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AI Translation Optimization for Culturally-loaded Words in Hubei Provincial Museum Audio Guide

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ABSTRACT

This study examines the performance and optimization pathways of artificial intelligence in translating culturally-loaded words, focusing on the guide texts of the Hubei Provincial Museum. Through interviews and questionnaires, this study systematically examines the major challenge AI faces, namely the loss of cultural information, when translating culturally-loaded words with historical backgrounds, cultural symbolism, or context-dependent meanings. This paper proposes optimization directions including building a corpus of culturally-loaded words, adopting multimodal presentation, and establishing human-machine collaboration models.

Keywords: *AI translation optimization, Culturally-loaded words, Audio Guide, Hubei Provincial Museum.*

1. INTRODUCTION

Artificial intelligence technology has advanced rapidly in recent years, enabling machines to achieve remarkable progress in language translation. Generative AI, trained on human text corpora exceeding one trillion bytes and fine-tuned through reinforcement learning with human feedback, increasingly produces content that is both logically coherent and aligned with human linguistic conventions and value preferences, demonstrating powerful natural language processing capabilities[1]. However, culturally-loaded words—as the most culturally specific and context-dependent elements of language—remain one of the major challenges facing AI translation. culturally-loaded words typically carry connotations rooted in geographical environments, historical contexts, social systems, religious beliefs, and ethnic ideologies, whose meanings often cannot be deduced from their literal definitions. Liao Qiyi emphasizes that such vocabulary "reflects the unique modes of activity accumulated by a specific ethnic group over a long historical process, distinct from those of other ethnic groups"[2]. For museum guide texts aimed at cultural dissemination, the accurate translation of culturally loaded terms is crucial to the extent to which foreign audiences comprehend Chinese culture, and is critical to the effectiveness of the museum's cross-cultural communication.

The Hubei Provincial Museum features Chu culture as its specialty, with its guide texts frequently employing culturally significant terms such as "chime bells"(an ancient Chinese bronze percussion instruments.) and "patrilineal clan system"(a system in ancient China that allocated state power based on blood ties to maintain the hereditary rule of the nobility). The English translations of these terms must not only accurately convey their surface meanings but also reflect the underlying institutional, historical, and spiritual connotations. However, the AI translation tools currently used in museums are mostly general-purpose models lacking specialized corpus support, resulting in semantic deviations or insufficient cultural interpretation in some translations. Therefore, it is necessary to evaluate the performance of AI translation in specific scenarios and propose optimization strategies suitable for museum tours.

From the perspective of current research, foreign studies have long focused on culture-bound terms. Nida proposed relevant concepts along with the strategies of foreignization and domestication,

laying the foundation for cross-cultural translation. With the advancement of AI, research has shifted toward examining machine translation's performance within cultural contexts, highlighting its persistent semantic deviations in handling allusions, religious terminology, and historical vocabulary.

Domestic research primarily explores the types of culture-laden words and translation strategies. While human translation has become a recent research focus, studies based on real cultural settings such as museums remain scarce. Therefore, this study focuses on the guide texts of the Hubei Provincial Museum, and through questionnaires and interviews, examines the actual performance of AI translation in handling culture-laden words and proposes optimization pathways.

2. RESEARCH METHODS

2.1 Research Questions

Culturally-loaded words are significant linguistic units that carry historical contexts, cultural imagery, and social values. Their cross-cultural transmission involves not only semantic correspondence but also cultural interpretation. This study focuses on culturally-loaded words in the guided tour texts of the Hubei Provincial Museum and proposes the following two core research questions:

Research Question 1: What are the primary issues encountered by AI translation when handling culturally-loaded words in the Hubei Provincial Museum?

Research Question 2: Against the backdrop of smart museum development, how can an effective optimization pathway be constructed to enhance the depth and accuracy of AI translation for culturally-loaded words?

