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The Promoting Role of Diversified Learning Methods in English Reading Instruction on Students' Comprehensive Language Proficiency

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Abstract In the context of English reading teaching reform, this study empirically explores the promotion effect of diversified learning styles on comprehensive language proficiency by constructing a comprehensive language proficiency evaluation system for students with four primary indicators and 31 secondary indicators, and by combining the entropy value correction G1 method, the object-element topologically tractable model, and step-by-step multiple regression analysis. The entropy correction G1 method based on the assignment of 20 experts shows that learning ability (weight 0.4552) > language ability (0.2261) > thinking quality (0.2044) > cultural awareness (0.1143). Among the core secondary indicators, C6 Phono-grammatical Knowledge (combined weight 0.0609), C4 Communicative Strategies (0.0497) and C13 Active Learning Approach (0.0475) ranked in the top three, indicating that the language foundation and learning strategies are the key competence pillars. The evaluation of the Object Meta-Topological Model for the class applying diversified learning styles found that 87% of the secondary indicators reached the “excellent” level, of which the correlation of the N1 level of Language Awareness, Lifelong Learning Ability, and Spirit of Science was >1.0. The eigenvalue of the variable of the overall comprehensive language proficiency level of the class was e*=1.716 (excellent) and the learning ability dimension had the best correlation. And the correlation of learning ability dimension is optimal (e*=1.737), which confirms that diversified learning significantly enhances independent inquiry and strategy application ability. Regression analysis showed that the types of diversified learning styles were significantly and positively correlated with English proficiency ($r=0.513$, $p<0.001$). In the stepwise regression model, its standardized coefficient $\beta=0.187$, second only to self-efficacy ($\beta=0.254$) in terms of contribution, jointly explained 25.4% of the variance in English proficiency.

Index Terms diversified learning styles, comprehensive language proficiency, entropy-corrected G1 method, object-element topable model, English reading teaching

I. Introduction

As an important tool for international communication, English is increasingly demanding higher reading proficiency from students in the current globalized context [1]. English reading instruction can promote language accumulation and construction, supporting the development of students' core competencies such as language proficiency, cultural awareness, critical thinking skills, and learning abilities [2], [3]. However, current English reading instruction practices face numerous challenges and issues. First, monotonous reading content can make students feel bored, making it difficult for them to achieve the goals of deepening language perception and promoting language construction through English reading learning [4]-[6]. Second, current educational practices focus on students' reading outcomes rather than cultivating their reading interest, neglecting the role of reading interest in promoting students' reading autonomy, which in turn affects the progress of English reading instruction [7]-[10]. Additionally, the disconnect between reading and practical application is another issue in current English reading instruction. The current educational model fails to provide students with opportunities to apply their knowledge in specific contexts, making it difficult to achieve the objectives of English reading instruction [11]-[14]. These issues and challenges all point to the inadequacies and limitations of current English reading instruction strategies.

Traditional teaching methods often center on the teacher, with students playing a passive role in absorbing knowledge in the classroom, lacking opportunities for active participation and practical application of English [15], [16]. Therefore, English reading instruction must revisit the essence of education, reassess students' learning needs, reform teachers' teaching methods, break down disciplinary barriers, and innovate diverse educational models [17]-[19].

In the field of education, various media technologies and online resources have provided students with richer audiovisual resources, making teaching more efficient and convenient. Nurmawati, N., et al. investigated the application of multimedia technology in mathematics education, utilizing text, images, and other multimodal teaching materials to help students quickly grasp the challenges in mathematical education [20]. Hadisaputra, S., et al. introduced interactive multimedia based on green chemistry, which enhances students' understanding of chemical concepts and related scientific literacy, playing a significant role in cultivating students' chemical subject competencies [21]. However, due to the unique nature of English reading instruction, there is limited research on effectively integrating multimedia resources with English reading instruction to enhance learning efficiency.

Additionally, some scholars have conducted detailed examinations of instructional guidance and practical applications, providing references for the diversified design of English reading instruction strategies. Sun, X analyzed the application of differentiated teaching methods in second language extensive reading instruction, enabling students to achieve higher reading outcomes in online second language learning through the development of personalized reading plans, processes, and products [22]. Brevik, L. M. compared the effectiveness of strategy-based teaching and practical application in English reading instruction. Extensive teaching observation data indicated that encouraging students to apply known reading comprehension strategies and develop authentic English dialogue texts promotes the cultivation of their critical literacy and metadiscourse awareness [23]. Adhikari, B. R., and Poudel, K. K. emphasized that teaching methods guided by theory and context significantly influence the effectiveness of English reading instruction. By assessing the gap between students' reading knowledge and classroom performance under current teaching methods, they provide references for establishing better instructional guidance methods [24]. The aforementioned studies have clarified the importance of instructional guidance and practical expansion, but the mechanisms underlying the effects of the aforementioned diversified teaching methods remain poorly described, presenting significant research value in this area.

In order to scientifically assess students' comprehensive language proficiency, this study constructs an evaluation system containing 31 secondary indicators based on four aspects: language proficiency, learning ability, cultural awareness, and thinking quality, based on the theory of core literacy. To address the issue of indicator assignment, the entropy correction G1 method is innovatively adopted. On the one hand, the preliminary order relationship between indicators is determined by expert ranking, reducing the complicated comparison of traditional AHP. On the other hand, the entropy value method is introduced to quantify the discrete degree of the indicator data itself, to correct the arbitrariness of the subjective ranking of experts, and ultimately to generate a combination of weights that takes into account both empirical judgment and objective data. Second, to dynamically evaluate the state of competence development under diversified learning styles, the Object Element Expandable Model is introduced. This method considers students' ability as the object elements to be evaluated, defines the classical domain and section domain, calculates the affiliation relationship between each indicator and the ability level by using the correlation function, and finally calculates the comprehensive correlation degree by combining the weights obtained from the entropy G1 method, so as to accurately locate the ability level of the students and their bias. The model effectively deals with the nonlinear and nonhomogeneous problem of multidimensional indicators. Finally, in order to deeply analyze the influence path of diversified learning, stepwise multiple regression analysis is used. Based on the large-sample questionnaire data, the explanatory variables (oral proficiency, written proficiency, reading proficiency) and core explanatory variables (self-efficacy, learning anxiety, language attitudes, types of diversified learning styles, etc.) were included in the model, and the significant predictors were screened step by step and quantified in terms of their contribution, revealing how the interaction mechanism between learning styles and other factors jointly shaped the comprehensive language proficiency.

