

A Q-Methodology Research on College Students' Cognitive Types of English Grammar from the Perspective of Cognitive Metaphor

Fang Huan, Furong Dai, Luyao Ma

School of Foreign Languages, Yan'an University, Yan'an 716000, Shaanxi, China

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Abstract: As the structural core of language systems, grammar lays the foundation for linguistic communication and thought organization. Its acquisition process profoundly reflects learners' internalization and conceptual construction of linguistic rules. From the perspective of cognitive linguistics, grammar is regarded as a cognitive outcome and a problem-solving tool derived from language use and evolving dynamically along with cognition. Grammar acquisition is more than memorization of formal rules; it is a process of restructuring cognitive structures and forming conceptual systems^[1]. Therefore, exploring how grammar can be effectively transformed from formal knowledge into cognitive schemas has become a core issue in foreign language teaching research. As a core thinking mode that interprets abstract concepts through mapping from source domains to target domains, cognitive metaphor theory provides a powerful analytical perspective for exploring this mechanism, especially regarding the specific functions of metaphorical mapping in conceptualization^[2]. Though existing studies have touched upon the cognitive dimension of grammar acquisition, they have not systematically explored the internal cognitive mechanisms through which learners construct grammatical concepts. Against this background, this paper adopts cognitive metaphor theory as the theoretical framework and employs Q methodology to deeply reveal college students' metaphorical cognitive types of English grammar and their structural characteristics. This research focuses on three research questions: (1) What typical shared conceptual patterns exist in college students' metaphorical cognition of English grammar? (2) What characteristic differences do different conceptual patterns display in metaphor preferences and cognitive structures? (3) Are there internal correlations among various conceptual patterns, and do cross-group consensual understandings exist? This study intends to provide theoretical enlightenment and practical paths for shifting grammar teaching from form-oriented to cognition-adaptive modes.

Keywords: Cognitive metaphor theory; English grammar; Metaphorical cognition; Concept construction; Q methodology

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1. Concept construction and theoretical framework

Grammatical concept construction refers to the dynamic cognitive process in which learners mentally represent, endow with meanings, and systematize grammatical rules and forms during foreign language acquisition. It is not simple memorization of static formal rules. Instead, learners actively integrate and reconstruct discrete grammar points into internal operable conceptual structures or “cognitive schemas” based on language input and interaction as well as reflective thinking ^[3]. This process involves comprehension of grammatical functions, establishment of form-meaning-usage connections, and adaptive application in new contexts, with conceptualization as its core feature. Conceptualization means learners transform abstract grammatical relations into mental models that can be simulated and manipulated psychologically via existing experience or concrete images ^[4].

Cognitive metaphor theory offers a robust analytical framework for interpreting the internal mechanisms of grammatical concept construction. Grammar is highly abstract, while metaphorical mapping serves as a vital cognitive bridge for understanding abstract concepts. To a considerable extent, grammatical concept construction can be regarded as a metaphorical cognitive process. By identifying and establishing cross-domain mappings, learners assign conceptual connotations and mental images to grammatical forms, thus completing the transformation from formal knowledge to cognitive schemas ^[5]. Exploring how learners generate and apply metaphors spontaneously or under guidance can reveal the dynamic paths and cognitive depths of grammatical concept formation.

This study adopts dual connotations of cognitive metaphor theory simultaneously. First, it takes the theory as the core theoretical perspective to frame and analyze learners’ metaphorical cognitive structures of grammatical essence. Second, it treats metaphorical expressions produced by learners as key empirical objects, through which potential grammar cognitive types and characteristics can be uncovered. This research regards metaphorical statements as core cognitive units for analyzing grammar cognition types, aiming to systematically capture and interpret the deep conceptual frameworks relied upon by learners when understanding grammar.

2. Literature review

2.1. Research on cognitive metaphor theory and its application in foreign language teaching

Since the rise of cognitive linguistics at the end of the 20th century, cognitive metaphor theory, its core branch, has provided a revolutionary perspective for understanding the nature of language and thought. On this basis, the application potential of this theory in second language acquisition and foreign language teaching has become a focal academic concern. Such a paradigm shift has elevated metaphor from a marginal topic in language teaching to a key cognitive tool for exploring the formation and development of learners’ conceptual systems. Existing empirical studies feature uneven distribution and limitations in application fields. A large number of research achievements on cognitive metaphor theory in foreign language teaching concentrate on vocabulary instruction, especially metaphorical interpretation of polysemous words and idioms; a small number extend to cultural teaching and discourse comprehension. However, research on metaphorical cognition processes for systematic grammatical concept construction is extremely scarce. Most relevant studies only interpret specific grammar points without deeply exploring how learners spontaneously form and utilize metaphor networks to organize overall grammar knowledge systems ^[6]. A small number

