



Can the three-level analysis of language use be applied in human-machine collaborative translation with ChatGPT? - A case study of culturally loaded words in Thai translation

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Abstract

This study explores the application of the Three-Level Analysis of Language Use (Xu & Liu, 2024) in human-machine collaborative translation of culture-loaded words. By examining the translation of terms such as *xietian* and *sheguang*, the study analyzes the effectiveness of the three-level analysis in enhancing translation accuracy and cultural adaptability. The first-level analysis focuses on literal translation, the second-level analysis integrates contextual background for refinement, and the third-level analysis delves into cultural and academic significance to ensure the transmission of deep cultural connotations. Findings indicate that the combination of human translators' in-depth understanding with ChatGPT's efficiency significantly improves translation quality, particularly for complex terms involving cultural and historical contexts. This approach provides new insights into human-machine collaborative translation and highlights its potential in handling culture-loaded words.

Keywords: Three-Level Analysis of Language Use, Human-Machine Collaborative Translation, Culture-Loaded Words

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1. Introduction

In the context of globalization, cross-cultural communication is increasing rapidly, and translation, as an important tool for cultural dissemination, carries a significant mission. In the translation process, especially when dealing with culture-loaded words, how to accurately convey the cultural information embedded in the source language has become one of the core challenges. Culture-loaded words are those specific to a particular cultural scope, directly or indirectly reflecting the national culture within language vocabulary, often closely related to the unique lifestyle, customs, values, and ideologies of that culture (Hong, 2018; Lu, 2004; Wang, 2015). The translation difficulty of culture-loaded words mainly lies in the dual influence of cultural differences and cognitive differences. Translators need to find a balance between preserving the cultural features of the original text and meeting the understanding needs of the target language readers, flexibly applying various translation methods, such as transliteration, literal translation, free translation, and annotation, to achieve effective cross-cultural communication (Liu & Chen, 2018; Wu, 2007; Dong, 2017; Hu, 2022). Culture-loaded words carry ethnic cultural information and are direct or indirect reflections of the national culture. Correctly translating these words is crucial for the accurate transmission of language and the effective communication and deepening of cultural information. Accurate translation helps promote understanding and respect between different cultures and builds an open and inclusive international communication environment (Wang, 2015; Wang, 2014; Zhou, 2017).

With the development of artificial intelligence technology, especially the application of large language models like ChatGPT, machine translation has made significant progress in terms of efficiency and quality. ChatGPT has become proficient in handling conventional translation cases, but when faced with more specific Chinese expressions, especially culture-loaded words, errors still occur. Although AI translation performs excellently in many aspects, it still faces numerous challenges when handling culture-loaded words, such as inadequate translation, literal translation, and mistranslation (Gong & Hu, 2024). Machine translation errors can be mainly divided into lexical content errors and syntactical grammatical errors (Li, 2021). The main reason for this is that machine translation is based on built-in translation memories, so it is difficult for it to find perfectly matching reference translations for specialized vocabulary containing specific cultural concepts and complex sentences (Zhu, 2024). Therefore, there is a need to introduce a human-machine collaborative translation model, combining the deep understanding of human translators with the efficiency of machine translation, to ensure accurate translation results with strong cultural adaptability.

This study attempts to introduce the Three-Level Analysis of Language Use framework (Xu & Liu, 2024) combined with the human-machine collaborative translation model, particularly in the translation of culture-loaded words. By integrating human translators' in-depth understanding with the efficiency of machine translation, the Three-Level Analysis aims to enhance AI's adaptability to cultural backgrounds and improve translation accuracy. To date,



there has been insufficient research on how to effectively integrate human understanding with AI capabilities in machine translation, especially in handling culture-loaded words. Therefore, this study seeks to propose a new exploratory approach in this field, aiming to achieve higher precision and cultural adaptability in the translation of culture-loaded words and to provide new perspectives and theoretical support for the further development of translation technologies.

2. Research Objectives

This study aims to explore the application of the three-level analysis of language use (Xu & Liu, 2024) in the human-machine collaborative translation process of culturally loaded terms.