2.2 Research Design

This study employs a combination of quantitative and qualitative analysis to conduct a systematic investigation into the current state of translating culturally-loaded words in the guided tour texts of the Hubei Provincial Museum, proposing feasible optimization pathways. The research design follows a logical chain of "problem identification—data collection—analysis and verification—conclusion drawing" to ensure the scientific rigor and practical applicability of the findings.

First, during the preliminary research phase, this study reviewed literature to clarify the conceptual definition of culturally-loaded words and identify key research findings on AI translation within cultural contexts. We also preliminarily identified representative culturally-loaded words in museum guide texts, laying the theoretical and material foundation for the study. Subsequently, the research entered the fieldwork phase. This study employed questionnaires to gather authentic user experiences with AI translation, including comprehension difficulty, satisfaction levels, and cultural explanation needs. This was supplemented by interviews to obtain practical feedback from translation learners and visitors, thereby forming a multifaceted understanding of user needs and problem perceptions.

During the data analysis phase, this study employed Excel to conduct descriptive statistics on questionnaire data, extracting key trends from user feedback to quantitatively present common issues with AI translation and user preference patterns. Concurrently, through case studies, several representative culturally-loaded words were selected. Qualitative analysis was performed by comparing AI translations with human translations across dimensions such as semantic accuracy, cultural nuance representation, and contextual appropriateness. This approach validated issues identified in the questionnaire and provided deeper insights into their underlying causes.

Finally, by integrating quantitative findings with qualitative analysis, this study proposes optimization pathways for the Hubei Provincial Museum's smart tour guide system. These include human-machine collaboration, multimodal cultural presentation, and cultural corpus development. The overall research design aims to establish an objective assessment of AI translation issues concerning culturally-loaded words through mutual validation of empirical data and theoretical analysis, while providing feasible improvement proposals.

2.3 Research Tools

2.3.1 Interview Method

This study employed interviews with several participant groups, including students and teachers with translation backgrounds, as well as visitors possessing cultural experience. The discussions

centered on challenges in understanding culturally-loaded words, experiences with AI translation tools, and practical needs for guided tour services. Six in-depth interviews were conducted, each lasting approximately 20 – 30 minutes. Interview topics encompassed perceptions of translating culturally-loaded words, frustrations encountered with AI translation tools, comparative experiences between human and AI translation, and expectations for future intelligent tour guide systems. The interview data provided substantial real-world feedback from practical usage scenarios, serving as a primary basis for analyzing AI translation challenges.

2.3.2 Questionnaire Survey Method

This study distributed questionnaires to museum visitors, docents, and translation learners to investigate their perceptions regarding the difficulty of understanding culturally-loaded words, their acceptance and satisfaction with AI translation, and their preferences for translation styles. The survey results were used to quantify feedback from different groups, aiding in the analysis of shortcomings in AI translation's expression of cultural information.

3. DATA ANALYSIS

3.1 Data Collection

This study collected a total of 105 valid questionnaires (As shown in Table 1). Among the respondents, females slightly outnumbered males (60.95%), with ages predominantly concentrated in two groups: 18-25 years old (49.52%) and 36 years old and above (34.29%). Educational attainment was predominantly bachelor's degree level (62.86%). The proportion of respondents with foreign language-related majors and non-related backgrounds was roughly equal (53.33% vs. 46.67%), ensuring the sample's representativeness in terms of linguistic cognition. Regarding museum visit frequency, respondents were distributed fairly evenly across categories ranging from "rarely" to "very frequently," indicating that the data can reflect the needs of visitors with diverse habits.

Table 1. Museum visit frequency statistics

Question 4: Are you majoring in a foreign language related major (such as English, translation, foreign language education, etc.)? [Multiple choice]

Option	Subtotal	Scale
Yes	56	53. 33%
No	49	46. 67%
Number of valid responses to this question	105	