of enlightening preliminary studies have made breakthrough attempts. Based on cognitive linguistics, they develop systematic metaphorical schemas for explaining grammatical categories such as English preverbs and modal verbs, and verify their effects in small-scale teaching, offering micro examples for cognition-oriented grammar teaching. Though these studies do not take conceptual construction mechanisms as core research questions, their attempts to reconstruct grammar knowledge from a cognitive perspective provide critical paradigm inspiration for this paper's analysis of deep mechanisms of grammatical concept construction based on cognitive metaphor theory.

2.2. Paradigm evolution and cognitive turn of grammar teaching research

Grammar teaching research has undergone remarkable paradigm evolution from focusing on linguistic forms to centering on learners' cognitive processes. Dominated by structuralism and behaviorism, early research formed a form-training paradigm featuring rule memorization and sentence pattern drills. Under the influence of communicative language teaching and task-based language teaching, research focus shifted to implicit grammar integration in meaning negotiation, forming a communicative functional paradigm^[7]. Over the past two decades, the rise of cognitive linguistics has brought a profound cognitive turn to grammar teaching research. This paradigm treats grammar as conceptual products, and relevant research aims to help learners establish motivated connections between forms and images via tools such as image schemas and constructions. Despite deepening comprehension of the essence of grammar, existing research still mainly provides new teaching explanatory tools for teachers and verifies the effects of teaching interventions, failing to address the more fundamental issue of the internal construction processes and psychological mechanisms of learners' grammatical conceptual systems.

2.3. Research on cognitive mechanisms of grammatical concept construction

Grammatical concept construction refers to the dynamic cognitive process in which learners mentally represent, endow with meanings, and systematize abstract grammatical rules and forms during second language acquisition. In this process, metaphorical mapping, a basic cognitive operation that interprets abstract target domains through concrete source domains, plays a pivotal role^[8,9]. Learners often rely on embodied experiences such as space, force, and containers to construct abstract grammatical concepts, including tenses, voices, and clause relations. Nevertheless, current research on grammatical concept construction mechanisms mainly adopts quantitative experiments and corpus analysis. No empirical studies have been found that systematically utilize Q methodology to investigate how learners build grammatical conceptual networks via metaphorical mapping.

This study intends to adopt Conceptual Metaphor Theory as the analytical framework, employ Q-methodology, which can systematically reveal individuals' subjective viewpoint patterns and cognitive structures, and take "metaphorical expressions" as the analytical unit to systematically investigate college students' types of metaphorical cognition regarding the nature of English grammar and their structural characteristics. Three research questions are proposed:

- (1) What typical and shared viewpoint patterns exist in college students' metaphorical cognition of English grammar?
- (2) What characteristic differences do different viewpoint patterns exhibit in terms of metaphor preferences and cognitive structures?

- (3) Are there intrinsic correlations among various viewpoint patterns? Is there consensus understanding across groups?

From the perspective of conceptual metaphor, this study aims to uncover the multi-dimensional typology of college students' cognition of grammar concepts, so as to provide empirical evidence and practical approaches for shifting grammar teaching from a "one-size-fits-all" model toward "cognitive adaptation."

3. Research methodology

3.1. Research setting

This research is carried out within the college English curriculum of a comprehensive university, strictly following standard Q-methodology procedures with a one-off cross-sectional design. It identifies common viewpoint patterns (factors) displayed by participants when subjectively sorting a series of grammar metaphor statements. The Q sample is constructed based on preliminary semi-structured interviews ($n = 12$) and literature review. Metaphorical expressions about "what English grammar is" are extensively collected and screened to form a Q sample consisting of 34 statements. Data collection is conducted one-on-one in quiet classrooms under the supervision of research assistants. After each participant completes Q sorting, the researcher briefly records their reasons for selecting extreme items.

3.2. Research subjects

Purposive sampling is adopted in this study, with 25 full-time undergraduates as participants, including 13 English majors and 12 non-English majors (11 males, 14 females). The average age is 20.3 years ($SD = 1.2$). All participants have finished basic college English courses, with an average CET-4 score of 515 ($SD = 35$), corresponding to the upper-intermediate proficiency level. This indicates that participants possess stable grammar learning experience and cognitive foundations to understand and complete subjective sorting of grammar metaphor statements.