II. Indicator system for evaluating students' comprehensive language competence based on the G1 method

II. A. Construction of evaluation indexes for students' comprehensive language ability

In English reading teaching, the evaluation of students' comprehensive language competence should focus on students' core literacy, students' essential character and key abilities in terms of the content of evaluation. The article centers on the construction of the evaluation system of students' comprehensive language proficiency in four aspects: language proficiency, learning ability, cultural awareness and thinking quality.

Based on various language learning theories, policies, and research studies, the core elements of core literacy in English reading teaching and the key points to be concerned about in evaluation practice are summarized to obtain the evaluation index system of students' comprehensive language proficiency as shown in Table 1.

Table 1: Student Comprehensive Language Ability Evaluation System

Target layer	Primary indicator	Secondary indicator
Evaluation System for Students' Comprehensive Language Abilities in English Reading	B1: Language Skills	C1: Listening, speaking, reading, writing, and graphic comprehension skills
		C2: Long-term memory and short-term memory abilities
		C3: Language awareness and logical cognition
		C4: Communication strategies and communication skills
		C5: Applying knowledge to solve practical problems
		C6: Mastering and applying English pronunciation and grammar knowledge
	B2: Learning ability	C7: Understanding, participating in, and experiencing subject knowledge
		C8: Ability to design and organize inquiry processes
		C9: Application ability of learning resources
		C10: The ability to ask questions, make guesses, form hypotheses, reason, and conduct empirical research
		C11: The ability to analyze and solve problems using scientific methods
		C12: The ability to explain, express, and communicate
		C13: Actively applying learning methods
		C14: Understanding and using learning strategies
		C15: Attention and self-control
		C16: Conscious use of foreign language learning channels
		C17: The awareness and ability to strive to improve the efficiency of foreign language learning
		C18: Lifelong learning ability
	B3: Cultural Awareness	C19: Understanding and accepting the differences between Chinese and foreign cultures
		C20: Maintaining confidence in local culture
		C21: Understanding and appreciating others' viewpoints and worldviews
		C22: Open, appropriate, and effective interaction with people from different cultural backgrounds
		C23: Competence in taking actions for the collective welfare and sustainable development
	B4: Thinking Quality	C24: Dialectical materialist viewpoint
		C25: Patriotism and ideological quality
		C26: Logicality, criticality, and innovativeness
		C27: Using scientific knowledge, methods, and attitudes to understand the world
		C28: The scientific attitude of seeking truth from facts, curiosity, and interest
		C29: The scientific spirit of doubt, criticism, and exploration
		C30: Autonomy, problem awareness, and cooperative spirit
		C31: The ability to compare and make correct value judgments on diverse cultures

The comprehensive language proficiency evaluation system for students in English reading includes 4 primary indicators and 31 secondary indicators, of which B1 language proficiency contains 6 competencies, such as C1 listening, speaking, reading and writing; C6 phonological and grammatical knowledge; B2 learning competency covers 12 competencies, such as C10 reasoning and empirical ability, C18 lifelong learning ability; B3 cultural awareness focuses on cross-cultural competency, such as C19 understanding of Chinese and foreign cultural differences, C23 action for sustainable development; B4 thinking quality contains 8 competencies, such as C26 logical critical innovation, C31 multicultural value judgment. B3 Cultural Awareness focuses on cross-cultural competence, such as C19 Understanding Cultural Differences between China and Foreign Countries, C23 Activity for Sustainable Development; B4 Thinking Quality contains 8 competencies, such as C26 Logical Criticism and Innovation, C31 Multicultural Value Judgment. The system comprehensively covers language application, cognitive

strategies, cultural literacy and thinking dimensions, providing a structured basis for subsequent weighting calculation.

II. B.Theoretical basis of entropy correction G1 method

The G1 method is a common subjective assignment method based on an improved hierarchical analysis (AHP). The method is centered on the ordering of importance between indicator levels, which greatly reduces the huge workload caused by the need to perform the ordering of importance between all indicators and the construction of matrices, and is therefore also called the ordinal relationship analysis method.

II. B. 1) Advantages of the entropy-corrected G1 method

In view of the above analysis of the evaluation indexes of students' comprehensive language ability and the elaboration and comparison of subjective and objective methods, in order to ensure the effectiveness and scientificity of the evaluation indexes, this paper introduces the entropy correction G1 method. This method is a combined assignment method, and its advantages can be summarized as the following two points:

(1) The entropy value correction G1 method can effectively reduce the arbitrariness of the experts' ranking of the importance of indicators:

(2) The entropy value correction G1 method also avoids the problem of weight distribution between subjectivity and objectivity while realizing the skillful combination of expert opinion and indicator information. The idea of this method is to first rank the importance of indicators based on expert opinion, determine the entropy value of each second-level indicator, and then compare the indicators based on the ranking and determine the weight of the first-level indicators by the G1 method. The weight of the evaluation object is determined by the same processing method. Combined weights can be obtained by combining the evaluation object with the first-level indicators. As analyzed in the above process, the principle of evaluation of students' comprehensive language ability based on entropy value correction G1 method is shown in Figure 1.