3.1.1 Barriers to Understanding and Translating Culture-Bound Terms

The survey revealed that while 42.86% of respondents claimed to understand the meaning of "culturally loaded words," specific categories such as linguistic-cultural terms (e.g., "Chu Ci," 60.95%), socio-cultural terms (e.g., "ritual system," 51.43%), and eco-cultural terms (e.g., "land of Jingchu," 52.38%) were widely regarded as the most challenging to comprehend. This confirms the characteristic highlighted in the introduction that culturally loaded terms possess profound historical and social contexts. Regarding comprehension barriers, "linguistic differences (no corresponding concept in the target language)" (54.29%) and "confusion caused by inconsistent translations across different versions/channels" (50.48%) emerged as the two primary bottlenecks, underscoring the inherent challenges of cross-cultural translation. Furthermore, respondents strongly desire detailed explanations for culturally loaded terms (average score 3.97/5) and multilingual translations (average score 4.06/5).(As shown in Table 2)

Table 2. Categorization of culture-bound terms and comprehension barriers

Q7: Which type of culturally loaded words do you find most difficult to understand? (Multiple choice)

Options	Minor Total	Proportion
Ecological culture words (e.g., "Jing-Chu Region")	55	52.38%
Material culture words (e.g., "Chime Bells", "Lacquerware")	47	44.76%
Social culture words (e.g., "Ritual System", "Patrilineal Clan System")	54	51.43%
Religious culture words (e.g., "Sacrifice", "Ancestor Worship")	29	27.62%
Linguistic culture words (e.g., "Songs of Chu", "Harmony but Not Uniformity")	64	60.95%
Number of valid respondents for this survey	105	

3.1.2 Current Applications and Performance Evaluation of AI Translation

A more detailed questionnaire analysis further reveals that the core problems with AI translation lie at the level of cultural expression. In single-choice questions, 35.24% of respondents identified "lack of cultural nuance" as the biggest issue with AI translation. Additionally, "inaccurate word meanings" and "stiff translations" each accounted for 30.48%, indicating that insufficient cultural expressiveness is the most prominent pain point. (As shown in "Table 3") This trend became even clearer in the multiple-choice questions: 71% of respondents pointed to "lack of cultural interpretation" as the primary obstacle to understanding culturally loaded terms; 64% noted AI's "pronounced tendency toward literal translation," which weakens or misrepresents original cultural meanings; and 52% cited "insufficient historical context supplementation," preventing translations from accurately reflecting cultural concepts within their contextual significance. Overall, these issues collectively highlight AI's shortcomings in processing cultural information—it can provide linguistic frameworks but fails to convey the contextual background essential for cultural understanding, thereby struggling to meet museum visitors' deep cultural needs. (As shown in "Figure 1")

Table 3. The most likely problem of AI translation

Question14:What do you think is the most likely problem when AI translates cultural loadwords? [Singlechoice]

Options	Minor Total	Proportion
Inaccurate word meaning	32	30. 48%
Lack of cultural nuance	37	35. 24%
The translation is stiff and unna-tural	32	30. 48%
Other_____ [Details]	4	3. 81%
Number of valid respondents for this survey	105	