3.3. Data collection methods, procedures, and analytical tools

This study strictly complies with standard Q-methodology procedures. Q methodology is a mixed research method integrating quantitative and qualitative orientations. It systematically reveals participants' subjective viewpoint patterns and grouping features, which highly matches the core objective of this paper to explore learners' grammar metaphor cognition types.

The specific research steps are as follows:

- (1) Collecting Q-concourse: Metaphorical statements regarding "what English grammar is" were extensively collected by combining semi-structured interviews and literature analysis ^[10]. The research team conducted one-on-one interviews with 12 undergraduates (with an average duration of approximately 40 minutes per participant), and initial textual data were obtained after transcribing the interview recordings. Meanwhile, grammatical metaphorical statements from relevant literature in the fields of cognitive linguistics and foreign language teaching were systematically sorted out. The two sources jointly formed the initial statement pool.
- (2) Q-sample construction: Two researchers majoring in Subject Teaching (English) independently screened and categorized the initial statements based on statement clarity, representativeness, and diversity of metaphor categories. After multiple rounds of discussion and integration, 34 most representative

metaphorical statements were retained to form the formal Q-sample.

- (3) Q-sorting: Twelve students filled in the item serial numbers into the Q-questionnaire, with a unique serial number for each blank. Data collection was carried out one-on-one in a quiet classroom of a comprehensive university, hosted by two trained research assistants, and each participant spent approximately 25–30 minutes. The specific procedure is as follows: researchers first informed participants of the research purpose and explained the requirements of the Q-sorting task—participants assigned 34 cards onto an approximately normal-distribution grid ranging from “most consistent with my views” (+4) to “least consistent with my views” (-4) (9 columns in total, and the number of cards allowed in each column in sequence: 2-3-4-5-6-5-4-3-2) according to their personal degree of agreement with each statement. Participants first read through all cards and roughly divided them into three piles: “agree,” “neutral,” and “disagree.” Afterward, they selected the two statements most consistent with their personal views from the “agree” pile and placed them in the +4 column, and proceeded in this manner until all cards were mandatorily assigned to the respective slots of the grid to generate a unique Q-sorting result.
- (4) Q-post-sorting interview: Upon completion of sorting, researchers recorded the column position of each card and invited participants to briefly explain their sorting rationales for several statements placed at extreme positions (+4/-4), so as to obtain qualitative interpretative materials. All interview contents were audio-recorded and transcribed, yielding approximately 25,000-word textual data to support subsequent factor interpretation.
- (5) Data analysis and factor extraction: Data processing was performed using PQMethod 2.35, specialized software for Q-methodology. Firstly, principal component analysis was conducted on 25 Q-sorting data matrices. Four factors were determined for extraction in accordance with the Kaiser criterion (eigenvalue > 1) combined with a scree plot test. Subsequently, varimax rotation was implemented for factor rotation to render the factor structure clearer and more interpretable. Standardized factor scores (Z-scores) of each factor across the 34 statements were calculated to obtain the typical attitudes of the viewpoint group represented by each factor toward every statement. Furthermore, by comparing the statistical differences in statement Z-scores across different factors ($P < 0.05$), “consensus statements” with no significant differences among factors and “distinguishing statements” whose scores on specific factors were significantly higher or lower than those on other factors were identified.

Four factors with eigenvalues greater than 1 were extracted through factor analysis, cumulatively accounting for 57% of the total variance (after rotation), indicating favorable explanatory power of the model. The eigenvalue, percentage of explained variance for each factor, and the number of participants with significant loadings (>0.40) on each factor are shown below. Among them, Factor 1 explained the largest proportion of variance (24%) and had the largest number of representative participants (13 individuals), constituting the primary cognitive type.

4. Research findings and discussion

4.1. Four typical modes of metaphorical cognition of English grammar

Based on the semantic features of high-scoring core metaphors of each factor and their internal cognitive orientations, the researchers named and interpreted the four modes. The naming is inspired by the metaphor clusters and underlying cognitive schemas revealed by factor analysis results.