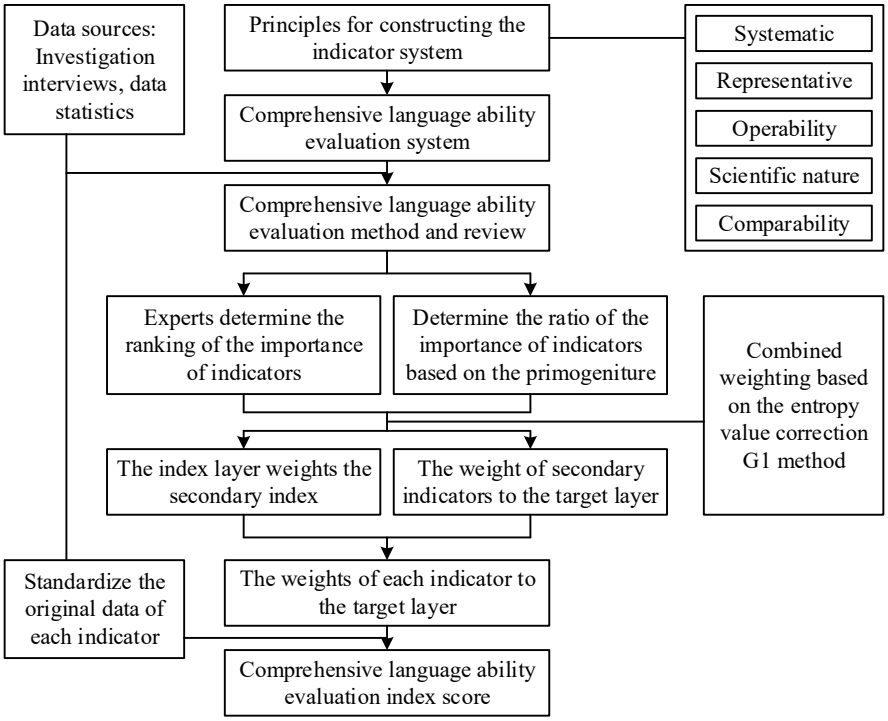

Figure 1: Comprehensive Language Ability Evaluation Based on G1 Method

II. B. 2) Calculation steps of entropy correction G1 method

The final determination of the evaluation index outline, the unit has a certain difference, has the incommensurability, so before using the data need to be standardized. As for the standardization treatment, the Kendall's harmony coefficient can be used to analyze and compare in detail the five linear dimensionless methods of polar difference method, Z-SCORE standardization method, homogenization method, and the great and small methods. The results show that although the Kendall's harmony coefficients of the different methods are quite different, the advantages of the extreme variance method are significantly higher than those of the other four methods and have the least

impact on the model, and the model has the best robustness. Therefore, this paper chooses to standardize the data by the extreme difference method. The calculation formula is as follows:

The larger the value of the indicator, the better the model:

$$a_{ij} = \frac{b_{ij} - \min b_{ij}}{\max b_{ij} - \min b_{ij}} \tag{1}$$

The smaller the value of the indicator, the better the type:

$$a_{ij} = \frac{\max b_{ij} - b_{ij}}{\max b_{ij} - \min b_{ij}} \tag{2}$$

In the formula, b_{ij} represents the original data of the j rd evaluation index under the i nd module $(i = 1, 2, 3, \ldots, n; j = 1, 2, 3, \ldots, m)$. $\max b_{ij}, \min b_{ij}$ represents the maximum and minimum values of the original data of the j th evaluation index under the i th module respectively.

(1) According to the expert opinion, the importance of the indicators is ranked.

(2) Calculation of entropy value of evaluation indicators.

$$q_{ij} = \frac{\overline{x}_{ij}}{\sum_{i=1}^{m} \overline{x}_{ij}} \tag{3}$$

$$E_j = -\ln(m)^{-1} \sum_{i=1}^{m} q_{ij} \ln q_{ij} \tag{4}$$

(3) Applying the entropy value E_j obtained from (1) and (2), and combining with the expert opinion, we will make a two-by-two comparison of the neighboring indicators and obtain the importance ratio r_k between the indicators:

$$r_k = \begin{cases} \dfrac{e_x - 1}{e_x} & e_{k-1} \geq e_k \\ 1 & e_{k-1} \leq e_k \end{cases} \tag{5}$$

(4) Based on the r_k obtained in step 3, determine the weight w_n of the m nd indicator in the first level for the indicator based on the entropy correction G1 method, Eq:

$$w_m = \left(1 + \sum_{i=1}^{m} \prod_{i=k}^{m} r_i\right)^{-1} \tag{6}$$

(5) Calculate the secondary indicator weights w_{k-1} based on the w_m obtained in step 4, and the formula is:

$$w_{k-1} = r_k w_k, k = m, m-1, \cdots, 3, 2 \tag{7}$$

where w_{k-1}, w_k represents the value of the weights of the $k-1$ nd and k rd indicators, respectively.

(6) Determine the weight of the evaluation object a_k

(4) The weight of the first level of indicators obtained w and the evaluation of the next level of indicators for the evaluation of the weight of the object z, that is, to find the weight of the evaluation of the object a_k:

$$a_k = w \times z \tag{8}$$

Assuming that the comprehensive score of the i st research object is μ_i, the standardized data is μ_j, and the weight of the j th evaluation index to the evaluation object based on the entropy correction G1 method is v_j, the calculation formula is:

$$\mu_i = \sum_{i=1}^{m} \mu_{ij} v_j \tag{9}$$

II. C.Determination of indicator weights based on the G1 method

The evaluation of students' comprehensive language proficiency can be based on a combination of scoring and grading, i.e., scoring based on qualitative or quantitative assessment of students' comprehensive language proficiency, and combining the scoring results with the combination weights of the indicators to get the relative scores of the secondary indicators, which can be used to better understand the promotion of students' comprehensive language proficiency by diversified learning styles in the teaching of English reading. The relative scores are summed up to get the score of students' comprehensive language proficiency evaluation system, and the evaluation grade of students' comprehensive language proficiency is divided into four levels according to the ten-point system. [0,5] is not important, (5,7] is generally important, (7,9] is relatively important, and (9,10] is very important.

II. C. 1) Relative subjective weights of evaluation indicators

In order to ensure the reliability of indicator selection, 20 authoritative experts in the field of English linguistics were invited to determine the ordering of each indicator based on the importance level of the indicators at each level of the evaluation system. The relative subjective weights of the second-level indicators relative to the first-level indicators derived from the entropy-corrected G1 method are shown in Table 2.