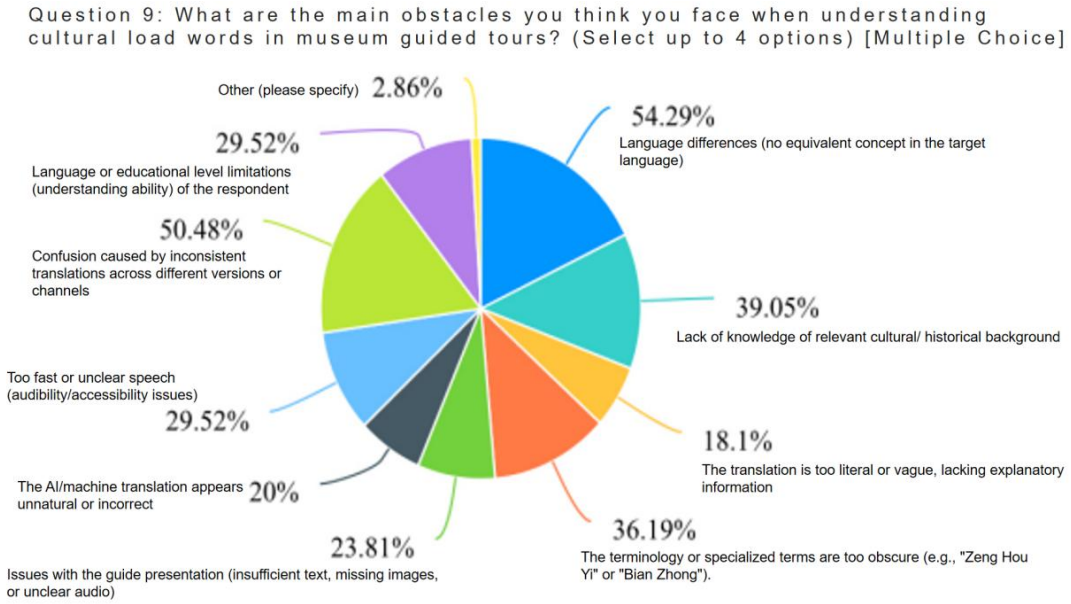

Figure 1 The primary difficulty in understanding culturally-loaded words.

3.1.3 Public Demand for Translations of Culturally Charged Terms3: Acceptance of AI-Powered Translation Guides and Future Expectations

Despite moderate trust in AI (average score 3.59/5), most respondents expressed openness to museums introducing AI translation guide systems, with a combined 75.23% indicating they would "probably try it" or "be very willing to try it." (As shown in "Table 4" and "Figure 2") Regarding desired features for future guide systems, "bilingual text comparison" (66.67%) and "professional guides/human translators" (54.29%) ranked highest, while demand for "AI real-time translation" (39.05%) was relatively lower. This suggests users expect AI to serve as an auxiliary tool rather than a complete replacement for human services. This perspective is further supported by role positioning: 48.57% of respondents believe "AI can assist human translators," representing the most prevalent view. Finally, respondents identified "user experience (interface, interaction)" (41.9%) as the most critical area for future improvement, followed by "cultural context interpretation" (30.48%), indicating that optimizing usability is equally important as enhancing translation quality. (As shown in "Figure 3")

Table 4. Respondents' acceptance of AI-guided tours

Question 16: Would you use an AI-guided tour system if museums were to offer it in the future? [Single Choice]

Option	Subtotal	Scale
Willing to do that	31	29.52%
Try	48	45.71%
Not very willing	21	20%
Totally unwilling	5	4.76%
Number of valid responses to this question	105	

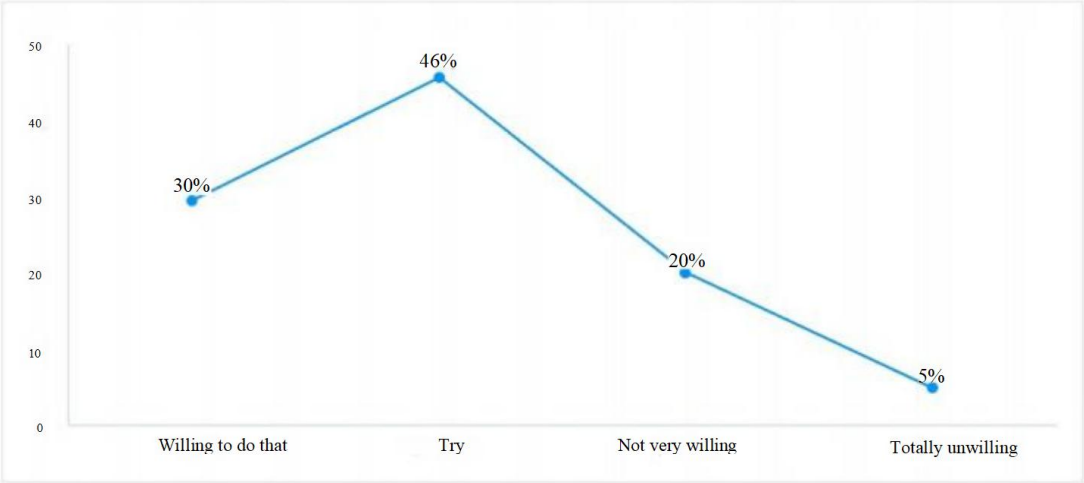

Figure 2 Respondents' acceptance of AI-guided tour.