4.1.1. Structured tool type

The core high-scoring metaphors of Factor 1 collectively reflect learners' specific understanding of the nature of grammar. A typical statement from one participant goes: "Grammar is like a mathematical formula with strict derivation rules, and sentences have definite answers. It provides clear criteria for judging right and wrong." This cognitive mode accounts for 52% of the sample, and it constructs English grammar as a highly cohesive and prescriptive formal system. Its dominant metaphor cluster (tree root, skeleton, mathematical formula, pyramid) points to static, layered, and self-contained cognitive schemas. From this perspective, grammar is not an accompanying feature of language use, but an underlying logical framework that precedes and determines linguistic legitimacy. Learners holding this view show a strong preference for certainty, clarity, and derivability. They analogize grammatical rules to mathematical axioms or engineering blueprints, believing there exists a single or optimal correct form. Their learning process is accompanied by deliberate rule searching, classification, and error attribution, with low tolerance for linguistic ambiguity and variants.

4.1.2. Navigation guidance type

The core high-scoring metaphors of Factor 2 reveal learners' unique understanding of grammar as a functional tool. A representative statement from a participant: "Grammar is like maps and compasses. It is not the destination itself, but a tool that provides direction and path options when you feel confused about organizing ideas or parsing complex sentences during reading and writing." This cognitive perspective covers 16% of the sample, and it interprets English grammar as a dynamic meta-cognitive tool. Its core metaphors (map, compass, lighthouse, bridge) jointly outline a cognitive picture of exploration and pathfinding. Grammar is regarded as strategic resources and problem-solving frameworks embedded in language use, rather than self-sufficient systems separated from contexts. Learners of this type focus on the instrumentality and situational adaptability of grammar, and tend to apply grammatical knowledge through conditional reasoning of the "if...then" structure to achieve specific communicative goals, such as improving text readability or removing comprehension barriers. Their learning behaviors are distinctly goal-oriented and strategic. Learning grammar equals mastering navigation skills to plan routes, locate personal status, and adjust progress amid complex linguistic tasks.

4.1.3. Creative expression type

The core high-scoring metaphors of Factor 3 reflect learners' cognitive orientation linking grammar to personal meaning expression. One participant offered a vivid explanation: "Grammar is the note rules on music scores. It sets boundaries precisely to make creation freer and more harmonious and powerful. It teaches me to organize language ingeniously to convey delicate thoughts and emotions instead of restricting me." This cognitive orientation accounts for 20% of the sample, and it reconceptualizes English grammar as an enabling framework for personal meaning expression and aesthetic creation. Its core metaphors (music score, palette, script, cosmetics) all connect grammar to artistic creation, stylization, and identity presentation. Rules are interpreted as creative constraints and structural resources serving higher expressive intentions. Learners of this type value the rhetorical potential and stylistic effects of grammar, and pay attention to subtle differences in meaning, emotional tones, and stylistic registers brought by different grammatical choices. Their learning goes beyond judging correctness and enters the level of appreciation, selection, and deliberate refinement. Grammatical competence is equivalent to proficiency in a writer's toolbox, aiming to improve the precision, expressiveness, and uniqueness of personal voice.

4.1.4. Entry threshold type

The core high-scoring metaphors of Factor 4 unfold learners' unique perspective of understanding grammar from social and cultural dimensions. One participant's statement profoundly reflects this cognitive tendency: "Mastering grammar well is like holding a symbolic key. It is not only a practical tool to open the door to authentic English, but also a signal that makes others willing to listen and take your words seriously, a prerequisite for gaining a voice in communication." This cognitive framework accounts for 12% of the sample, and it interprets English grammar from the dimension of social cultural capital and identity politics. Its core metaphors (key, gate, bridge, pass, cosmetics) strongly imply the social symbolic function of grammar: it is a critical access condition and identity marker for individuals to enter specific discourse communities and obtain membership recognition. Learners of this type closely link grammatical competence to social mobility, group belonging, and symbolic power. They are sensitive to the signaling function of grammatical accuracy in academic, professional, and cross-cultural communication scenarios, which stands for educational attainment, professional literacy, and cultural adaptation. Their learning motivation may be highly extrinsic, stemming from strong expectations of social evaluation, opportunity acquisition, and identity transformation. Grammar becomes a kind of social code or cultural makeup that must be mastered.

The four metaphorical cognitive modes above reveal learners' in-depth understanding of English grammar from distinct dimensions: the Structured Tool Type focuses on grammar's internal logical rule system; the Navigation Guidance Type emphasizes grammar's instrumental and situational adaptability; the Creative Expression Type highlights grammar's rhetorical and aesthetic value; the Entry Threshold Type underscores grammar's social symbolic function and cultural capital attribute. These four modes are not mutually exclusive, but form a multi-dimensional cognitive continuum that jointly depicts the complex landscape of Chinese college students' comprehension of English grammar.

