen that the highest degree of similarity [1,2], [5,6], [8,9], [11,12] are each categorized as a class. Then [1,2] and [3], which have the next highest degree of similarity, are grouped together, [5,6] and [7] are grouped together, and [8,9] and [10] are grouped together. After that [5,6,7] and [4] were categorized again. Finally, this group of students was categorized into 4 classes according to [1,2,3], [4,5,6,7], [8,9,10] and [11,12]. According to the dynamic classification process, it can be seen that the K-means clustering algorithm has better classification results.



(a) Contour of the number of 2 categories



(b) Contour of the number of 3 categories



(c) Contour of the number of 4 categories

Figure 1: Contours with a category number ranging from 2,3,4

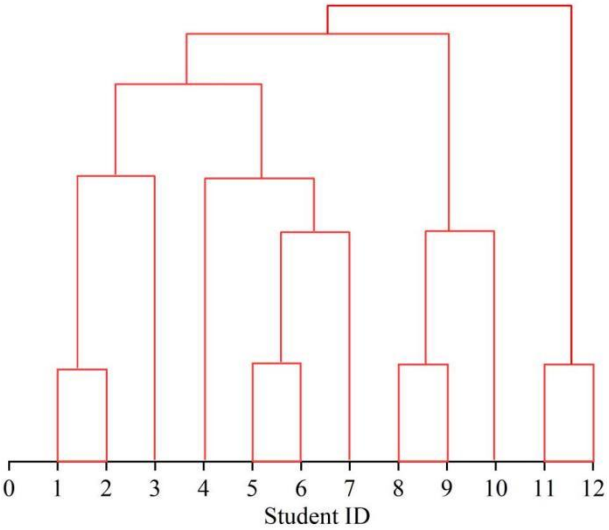


Figure 2: The dynamic clustering process of K-means (parts)

3.1.2 Analysis of the best clustering results

Based on the distribution of the profile values, the optimal number of clusters was determined as 4 classes. Figure 3 shows the results of K-means clustering of 80 students into 4 classes according to their grades. Each of the four categories consisted of 20 students, with Category 1 students scoring between [50,60] in English multicultural comprehension and named the "Incompetent Category". Category 2 students with a score of [60,75) are designated as "to be improved". Category 3 students were given a score of [75,90] and were named "more balanced". Category 4 students achieved [90,100] and were named "Fully Developed". The categorization task was accomplished more clearly by dividing students into four categories according to their English multicultural comprehension scores.

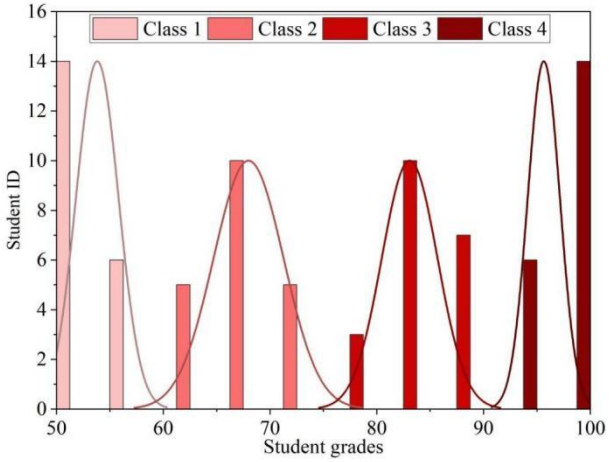


Figure 3: K-means classification into 4 categories

3.2 Group Analysis of Student Competency Enhancement Path Mining

3.2.1 Necessity tests for individual conditions

Based on the ability analysis and precise recommendation method of knowledge graph, the deep learning model of multicultural comprehension ability enhancement path of college students is constructed. Each enhancement condition obtained from mining is taken as an

independent variable, and students' English multicultural comprehension ability is taken as a dependent variable. The consistency coefficient is utilized to test whether the respective variables are necessary conditions for the dependent variable. Table 1 shows the results of the necessity test for individual conditions. “~” stands for “not”. In the consistency coefficient test, the coefficients of each condition variable are less than 0.900, indicating that these conditions, when they exist as individual conditions, are not sufficiently necessary to promote or inhibit the enhancement of students' multicultural comprehension of English, that is to say, the enhancement of students' multicultural comprehension of English is the result of the joint action of these conditions.

Table 1: The result of the necessity test for a single condition

Independent variable	Dependent variable			
	Promote the improvement of students' abilities		Holding back students' ability to improve	
	Consistency	Coverage	Consistency	Coverage
English teaching proficiency	0.875	0.821	0.636	0.659
~English teaching proficiency	0.622	0.535	0.809	0.724
Multicultural integration index	0.821	0.814	0.678	0.672
~Multicultural integration index	0.609	0.566	0.869	0.848
Cultural inclusive atmosphere	0.809	0.836	0.634	0.663
~Cultural inclusive atmosphere	0.632	0.554	0.825	0.731
English teaching style	0.881	0.861	0.622	0.672
~English teaching style	0.667	0.526	0.858	0.831

3.2.2 Grouping for student empowerment

Setting the consistency threshold at 0.85 and analyzing the groupings, the five paths to promote students' English multicultural comprehension ability are derived from Table 2.The overall coverage of the five groupings is 0.805, and the overall consistency is 0.840, which is higher than 0.800, indicating that the five paths constitute the sufficient conditions for the enhancement of students' English multicultural comprehension ability. According to different types of students, selecting learning resources in different paths to be recommended in combination with knowledge mapping can enhance students' English multicultural comprehension ability in a targeted way.

Table 2: The configuration for enhancing students' abilities

Conditions	Promote the improvement of students' abilities				
	H1a	H1b	H1c	H1d	H1e
English teaching proficiency	√		√		√
Multicultural integration index		√	√	√	√
Cultural inclusive atmosphere		√		√	√
English teaching style	√	√			
Consistency	0.793	0.886	0.796	0.832	0.895
Original coverage	0.736	0.894	0.727	0.782	0.887
Only coverage extent	0.015	0.031	0.019	0.018	0.034
Overall coverage	0.805				
Overall consistency	0.840				

Note: "√" indicates the presence of the core condition; "Blank" indicates that this condition can either occur or not occur.

4 Conclusion

In this paper, we provide students with learning resources needed for multicultural comprehension enhancement by constructing a knowledge map and portrait clustering. When clustering students into 4 categories, the profile coefficients of each category are between 0.0 and 1.0, which is clearer to achieve effective classification. The four conditions of English teaching level, amount of multicultural integration, culturally inclusive atmosphere, and English teaching style combined to produce five different paths for English multicultural comprehension enhancement. For students at different levels, English teachers can intentionally choose different paths and provide different resources when teaching to help students make up for their shortcomings in multicultural comprehension and promote their overall development.

About the Author

Xun Wang was born in Xiangyang, Hubei, P.R. China, in April 1989. She obtained a bachelor's degree in English from the School of Foreign Languages, Central China Normal University, and a master's degree in Linguistics from Newcastle University, UK, with a research focus on Applied Linguistics. She is currently working as a lecturer in the English Department of the School of Foreign Languages at Hubei University of Arts and Science.

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