Table 2: The relative subjective weights of various evaluation indicators

Primary indicator	Weight	Secondary indicator	Weight	Relative subjective weight
B1	0.2261	C1	0.1115	0.0252
		C2	0.1079	0.0244
		C3	0.1331	0.0301
		C4	0.2149	0.0486
		C5	0.1521	0.0344
		C6	0.2804	0.0634
B2	0.4552	C7	0.0896	0.0408
		C8	0.0846	0.0385
		C9	0.0760	0.0346
		C10	0.0545	0.0248
		C11	0.0918	0.0418
		C12	0.0890	0.0405
		C13	0.1046	0.0476
		C14	0.0775	0.0353
		C15	0.0824	0.0375
		C16	0.0874	0.0398
		C17	0.0688	0.0313
		C18	0.0938	0.0427
B3	0.1143	C19	0.2266	0.0259
		C20	0.2283	0.0261
		C21	0.2458	0.0281
		C22	0.1689	0.0193
		C23	0.1304	0.0149
B4	0.2044	C24	0.0856	0.0175
		C25	0.0744	0.0152
		C26	0.1194	0.0244
		C27	0.1473	0.0301
		C28	0.1399	0.0286
		C29	0.1194	0.0244
		C30	0.1145	0.0234
		C31	0.1996	0.0408

Based on the results of the weights derived by 20 experts through the entropy correction G1 method, it can be seen that the order of the weights of the first-level indicators is B2 Learning Ability (0.4552) > B1 Language Ability (0.2261) > B4 Thinking Quality (0.2044) > B3 Cultural Awareness (0.1143), which indicates that the experts attach the most importance to learning ability. The highest weights were C6 Phono-grammatical Knowledge with a relative subjective weight of 0.0634, C4 Communicative Strategies (0.0486), and C13 Active Use of Methods (0.0476). The lowest weights were C23 sustainability activism (0.0149), C22 intercultural interaction (0.0193), and C25 patriotism

(0.0152). The data reflect the experts' opinion that language-based skills (C6) and communicative strategies (C4) have the greatest impact on students' competence.

II. C. 2) Indicator evaluation statistics

Combining the developed evaluation system hierarchical table and the evaluation scores of 20 experts on the indicators at all levels of the evaluation of students' comprehensive language competence, the number of support for 31 L2 evaluation indicators at different evaluation levels is obtained, and the statistics of the indicator evaluations are shown in Table 3.

Table 3: Indicator evaluation statistics

Secondary indicator	Evaluation grade			
	Very important [0,5]	Important (5,7]	Generally important (7,9]	Unimportant (9,10]
C1	9	5	5	1
C2	11	3	5	1
C3	12	6	2	0
C4	11	6	2	1
C5	14	5	1	0
C6	9	10	1	0
C7	11	4	3	2
C8	9	6	4	1
C9	6	7	6	1
C10	12	6	2	0
C11	12	5	3	0
C12	14	5	1	0
C13	8	11	1	0
C14	8	6	5	1
C15	8	8	4	0
C16	6	10	3	1
C17	14	4	2	0
C18	9	6	3	2
C19	9	7	3	1
C20	6	8	4	2
C21	5	5	8	2
C22	5	3	9	3
C23	9	1	8	2
C24	4	7	8	1
C25	8	6	4	2
C26	9	4	6	1
C27	7	8	4	1
C28	9	7	4	0
C29	10	3	5	2
C30	13	3	3	1
C31	9	5	5	1

Table 4: The relative objective weights of evaluation indicators

Secondary indicator	Entropy value L_i	Relative objective weight
C1	0.9045	0.0234
C2	0.8706	0.0277
C3	0.8962	0.0246
C4	0.7261	0.0507
C5	0.8576	0.0318
C6	0.7192	0.0583
C7	0.8215	0.0388

C8	0.8440	0.0327
C9	0.8265	0.0358
C10	0.8726	0.0273
C11	0.7505	0.0461
C12	0.8175	0.0391
C13	0.7462	0.0473
C14	0.8112	0.0412
C15	0.8143	0.0401
C16	0.7680	0.0424
C17	0.8383	0.0328
C18	0.7974	0.0417
C19	0.8918	0.0256
C20	0.8634	0.0299
C21	0.8511	0.0323
C22	0.9205	0.0198
C23	0.9419	0.0118
C24	0.9388	0.0173
C25	0.9392	0.0136
C26	0.9152	0.0219
C27	0.8308	0.0345
C28	0.8642	0.0293
C29	0.9181	0.0215
C30	0.9278	0.0188
C31	0.7871	0.0419

II. C. 3) Relative objective weighting of evaluation indicators

Through the original data in Table 3, the relative objective weights were calculated by the improved entropy weight method, and the entropy value Li of each index and its relative objective weights were obtained as shown in Table 4.

The entropy values were distributed between 0.7192 (C6) and 0.9419 (C23), with lower entropy values indicating greater data dispersion and higher weights. The highest objective weights are C6 (0.0583), C4 (0.0507), and C13 (0.0473). The lowest objective weights are C23 (0.0118), C22 (0.0198), and C25 (0.0136). It can be found that the basic trend of objective weights and subjective weights is consistent, both highlighting the core position of C6 and C4, verifying the reliability of expert judgment.

II. C. 4) G1 method-improved entropy weighting method for determining portfolio weights

Based on the relative subjective and objective weights obtained above, combined with the formula of entropy correction G1 method in section 2.2, the combined weights of each secondary indicator are obtained as shown in Table 5.