4.2. Correlation analysis between consensus metaphors and cognitive types

The study finds that three metaphor statements show no statistically significant differences in Z-scores across all four factors ($P > 0.05$), so they are defined as consensus metaphors representing universal understandings transcending individual cognitive types (see **Table 1**).

Through statistical comparison of standardized Z-scores of all metaphor statements across four factors, the distribution of Z-scores of three statements shows no significant statistical difference between factors ($P > 0.05$). This result indicates that despite dominant cognitive types within the learner group, there still exist universal understandings of certain essential attributes of English that cross cognitive boundaries. These consensus metaphors constitute the "least common denominator" of college students' grammatical cognition and reveal their shared basic interpretive framework.

Table 1. Z-scores of consensus metaphors on each factor

Metaphor statement	No.	Factor 1	Factor 2	Factor 3	Factor 4	Variance (SD)
English grammar is a spider web	3	-1.19	-1.91	-1.50	-1.46	0.27
English grammar is a map	6	-0.78	-1.31	-1.27	-0.96	0.23
English grammar is stars	26	0.37	0.15	-0.08	0.40	0.21

4.2.1. Cognitive awareness of grammatical relevance: The spider web metaphor

This metaphor gains stable recognition across all groups and reflects learners' shared perception of the

internal complexity and dynamic connectivity of grammatical systems. The spider web image accurately captures two core features of grammar: first, its constituent elements (vocabulary, syntax, morphological rules) are like crisscross threads forming a precise, interdependent network system; second, mastering grammar means understanding and manipulating such systematic connections rather than memorizing isolated rules. It reflects that learners generally regard grammar as an organic whole requiring active exploration and connection sorting, instead of scattered fragments.

4.2.2. Cognitive awareness of grammatical instrumentality: The map metaphor

As a consensus metaphor, the map highlights grammar's core instrumental and meta-cognitive functions in language learning practice. The essence of a map is to provide spatial representation and action guidance for explorers. Similarly, learners unanimously recognize that grammar supplies indispensable cognitive guidance and structural references for language comprehension and production. It helps learners "locate" themselves in linguistic activities (judging appropriateness of linguistic forms), "plan" routes (organize sentences and texts), and "navigate" toward communicative goals. This consensus confirms the practical value of grammar as an operable knowledge system and acknowledges its instrumental dimension.

4.2.3. Cognitive awareness of grammatical regularity and authority: The star metaphor

The consensus of this metaphor reveals learners' profound psychological impression that grammar combines regularity and sublimity. The star image carries dual connotations: on one hand, star movements follow constant laws, which metaphorizes grammar as an ordered, rule-based formal system; on the other hand, the remoteness and grandeur of stars reflect that some learners view grammar as a profound, comprehensive, and even slightly awe-inspiring knowledge domain. This consensus shows learners generally recognize the rigor and scale of grammatical systems, while they may sense a certain psychological or ability gap between themselves and full internalized, flexible command of grammar.

4.2.4. Internal correlations between cognitive types

The correlation matrix between factors (Table 2) reveals internal links of different cognitive modes. Factor 1 (Structured Type) has a moderate positive correlation with Factor 3 (Creative Type) ($r = 0.66$), which suggests an internal connection between recognition of rigorous systems and expressive logic. In contrast, Factor 4 (Entry Type) shows low correlation with other factors ($r < 0.33$), highlighting the relative uniqueness of its perspective that grammar is social cultural capital. The correlation coefficients of Factor 2 (Navigation Type) with Factor 1 and Factor 3 are 0.411 and 0.278, respectively, meaning its instrumental cognition is related to structured and creative cognition to varying degrees.

Table 2. Pearson correlation coefficient matrix between factors

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	1.000	0.411	0.656	0.327
Factor 2	0.411	1.000	0.278	0.252
Factor 3	0.656	0.278	1.000	0.192
Factor 4	0.327	0.252	0.192	1.000

The above correlation structure proves the four cognitive types are not isolated, but form an interconnected continuous spectrum. The strong correlation between structured and creative cognition implies

that recognition of rigorous grammatical rules and pursuit of expressive potential may derive from shared cognitive foundations, namely in-depth attention to grammar's internal logic ^[11]. The independence of the entry threshold cognition reflects the uniqueness of sociocultural perspectives in grammar comprehension, which is more associated with external identity and capital accumulation rather than the operable features of grammatical knowledge itself.