3. Research Design

To validate the effectiveness of the Three-Level Analysis of Language Use theory in handling culture-loaded words in human-machine collaborative translation, this study aims to design a systematic research framework based on the aforementioned concepts. The goal is to explore whether this theory can provide a feasible guiding framework for human-machine collaborative translation with the assistance of ChatGPT, ultimately achieving more accurate and culturally adaptive translation results. This research focuses on verifying the following core hypotheses: whether the Three-Level Analysis of Language Use theory can provide a systematic operational path for human-machine collaborative translation of culture-loaded words; and whether the intervention of human translators at different levels of interpretation (first-level, second-level, and third-level) can effectively compensate for AI's limitations in context comprehension and cultural adaptation, thereby improving the accuracy and cultural compatibility of the translation.

3.1 Sample Selection

This study will select five Chinese culture-loaded words for analysis: *xietian* (邪田), *sheguang* (舌广), *chumeng* (芻穀), and *kun* (闔). These words are characterized by significant differences between their literal meanings and cultural connotations, and they are strongly dependent on cultural context. Each culture-loaded word will be analyzed in conjunction with specific contextual information to facilitate multi-level translation optimization, ensuring both accuracy and cultural adaptability throughout the translation process.

3.2 Experimental Process Design

The experiment is divided into three main stages: first-level interpretation, second-level interpretation, and third-level interpretation. Each stage will involve the use of different instructions for ChatGPT, in combination with the intervention of human translators, to gradually optimize the translation.

Stage 1 : First-Level Interpretation (Initial Translation and Problem Identification) The goal of this stage is to address the "comprehension" issue by understanding both the literal and non-literal meanings of culture-loaded words. In this stage, instructions are input into ChatGPT (e.g., Please translate the following terms into Thai), and ChatGPT provides the initial translation based on



the source text. The human translator then reviews the initial translation, assessing whether it accurately reflects the meaning of the culture-loaded words and identifying potential issues in the translation. If the initial translation fails to accurately convey the deeper cultural connotations of the terms, the human translator decides to proceed to the next stage, providing more contextual information to further refine and optimize the translation.

Stage 2 : Second-Level Interpretation (Contextual Association and Translation Optimization) The goal of this stage is to relate language expression to specific contexts, making the translation more aligned with the cultural background of the target language. In this stage, the human translator inputs instructions (e.g., Translate the following terms into Thai, considering their specific application in the source language, and involving [briefly describe the background or cultural meaning of the term]. Please optimize the translation based on the context to make it more suitable for Thai expression: [source text]). The translator provides more detailed contextual information to help optimize the translation. By inputting this contextual information, ChatGPT can further adjust the translation according to the provided background, making it more aligned with the implied meaning and context of the original text. The human translator then evaluates the optimized translation, confirming whether it accurately conveys the intended meaning of the culture-loaded word and determining whether further adjustments are necessary to ensure that the translation aligns with the cultural norms and expectations of the target language. If the translation still requires improvement, the human translator will continue to provide additional contextual or cultural information to refine the translation, enhancing both its accuracy and cultural adaptability.

Stage 3 : Third-Level Interpretation (Deep Expression and Cultural Adaptation) The goal of this stage is to address non-literal expressions by deeply integrating the cultural connotations of culture-loaded words with the cultural background of the target language. In this stage, the human translator inputs instructions (e.g., Translate the following terms into Thai, considering the deep cultural connotations and historical background of the term in the source language, including [detailed description of the term's background or cultural meaning], especially its role and significance within a specific cultural system. Ensure that the translation accurately conveys its cultural value and aligns with similar terms in Thai culture: [source text]). The human translator provides more detailed cultural background information to assist ChatGPT in aligning the translation with the cultural norms of the target language. The cultural background information input by the human translator guides ChatGPT to adjust the translation so that it not only reflects the literal meaning of the original text but also conveys the implicit meanings and emotional undertones of the culture-loaded word. Based on the provided cultural background information, the final translation generated by ChatGPT will fully consider the cultural practices, context, and emotional tone of the target language, ensuring that the translation is both faithful to the source language and meets the cultural expectations of the target language. After confirming the translation, the human translator evaluates its accuracy and cultural suitability, ensuring that the translation not only



conveys the cultural connotations of the original text but also aligns with the linguistic habits and emotional tone of the target language, ultimately finalizing the translation.