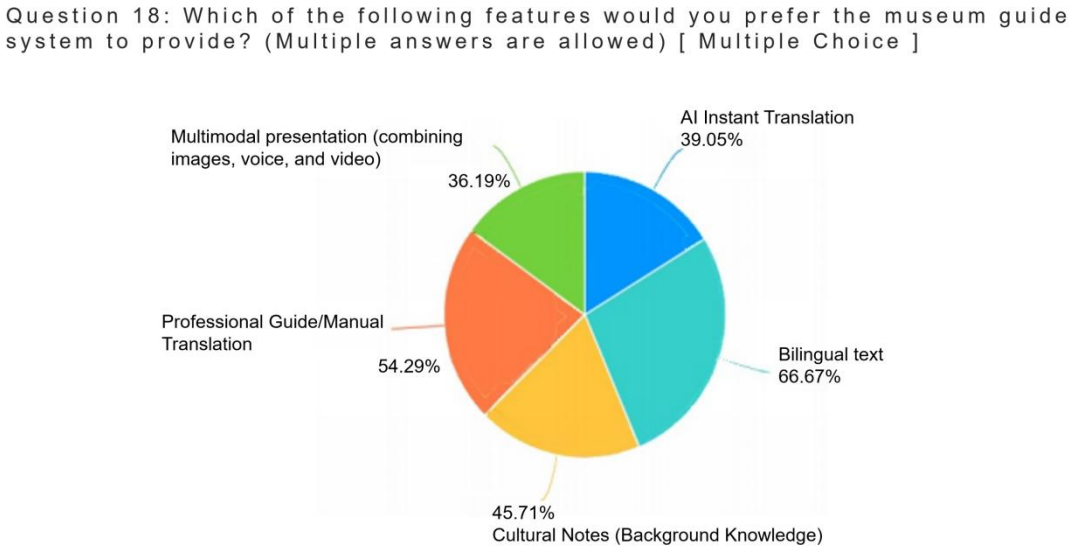

Figure 3 Features of preference

3.2 Key Findings: The "Efficiency Advantage" and "Lack of Cultural Depth" in AI Translation

Through questionnaires, interviews, and case studies, this research reveals that AI translation in museum tour scenarios exhibits "high efficiency but insufficient cultural depth." Over 70% of respondents reported using AI tools during visits, indicating AI's clear convenience in swiftly meeting basic language conversion needs. However, when encountering culturally loaded terms like "Chu Ci"(A literary genre created by Warring States poets represented by Qu Yuan, the earliest anthology of Romantic poetry and the origins of Romantic literature) or "Zeng Hou Yi Bells"(A set of large ritual musical instruments belonging to the ruler of the Zeng State during the early Warring States period) users perceive AI translations as lacking cultural context and emotional nuance. Such terms heavily rely on historical knowledge and cultural frameworks, making literal interpretations insufficient to convey their full meaning — resulting in AI's tendency toward superficial translations. Furthermore, the survey revealed widespread user expectations for "cultural annotations," "text-image integration," and "multimodal presentation," indicating that plain

text translation alone cannot satisfy cultural comprehension needs.

This phenomenon stems from AI models relying on large-scale general-purpose corpora for training, where the focus is on lexical and syntactic recognition rather than cultural context. The exhibition texts at the Hubei Provincial Museum, however, belong to the category of "high-context, information-dense" content, demanding that the system possess cross-contextual cultural comprehension capabilities. AI cannot capture the historical and cultural value of exhibits within limited textual data, making it difficult to achieve deep cultural transmission.