Table 5: The composite relative weights of each sub-evaluation index of the system

Secondary indicator	Combination weight
C1	0.0243
C2	0.0260
C3	0.0272
C4	0.0497
C5	0.0331
C6	0.0609
C7	0.0398
C8	0.0355
C9	0.0352
C10	0.0261
C11	0.0440

C12	0.0398
C13	0.0475
C14	0.0382
C15	0.0388
C16	0.0411
C17	0.0321
C18	0.0422
C19	0.0258
C20	0.0280
C21	0.0302
C22	0.0196
C23	0.0133
C24	0.0174
C25	0.0144
C26	0.0231
C27	0.0323
C28	0.0290
C29	0.0229
C30	0.0210
C31	0.0414

The top 5 final combined weight indicators are C6 Phonological grammar (0.0609) > C4 Communicative strategies (0.0497) > C13 Active learning methods (0.0475) > C11 Problem solving (0.0440) > C18 Lifelong learning (0.0422). The last 3 indicators are C23 Sustainable Development (0.0133) < C25 Patriotism (0.0144) < C22 Intercultural Interaction (0.0196). It can be seen that C6 Basic Language Skills, C4 Communicative Strategies and C13 Learning Methods are the key factors to promote students' comprehensive language competence, while the influence weights of cultural indicators (e.g., C22, C23) are consistently low.

III. Evaluation of Students' Comprehensive Language Proficiency under Diversified Learning Based on Object-Element Expansion Modeling

The comprehensive language proficiency evaluation index system constructed based on the entropy-corrected G1 method provides a weighting basis for quantitatively analyzing the role of diversified learning styles. As a result, Chapter 3 introduces the object element topable model to empirically assess the effect of diversified learning styles on the improvement of students' proficiency level, taking the English teacher-training class of a university as a sample.

III. A. Evaluation Model of Students' Comprehensive Language Proficiency Based on Objective Elemental Topologizable Modeling

III. A. 1) Identification of elements to be evaluated

The research object N is regarded as the object to be evaluated, and the object element constituted by this feature is called the object element to be evaluated, and the object element matrix R_0 is established based on the data values of each index of the object element to be evaluated.

$$R_0 = (N_0, C_i, V_i) = \begin{bmatrix} N_p & C_1 & V_1 \\ & C_2 & V_2 \\ & \cdots & \cdots \\ & C_n & V_n \end{bmatrix} \tag{10}$$

In the formula, N_0 - object to be evaluated, V_i - the value corresponding to the evaluation feature C_i, N_0 is the comprehensive language proficiency of students in English reading, C_i is each secondary indicator, and V_i is the corresponding measurement value of each secondary indicator.

III. A. 2) Determination of classical and sectional domains

The classic domain element refers to the range of values contained in the partial feature C of object N. Let the classical domain object R_j of the evaluation object N, with respect to the j st evaluation level $(j=1,2,...,k)$, be as follows.

$$R_j=\left(N_j,C_j,V_j\right)=\begin{bmatrix} N_p & C_1 & V_{j1} \\ & C_2 & V_{j2} \\ & ... & ... \\ & C_{jn} & V_{jn} \end{bmatrix}=\begin{bmatrix} N_p & C_1 & [a_{j1},b_{j1}] \\ & C_2 & [a_{j2},b_{j2}] \\ & ... & ... \\ & C_{jn} & [a_{jn},b_{jn}] \end{bmatrix} \tag{11}$$

where, N_j - the j nd evaluation level of the object of evaluation, C_{jn} - the i th evaluation indicator, $V_{ji}=[a_{ji},b_{ji}]$ - the range of intervals of eigenvalues of the i th evaluation indicator in the j th evaluation level.

The section domain object element is the domain of values contained in the thing N with respect to the full set of characteristics C. Let the evaluation object N, with respect to all evaluation levels of the section domain object element R_p be as follows:

$$R_p=\left(N_p,C_i,V_{pi}\right)=\begin{bmatrix} N_p & C_1 & V_{p1} \\ \vdots & C_2 & V_{p2} \\ \vdots & ... & ... \\ \vdots & C_n & V_{pn} \end{bmatrix}=\begin{bmatrix} N_p & C_1 & [a_{p1},b_{p1}] \\ & C_2 & [a_{p2},b_{p2}] \\ & ... & ... \\ & C_i & [a_{pn},b_{pn}] \end{bmatrix} \tag{12}$$

where, N_P - all evaluation levels of the subject of evaluation, C_i - the i rd evaluation indicator, $V_{pi}=[a_{pi},b_{pi}]$ - the range of intervals of eigenvalues corresponding to all evaluation objects.

III. A. 3) Determining the correlation function

The following formula was used to calculate the correlation function:

$$K_j(V_i)=\begin{cases} -\rho(v_i,v_{ji})\,|\,v_{ji}\,|^{-1}, v_i\in v_{ji} \\ \rho(v_i,v_{ji})[\rho(v_i,v_{pi})-\rho(v_i,v_{ji})]^{-1}, v_i\notin v_{ji}, \rho(v_i,v_{ji})\neq 0 \\ -\rho(v_i,v_{ji})-1, v_i\notin v_{ji}, \rho(v_i,v_{ji})=0 \end{cases} \tag{13}$$

$$\rho(v_i,v_{ji})=\left|v_i-\frac{a_{ji}+b_{ji}}{2}\right|-\frac{1}{2}(b_{ji}-a_{ji})(i=1,2,...,n;j=1,2,...,k) \tag{14}$$

$$\rho(v_i,v_{pi})=\left|v_i-\frac{a_{pi}+b_{pi}}{2}\right|-\frac{1}{2}(b_{pi}-a_{pi})(i=1,2,...,n) \tag{15}$$

where, $K(V_i)$ - the value of the correlation function of the i nd evaluation indicator with respect to the j rd evaluation level, $\rho(v_i,v_{ji})$ - V_i distance from the classical domain, $\rho(v_i,v_{pi})$ - the distance of V_i from the section domain, $|\,v_{ji}\,|$ - the mode of the j th classical domain object element i th indicator corresponding to the interval of quantitative values.

III. A. 4) Calculation of composite correlation

The composite correlation $K_{j0}(N_0)$ of the object to be evaluated N about rank j is:

$$K_{j0}(N_0)=\sum_{i=1}^{n}w_iK_j(V_i)(i=1,2,...,n) \tag{16}$$

where, w_i - Indicator weights.