3.3 Evaluation and Analysis

The evaluation criteria should include the following aspects: First, accuracy, which refers to whether the translation faithfully reflects the original text, accurately conveying both its literal meaning and deeper cultural or academic connotations. This is particularly important in the translation of cross-cultural terms, ensuring that the knowledge and concepts of the source language are accurately represented in the target language. Secondly, cultural adaptability, which assesses whether the translation aligns with the cultural background of the target language, ensuring that culture-loaded words are appropriately understood and accepted, avoiding misinterpretations, as shown in Table 1.

Table 1 Translation Evaluation Criteria

core	Accuracy (Faithfulness to the Original)	Cultural Adaptability (Cultural Fit in Target Language)
5	Fully faithful to the original, accurately conveying both literal meaning and deep cultural or academic connotations, with no errors.	Fully conforms to the target language culture, with culture-loaded words and idiomatic expressions being natural and appropriate.
4	Mostly faithful to the original, with minor deviations, conveying both literal and cultural/academic connotations.	Well adapted to the target language culture, with culture-loaded words slightly awkward, but overall acceptable.
3	Mostly faithful, but with some errors or omissions; some deeper meanings not fully conveyed.	Partially fits the target language culture, with some culture-loaded words not fully adapted, possibly leading to misinterpretation.
2	Significantly deviates from the original, failing to accurately convey some content, with cultural or academic meanings missing.	Does not fit well with the target language culture, causing cultural misalignment and possible difficulties in understanding.
1	Severely deviates from the original, unable to accurately convey literal meaning or deeper cultural connotations, with numerous errors.	Completely mismatched with the target language culture, culture-loaded words misused or unacceptable, leading to significant misinterpretations.



To validate the effectiveness of the Three-Level Interpretation framework in the translation of culture-loaded words, this study has designed two comparative groups. Group 1 is the baseline, where ChatGPT translates independently without any human translator intervention. Group 2 involves optimizing the translation through the Three-Level Interpretation framework, with the human translator gradually intervening and refining the translation in three stages: first, the human translator checks the initial translation's accuracy and provides feedback; second, the translator provides contextual information to help ChatGPT understand the specific application and background of the culture-loaded words; finally, the translator incorporates cultural background information to ensure the translation aligns with the cultural norms and requirements of the target language. In Group 2, the focus is on analyzing whether the involvement of the human translator improves the accuracy of the translation and enhances cultural adaptability. Ultimately, the translation results will be evaluated by linguistic experts and native speakers of the target language, and the outcomes of the two groups will be compared to further verify the effectiveness of the Three-Level Interpretation framework in translating culture-loaded words.

4. Literature Review

4.1 Three-Level Analysis of Language Use

Xu & Liu (2024) proposed the Three-Level Analysis of Language Use theory, which aims to enhance the accuracy, social effectiveness, and cultural adaptability of language expression through a multi-layered interpretive framework. This theory posits that language use is not simply a process of transmitting information but rather a cognitive activity that requires the engagement of the subject's cognitive abilities. This, in turn, facilitates the rational configuration and effective use of language elements. Through strategies such as unity projection and contextual association, the subject can flexibly adjust the language form during communication, enabling the use of economy, strategic, and skillful processing, ensuring the effectiveness of the expression and its social adaptability.

Under the framework of three-level analysis, the first level is primary interpretation, which focuses on understanding the language material by synthesizing and processing it appropriately to resolve the "comprehension" issue, ensuring an initial understanding of both the literal and non-literal meanings. This stage emphasizes the basic understanding of language expression, particularly the importance of translating and comprehending both literal and metaphorical meanings in everyday communication. Next, the second level is contextual association, where language is connected with specific contexts. This stage helps the subject to grasp the relevance of language expressions, ensuring that the translation not only adheres to the literal meaning but also fits the specific needs of the context, thereby improving the adaptability to the context. Finally, the third level involves a more in-depth interpretation of non-literal expressions. At this stage, the subject introduces external factors, such as cultural backgrounds, to further culturally adapt the language. This ensures



that the language is not only accurate in its literal meaning but also capable of conveying the underlying emotions, cultural, and social intentions. By moving through these layers, the theory facilitates more accurate, contextually appropriate, and culturally resonant language use, which is particularly useful in fields like translation and intercultural communication.