3.3 Implications for Practice

3.3.1 Establishment of an AI-Human Hybrid Translation Model for Balancing Efficiency and Quality

Survey results indicate that users prefer a collaborative mechanism where "AI assists human translators." AI can rapidly complete foundational translation and information retrieval, providing an efficient basis for human proofreading. Human translators then build upon this foundation to further adjust style and supplement cultural context. This model not only enhances translation efficiency but also effectively improves the accuracy of cultural interpretation.

For instance, when encountering culturally loaded terms like "bianzhong" (编钟), AI typically generates generic equivalents such as "chime bells" but struggles to convey its political symbolism within ritual music systems. Through collaboration, human translators supplement AI-generated terms with institutional context, refining the translation to "the bronze chime bells used in ancient state ceremonies to symbolize ritual hierarchy"—thus achieving cultural interpretation. This collaborative model not only elevates translation quality but also significantly reduces human processing time, making the system's overall operation more efficient.

3.3.2 Building of a Museum Cultural Vocabulary Corpus for AI Corpus Enhancement

Current AI systems have limited corpus resources in specialized fields such as Chu culture and the institutional history of bronze ware, resulting in translations that lack historical depth and conceptual precision. Therefore, building specialized terminology databases, knowledge graphs, and bilingual corpora centered around museums will become fundamental to enhancing the cultural adaptation capabilities of intelligent translation systems.

In practice, specialized terms like "zengshu"(缯书) were previously mistranslated by AI as "silk manuscripts" due to insufficient contextual data, failing to capture their significance as primary textual carriers in the pre-Qin era. By enriching AI translation tools with comprehensive corpora during our research, we enabled outputs such as "bamboo-bound silk manuscripts used as early textual carriers in the Warring States period," significantly enhancing contextual accuracy and precision.

3.3.3 Multimodal Presentation as a Key Pathway to Enhancing Cultural Understanding

User preferences for "multimedia presentation" and "text-image integration" in the survey indicate that explanations of culturally loaded terms cannot rely solely on text. For instance, the cultural significance of the "Zeng Hou Yi Bell Chimes" can be conveyed through audio, 3D models, images, and other formats. Multimodal AI compensates for the contextual comprehension limitations of text-only AI, making cultural information more intuitive and immersive.

4. DISCUSSION

4.1 Nida's "Dynamic Equivalence Theory" and the Problem of AI's Cultural Comprehension Gap

According to Nida's "dynamic equivalence theory" translation should achieve relative equivalence at the levels of meaning and reader response, rather than merely literal equivalence. However, the AI translations observed in this study often remain at the surface level of semantics, failing to provide target-language readers with a cultural experience comparable to that of source-language readers. For instance, when "鼎" is translated as "tripod," readers perceive it merely as a vessel without recognizing its symbolic representation of power and status within ancient Chinese political culture. AI's struggles with culturally loaded terms reveal its difficulty in

achieving "reader response equivalence," as its algorithms remain confined to statistical equivalence at the corpus level rather than cultural comprehension.

4.2 Hall's "High-Context/Low-Context Culture Theory" and the Limitations of AI in Museum Contexts

Hall's cultural context theory posits that high-context cultures rely on external knowledge, historical background, and nonverbal cues to convey meaning, whereas low-context cultures depend more on direct expression. Museum texts represent quintessential high-context content. However, current AI models are primarily trained on low-context corpora, rendering them incapable of perceiving the historical context or cultural symbolism embedded within exhibits. For instance, translating the "Chu Ci" without integrating the spiritual world of Chu culture inevitably distorts its meaning. This lack of contextual entry points prevents AI from performing genuine cultural interpretation—a finding that aligns closely with user feedback in this study highlighting "insufficient cultural depth" and "inadequate background information".

5. CONCLUSION

This study demonstrates that the core limitation of AI in translating culturally-loaded words lies not in technical capabilities, but in its inability to process cultural contexts and deep-level knowledge. Shifting user demands also indicate that the focus of smart guides is transitioning from "language assistance" to "cultural comprehension," requiring future translation systems to balance efficiency with cultural interpretive capabilities. The proposed approaches—human-machine collaboration, multimodal presentation, and specialized corpus development—offer viable pathways for enhancing cross-lingual communication of culturally loaded terms. While constrained by sample size and contextual limitations, the findings point to a clear trend: only by equipping AI with cultural knowledge and integrating it with human expertise can cultural information be accurately understood and effectively conveyed in digital environments.