III. A. 5) Determination of evaluation levels

If $K_{j0}(N) = \max K_j(N), j = 1,2,...,m$ is satisfied, object element N to be evaluated is said to belong to class j.

$$\overline{K_j(V_i)} = \frac{K_j(V_i) - \min K_j(V_i)}{\max K_j(V_i) - \min K_j(V_i)} \tag{17}$$

$$j^* = \frac{\sum_{j=1}^{m} j\overline{K_j(V_i)}}{\sum_{j=1}^{m} \overline{K_j(V_i)}} \tag{18}$$

where, $\overline{K_j(V_i)}$ is the evaluation grade of the nullclass after the polarization process. j^* is the eigenvalue of the grade variable of the element to be evaluated N. Eigenvalues j^* reflect the degree of bias of N in the evaluation rank.

III. B. Empirical evaluation and correlation analysis based on diversified learning styles

The students of the English Teacher 2 class of 2024 in a university, which innovatively adopts diversified learning styles, are taken as the object of the study. A study was conducted using the Objective Meta-topology based on the evaluation of students' comprehensive language proficiency in English reading teaching.

III. B. 1) Establishment of evaluation levels

It is assumed that N represents the students' comprehensive language proficiency level in English reading teaching, and N={N1, N2, N3, N4, N5} corresponds to the grades such as excellent, good, medium, poor and poor. Students' comprehensive language proficiency is mostly qualitative evaluation, and the form of statistical scoring can quantify the qualitative evaluation, this paper sets each index as a unified scoring standard, and all of them are 5-point system, students' comprehensive language proficiency level corresponding to the scoring standard is N1[0,1], N2(1,2], N3(2,3], N4(3,4], N5(4,5].

III. B. 2) Calculating the correlation of the evaluation indicators

The correlation degree of each indicator of the evaluation system about each level of competence was calculated based on the object element topable model. The correlations of the secondary indicators of the comprehensive language competence of the students in the class of the study about each level were obtained as shown in Table 6.

Table 6: The correlation degree of students' comprehensive language ability indicators

Secondary indicator	Comprehensive correlation degree					Level
	N1	N2	N3	N4	N5	
C1	-0.185	0.227	-0.451	-0.791	-0.742	Excellent
C2	-0.188	0.222	-0.689	-0.713	-0.589	Good
C3	1.223	0.144	-0.432	-0.659	-0.524	Excellent
C4	-0.229	0.183	-0.346	-0.451	-0.727	Good
C5	-0.136	0.144	-0.377	-0.798	-0.744	Excellent
C6	-0.248	0.175	-0.605	-0.654	-0.748	Good
C7	-0.167	0.312	-0.313	-0.553	-0.728	Excellent
C8	1.274	0.216	-0.513	-0.618	-0.568	Excellent
C9	0.855	0.151	-0.517	-0.599	-0.562	Excellent
C10	-0.197	0.109	-0.434	-0.707	-0.549	Excellent
C11	-0.193	0.293	-0.679	-0.590	-0.675	Excellent
C12	-0.231	-0.212	-0.35	-0.644	-0.610	Good
C13	-0.154	0.101	-0.698	-0.345	-0.513	Excellent
C14	-0.177	0.299	-0.512	-0.526	-0.687	Excellent
C15	0.476	0.357	-0.508	-0.416	-0.513	Excellent
C16	-0.299	0.145	-0.685	-0.764	-0.741	Good
C17	-0.226	0.270	-0.637	-0.645	-0.571	Excellent
C18	1.272	0.404	-0.589	-0.319	-0.505	Excellent
C19	-0.069	0.126	-0.409	-0.762	-0.563	Excellent
C20	-0.175	0.294	-0.492	-0.707	-0.751	Good

C21	-0.194	0.251	-0.606	-0.193	-0.558	Excellent
C22	-0.084	0.132	-0.564	-0.796	-0.511	Excellent
C23	1.076	0.138	-0.346	-0.667	-0.549	Excellent
C24	-0.018	0.190	-0.536	-0.669	-0.767	Good
C25	-0.107	0.293	-0.569	-0.771	-0.682	Excellent
C26	-0.105	0.288	-0.576	-0.575	-0.711	Excellent
C27	-0.238	0.156	-0.656	-0.228	-0.637	Excellent
C28	0.285	0.245	-0.571	-0.618	-0.573	Excellent
C29	0.623	0.416	-0.384	-0.521	-0.609	Excellent
C30	-0.025	-0.275	0.081	-0.732	-0.572	Excellent
C31	-0.195	0.211	-0.694	-0.621	-0.568	Excellent

C3 Language Awareness/Language Reasoning, C8 Organizational Inquiry Ability, C18 Lifelong Learning Ability, C23 Sustainable Development Action Ability, and C29 Scientific Spirit show a significant correlation (>1.0) at the N1 level, indicating that diverse learning methods have a significant effect on improving cognitive strategies and sustainable development literacy. C15 Attention/Self-Control, C28 Scientific Attitude, and other learning ability-related indicators all achieved an “Excellent” rating. C12 Explanation/Expression Ability and other indicators were rated as “Good” (correlation coefficients: N1: -0.231, N2: -0.212), indicating that expression ability requires focused enhancement.

Twenty-seven indicators (87%) achieved an “excellent” rating, validating that diversified learning methods have a broad promotional effect on students' comprehensive language abilities, particularly in language fundamentals (C1-C6), learning strategies (C13-C18), and thinking qualities (C26-C31).

III. B. 3) Calculation of composite correlation and hierarchical variable eigenvalues

According to the correlation degree of all second-level indicators of comprehensive language proficiency in English reading in the class applying diversified learning styles about each level in Table 6, combined with the comprehensive weights corresponding to the second-level indicators obtained in Table 5, the correlation degree of the first-level indicators of comprehensive language proficiency in English of the students in this class about each level can be calculated, and the specific results are shown in Table 7. Based on the values of the correlations of the first-level indicators about each level, the eigenvalues of the level variables are calculated.