The core finding of this study is that four structurally stable, connotatively distinct metaphorical cognitive modes exist among Chinese college students. This diversified picture strongly refutes the stereotype that grammar learning merely equals rule memorization, and demonstrates that learners' internal cognitive representations are far more complex and diverse than external teaching interventions. Such diversity may be rooted in learners' different learning motivations, past successful or frustrating learning experiences, varying teaching discourses they have encountered, as well as deep-rooted sociocultural perceptions about knowledge and learning ^[12].

Based on the four cognitive types, this study proposes a "cognition-adaptive" teaching framework. The framework suggests teachers first diagnose students' dominant cognitive tendencies through short metaphor preference surveys or classroom observation, then flexibly select resonant teaching discourses, activity designs, and evaluation methods (see **Table 3**). It aims to realize the transformation from teacher-centered rule indoctrination to learner-centered cognitive coordination.

Table 3. Cognition-adaptive teaching strategy framework

Cognitive type	Matching teaching metaphors	Core teaching strategies
Structured Tool Type	Tree root, skeleton, mathematical formula	Systematic deduction, clear rule explanation, structural drills
Navigation Guidance Type	Map, compass, road sign	Task-driven learning, route planning, resource navigation
Creative Expression Type	Music score, palette, script	Situational immersion, aesthetic appreciation, personalized creation
Entry Threshold Type	Bridge, key, pass	Link with real life, reduce anxiety, highlight practical value

Meanwhile, the three consensus metaphors (spider web, map, star) enjoy universal acceptance and can be adopted as anchoring metaphors at the opening or summary of grammar units to efficiently build a shared interpretive framework for the whole class. They represent learners' pre-existing understanding of grammar essence. Teachers may actively apply these consensus metaphors as starting points and anchors for classroom dialogue: for instance, use the spider web metaphor to illustrate interconnections of grammar items; adopt the map metaphor to design tasks cultivating students' ability to solve linguistic problems in contexts; employ the star metaphor to guide appreciation of grammatical rigor while designing progressive learning paths to narrow learners' psychological distance. Application of consensus metaphors helps build solid, flexible collective understanding while respecting individual cognitive differences ^[13].

5. Conclusion

Adopting Q methodology, this study systematically identifies four stable metaphorical cognitive modes of English grammar among Chinese college students: Structured Tool Type, Navigation Guidance Type, Creative Expression Type, and Entry Threshold Type. These four modes form a continuous cognitive

spectrum through varying correlation intensities, presenting the diversified landscape of learners' grammatical cognition. The study also identifies three cross-group consensus metaphors: spider web, map, and star, which respectively refer to the connectivity of grammatical systems, instrumentality of grammatical functions, and authority of grammatical laws, forming the least common denominator of college students' grammar cognition. From the perspective of teaching strategies, this study innovatively puts forward a cognition-adaptive teaching framework. Teachers are advised to flexibly select resonant teaching language, activity design, and evaluation modes according to learners' dominant cognitive types, providing operable approaches to shift grammar teaching from one-size-fits-all rule cramming to learner-centered cognitive coordination.

The four metaphorical cognitive modes discovered in this study form the first typological map of Chinese college students' English grammar cognition. The value of this map does not lie in answering the dynamic mechanism of conceptual construction—that is the core task of follow-up longitudinal tracking, experimental intervention, and process analysis studies; instead, it supplies indispensable prerequisite knowledge for all subsequent mechanism research: without clarifying existing cognitive types, all inquiries about cognitive change and influence will lack classification frameworks and measurement benchmarks^[14]. In this sense, the typological contribution of this research is foundational and pioneering, laying solid empirical grounds for in-depth follow-up exploration of grammatical conceptual construction mechanisms.

Based on the above findings, this study also acknowledges three limitations that point out directions for future research: First, the sample size is limited and concentrated in a single university, so the generalizability of conclusions needs to be further verified through comparative research across regions and different types of colleges. Second, Q methodology excels at revealing static opinion structures yet falls short of tracking dynamic cognitive changes, making it hard to answer in-depth questions about how each cognitive type forms and evolves^[15]. Third, although the cognition-adaptive teaching framework is proposed, its practical teaching effects still need rigorous intervention experiments for verification. Follow-up research may design systematic teaching intervention schemes based on the cognitive type framework constructed in this paper, and test the actual impacts of cognition-adaptive teaching on students' grammar learning performance, motivation, and long-term interest through controlled experiments.

Disclosure statement

The authors declare no conflict of interest.

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