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REFERENCES

[1] J. Zhang, L. Sun, Reconstruction of "the Babel Tower": The deep development of generative artificial intelligence and human communication, Guancha yu Sikao, 2024(12), pp. 111–119.

[2] Q. Liao, Corpus-based translation studies, Waiguo Yuyan Jiaoxue yu Yanjiu (Foreign Language Teaching and Research), 2000(05), pp. 380–384.

[3] W. Zhang, Q. Xiao, H. Liu, et al., Large-model-assisted extraction of Chinese culturally-loaded words and construction of a knowledge graph, Shuzi Tushuguan Luntan (Digital Library Forum), 21(01), 2025, pp. 33–45.

[4] J. Guo, A study on the translation of Chinese culturally-loaded words into English, Yuwen Jianshe (Language Planning), 2024(21), p. 88. DOI: 10.16412/j.cnki.1001-8476.2024.21.004

[5] H. Pan, F. Zhou, H. Cui, et al., Translation strategies for culturally-loaded words in traditional Chinese medical classics from the perspective of translation mediation studies, Zhonghua Zhongyiyao Xuekan, 42(07), 2024, pp. 44 – 47. DOI: https://doi.org/10.13193/j.issn.1673-7717.2024.07.010

[6] L. Ruan, Cultural loss of culturally-loaded words in the Chinese – English translation process, Jiaoxue yu Guanli (Teaching and Management), 2010(12), pp. 75–76.

[7] W. Gao, C. Wu, A study on the English translation of culturally-loaded words in Li Sao from the perspective of cognitive linguistics, Yuyan yu Fanyi (Language and Translation), 2021(02), pp. 42–50.

[8] X. Guo, N. Deng, Ecological translation of Chinese culturally-loaded words in the context of globalization, Hunan Keji Daxue Xuebao (Social Sciences Edition), 14(04), 2011, pp. 150–152.

[9] Y. Qian, M. Ji, A quantitative study of translation strategies for material culturally-loaded words in Hawkes' English version of Honglou Meng, Honglou Meng Xuekan (Journal of Dream of the Red Chamber Studies), 2011(06), pp. 59–72.

[10] Z. Ma, A study on the external translation of Chinese culturally-loaded words, Yuwen Jianshe (Language Planning), 2015(30), pp. 63 – 64. DOI: https://doi.org/10.16412/j.cnki.1001-8476.2015.30.033

[11] J. Song, A comparative analysis of English and Chinese culturally-loaded word schemas and their translation, Guangxi Minzu Daxue Xuebao (Philosophy and Social Sciences Edition), 38(06), 2016, pp. 172–176.

[12] Y. Wang, Chinese culture-loaded words and the international dissemination of Chinese science fiction: A case study of the translation strategies in the Spanish version of The Three-Body Problem MT translation, International Communication of Chinese Culture, prepublish, 2025, pp. 1 – 17. DOI: https://doi.org/10.1007/S40636-025-00346-X

[13] J. Zhu, From a study on translation strategies for culture-loaded words of ZIZHITONGJIAN from the perspective of eco-translatology MT translation, Journal of Contemporary Educational Research, 9(8), 2025, pp. 293 – 300. DOI:https://doi.org/10.26689/JCER.V9I8.12035

[14] Y. Ding, C-E translation of culture-loaded words from the perspective of cross-cultural communication: Taking A Dream of Red Mansions as examples, Journal of Education, Teaching and Social Studies, 7(3), 2025. DOI: https://doi.org/10.22158/JETSS.V7N3P1

[15] D. Wu, M. Zhang, Translating culturally-loaded words in Exploring Wuliangye: A translation compensation perspective, Journal of Education, Teaching and Social Studies, 7(3), 2025. DOI: https://doi.org/10.22158/JETSS.V7N3P92