Table 7: The correlation of the indicators of comprehensive language ability

Primary indicator	Comprehensive correlation degree					Level	Level variable characteristic value e*
	N1	N2	N3	N4	N5		
B1	0.267	0.103	-0.614	-0.662	-0.751	Excellent	1.689
B2	-0.191	0.447	-1.023	-0.503	-1.705	Excellent	1.737
B3	0.042	0.741	-0.697	-2.059	-0.623	Excellent	1.817
B4	0.376	0.371	-1.425	-0.597	-2.594	Excellent	1.783

B2 Learning ability has the highest weight (0.4552) and the best e* value (1.737), indicating that diversified learning styles most significantly enhance students' independent inquiry, resource application and lifelong learning ability; B3 Cultural awareness correlation is the highest at N2 level, 0.741, indicating that intercultural competence is in the “good→excellent” transition period. It indicates that intercultural competence is in the transition period of “good→excellent” and needs to be continuously strengthened in practice. The e* values of all dimensions are close to 2.0, of which B4 Thinking Quality has the best correlation at the N1 level, at 0.376, confirming the positive influence of C26 Diversified Learning on Critical Thinking and C30 Innovativeness.

Combined with the comprehensive correlation of the first-level indicators and the corresponding weights, the comprehensive correlation of the English language proficiency of the students in the class under the application of diversified teaching methods and the e* values of their grade variable characteristics can be calculated, and the specific results are shown in Table 8.

Table 8: The comprehensive correlation of comprehensive language ability

Primary indicator	Comprehensive correlation degree					Level	Level variable characteristic value e*
	N1	N2	N3	N4	N5		
A	0.372	0.103	-0.674	-0.673	-0.701	Excellent	1.716

The overall correlation of the class on the N1 level is 0.372, and the eigenvalue of the level variable is e* = 1.716, which is judged as “excellent”. It can be seen that the diversified learning approach promotes the overall language proficiency of the class to reach the excellent level, and the diversified learning approach significantly promotes the development of students' language proficiency, learning strategies and higher-order thinking.

IV. Research on the factors affecting students' comprehensive language proficiency based on step-by-step multiple regression

The Object Meta-Topology model verifies the significant contribution of diversified learning styles to 87% of the proficiency indicators, but the path of its influence needs to be further analyzed. Therefore, Chapter 4 explores how the interaction mechanism between diversified learning styles and other factors work together to shape students' comprehensive language proficiency through a large-sample questionnaire.

IV. A. Sources of Data and Definition of Variables on Factors Influencing Students' Comprehensive Language Proficiency

IV. A. 1) Data sources

This study takes undergraduate college students enrolled in the first to fourth year of a university as the research object and does not limit the scope of specialties. The questionnaire was designed on the basis of reference to national databases, relevant professional scales and existing literature, and in close connection with the need for research on the factors influencing college students' comprehensive language proficiency and their diversified learning styles in the teaching of English reading. Questionnaire Star was used as a platform to distribute the questionnaire to the target population. The whole survey process lasted two months, and 914 valid questionnaires were finally recovered, of which 277 were for freshmen, 254 for sophomores, 220 for juniors and 163 for seniors.

IV. A. 2) Definition of variables

English oral language level is a direct reflection of students' comprehensive language use ability. At the same time, written English language ability is an important part of students' comprehensive language ability, and reading a lot is the key to improving written English language ability. As an important part of language proficiency, reading ability plays an unignorable role in the process of improving language proficiency. Based on this, this study sets “language of conversation”, “English proficiency” and “reading ability” as the explanatory variables in the construction of the statistical model. It reflects the comprehensive language proficiency of college students in English through their choice of language in daily conversation, their perception of their English speaking level, their frequency of reading, and the amount of reading they have done in a multidimensional way.

Language behavior is typically influenced by both linguistic and non-linguistic factors. This study carefully selected seven variables as explanatory variables based on reference to the China Family Panel Studies (CFPS) database and in-depth analysis of previous literature: “self-efficacy,” “learning anxiety,” “health status,” “attitude toward language,” “parents' educational attainment,” “learning resources,” and “types of diversified learning methods.” Specifically, the study measures these seven explanatory variables by investigating college students' ability and belief in completing a certain activity at a certain level, whether they experience anxiety during the learning process, their physical and mental health status, their attitude toward learning English, their parents' highest level of education, the frequency with which they utilize learning resources, and the specific diversified learning methods they employ. Among these, different methods focus on different language skills, and the effectiveness of their combination directly influences the direction and extent of comprehensive ability improvement.

IV. B. Correlation and Regression Analysis of the Influence Mechanisms of Diversified Learning Styles on English Language Proficiency

Based on the questionnaire data and variable definitions of 914 undergraduate students, section 4.2 firstly identifies the strong association between diversified learning styles and English proficiency initially through Pearson correlation analysis, and then employs stepwise multiple regression to strip away their independent effects and reveal the core hierarchy of influencing factors.

IV. B. 1) Pearson correlation analysis

Pearson correlation analysis was used to test the correlation between the explanatory variables (conversational language, English language proficiency, and reading proficiency) and the explanatory variables (self-efficacy, learning anxiety, health status, language attitudes, parental qualifications, learning resources, and types of diversified learning styles), and the specific results are shown in Figure 2.

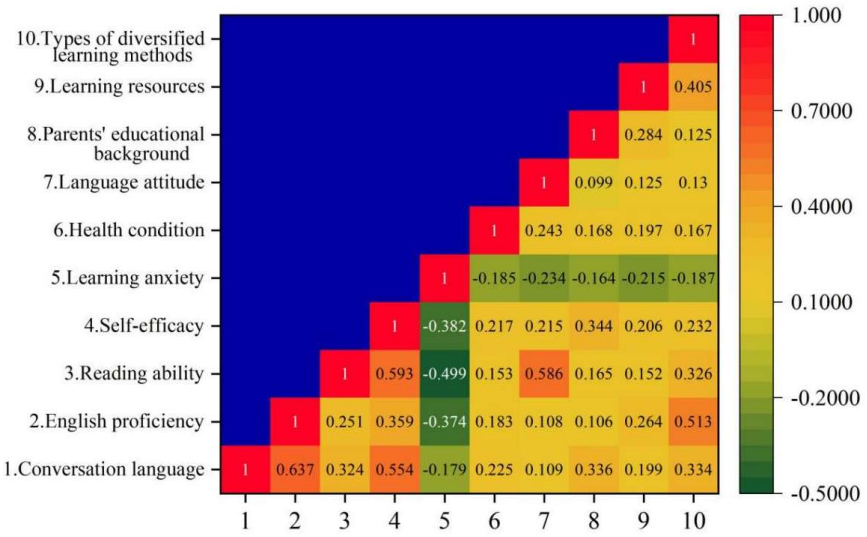

Figure 2: Pearson correlation analysis

Data shows that the correlation coefficient between English proficiency and the types of diversified learning methods is the highest (*r* = 0.513), indicating that diversified learning methods have a significant positive correlation with the improvement of language ability. The language of conversation is strongly correlated with English proficiency (*r* = 0.637), reflecting the close connection between oral expression and overall language ability. Reading ability is highly positively correlated with language attitude (*r* = 0.586) and self-efficacy (*r* = 0.593), indicating that learning motivation and psychological state are the key influencing factors of reading ability. Learning anxiety is negatively correlated with all language ability dimensions (such as English proficiency: *r* = -0.374), highlighting the inhibitory effect of anxiety on language learning. Learning resources have a strong correlation with the types of diversified learning methods (*r* = 0.405), suggesting that resource acquisition is the fundamental support for implementing diversified learning.

IV. B. 2) Analysis of factors affecting English language proficiency

Using step-by-step multiple regression analysis, the predictive ability of each explanatory variable on college students' English proficiency was explored in depth, and a regression model was established on this basis, and the results of the step-by-step multiple regression analysis of the influencing factors on English proficiency are shown in Table 9.

Table 9: Regression Analysis of the Influencing Factors on Mandarin Proficiency

		B	SD	β	t	F	R2	△R2
Model 1	Constant	2.415	0.112		25.183***	187.324***	0.147	0.146
	Self-efficacy	0.663	0.050	0.472	14.283***			
Model 2	Constant	1.924	0.119		12.363***	128.291***	0.206	0.205
	Self-efficacy	0.432	0.132	0.391	9.837***			
	Types of diversified learning methods	0.297	0.016	0.288	7.219***			
Model 3	Constant	1.557	0.107		10.221***	89.027***	0.236	0.234
	Self-efficacy	0.343	0.034	0.316	8.159***			
	Types of diversified learning methods	0.266	0.013	0.234	6.744***			
	Language attitude	0.191	0.117	0.191	5.474***			
Model 4	Constant	1.272	0.040		8.388***	71.294***	0.243	0.241
	Self-efficacy	0.292	0.113	0.274	7.897***			
	Language attitude Learning resources	0.156	0.026	0.207	7.392***			
	Constant	0.082	0.111	0.176	6.197***			
	Self-efficacy	0.045	0.113	0.141	6.003***			
Model 5	Diverse learning methods types	1.149	0.176		7.961***	54.196***	0.254	0.250
	Language attitude Learning resources	0.177	0.056	0.254	6.942***			
	Health condition	0.108	0.093	0.187	6.764***			
	Constant	0.062	0.006	0.156	6.041***			

	Self-efficacy	0.036	0.051	0.121	5.537***			
	Constant	0.012	0.024	0.086	4.455***			

Table 9 explores the mechanisms influencing English proficiency through stepwise regression, with five nested models constructed. Model 1 incorporated only self-efficacy and explained 14.7% of the variance in English proficiency ($R^2 = 0.147$, $\beta = 0.472$, *p* < 0.001). Model 2 added diverse learning style types, which increased the explanation rate to 20.6% ($\Delta R^2 = 0.059$), with a significant standardized coefficient ($\beta = 0.288$, *p* < 0.001), confirming the independent contribution of diverse learning to language proficiency. Models 3-5 progressively introduced language attitudes, learning resources, and health status, and the final model cumulatively explained 25.4% of the variance ($R^2 = 0.254$).

Among them, self-efficacy ($\beta = 0.254$, *p* < 0.001), type of diversified learning styles ($\beta = 0.187$, *p* < 0.001), language attitudes ($\beta = 0.156$, *p* < 0.001), learning resources ($\beta = 0.121$, *p* < 0.001), health status ($\beta = 0.086$, *p* < 0.001), learning anxiety and parental education did not enter the final model, indicating that their direct effects on English proficiency were not significant.

V. Conclusion

This study systematically verified the significant promotion effect of diversified learning styles on students' comprehensive language competence in English reading teaching through entropy correction G1 method, object element topable model and stepwise multiple regression analysis.

The entropy-corrected G1 method based on the assignment of 20 experts shows that B2 learning ability (weight 0.4552) is the core pillar of comprehensive language proficiency, followed by B1 language proficiency (0.2261), B4 thinking quality (0.2044) and B3 cultural awareness (0.1143). Among the key L2 indicators, C6 Phono-grammatical Knowledge (combined weight 0.0609), C4 Communicative Strategies (0.0497) and C13 Active Learning Approach (0.0475) ranked in the top three, highlighting the cornerstone roles of language foundation and learning strategies.

The assessment of the class applying diversified learning by the Objective Expansion Model shows that 87% of the secondary indicators reach the “excellent” level (N1 level), among which the correlation scores of Language Awareness (C3), Lifelong Learning Ability (C18), and Spirit of Science (C29) are all >1.0, which indicates that the cognitive strategies and higher-order literacy have been significantly enhanced. The overall comprehensive language proficiency e*=1.716 (excellent level) and the best performance in the learning ability dimension (e*=1.737) confirmed that diversified learning most significantly strengthened the ability of independent inquiry and strategy application.

Stepwise multiple regression analysis revealed that the type of diversified learning styles was significantly and positively associated with English proficiency, r=0.513, p<0.001, with a standardized coefficient of β=0.187, which was second only to self-efficacy in terms of contribution (β=0.254). Diverse learning styles, self-efficacy, language attitudes, learning resources, and health status together explained 25.4% of the variance in English proficiency (r^2=0.254), while the effects of learning anxiety and parental education did not reach significance.

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