4.2. Application of the Three-Level Analysis of Language Use in Human-Machine Collaborative Translation

In the process of human-machine collaborative translation, the question arises whether the Three-Level Analysis of Language Use theory (first-level, second-level, and third-level) can provide a systematic guide for handling the translation of culture-loaded words. Specifically, if the first-level interpretation fails to accurately reflect the meaning of a culture-loaded word, can the human translator intervene by providing more contextual and cultural information, gradually progressing to the second-level and third-level interpretations, thereby achieving a more accurate translation?

First-Level Interpretation

The goal of the first-level interpretation is to solve the "comprehension" problem, which involves comprehending both the literal and non-literal meanings of culture-loaded words. At this stage, ChatGPT provides an initial translation, and the human translator evaluates its accuracy and identifies potential issues. By analyzing the literal meaning, the initial translation can help identify problems in the translation, but it may not fully convey the implied meaning of the original text. The human translator's task at this stage is to recognize any deficiencies in the translation and decide whether it is necessary to move to the second-level interpretation.

Second-Level Interpretation

The second-level interpretation focuses on connecting language expression with a specific context. The human translator inputs additional contextual information to help ChatGPT optimize the translation. At this stage, the translation should not only consider the literal meaning but also integrate the specific context, ensuring that the translation aligns better with the cultural background and expression style of the target language. By incorporating contextual input, ChatGPT can make adjustments, making the translation more fitting and avoiding the biases introduced by literal translation.

Third-Level Interpretation

The third-level interpretation further refines the accuracy of the translation by addressing non-literal expressions. The goal is to deeply integrate the deeper cultural connotations of culture-loaded words with the cultural background of the target language. At this stage, the human translator inputs more detailed cultural background information to assist ChatGPT in achieving a more accurate translation. Cultural background information helps ChatGPT better understand the target language's culture, ensuring that the translation is not only faithful to the literal meaning but also effectively conveys the original text's cultural and emotional nuance. Through this process, the translation not only conveys the literal meaning but also accurately expresses the cultural connotations and emotional tones of the source text. Ultimately, the translation



resulting from the third-level interpretation will better reflect cultural differences, ensuring it is well-received and culturally appropriate in the target language environment.

5. Research Results

5.1 Meaning of the Samples

To accurately assess the meaning of each level of interpretation and its applicability in different contexts, this study will first clarify and elaborate on the specific connotations of the culture-loaded words. This ensures that the subsequent analysis is built on a clear and comprehensive theoretical foundation, as shown in Table 2.

Table 2 Meaning of Research Samples

Culture-Loaded Word	Meaning
xietian 邪田	A term used in ancient Chinese agriculture to describe irregularly shaped fields, typically referring to trapezoidal fields.
sheguang 舌广	The width of a geometric shape, commonly used to describe the horizontal dimension of fields or geometric bodies. The shape may specifically refer to a part of a rectangle or trapezoid.
chumeng 眇甍	A wedge-shaped body, resembling a grass roof or wedge-shaped prism. Its base is rectangular, with a ridge at the top and triangular slanted sides.
kun 阔	Refers to the horizontal timber beneath a doorframe, i.e., the threshold.

5.2 Third-Level Interpretation

5.2.1 First-Level Interpretation

Table 3 First-Level Interpretation Translation

Sample	Translation	ChatGPT's Understanding	Accuracy	Cultural Adaptability
xietian	<i>tʰî: nā tʰû:an</i>	Irregular or illegal farmland	1	1
sheguang	<i>lín kwâ:ŋ</i>	Tongue width, or metaphorically eloquent	1	1
chumeng	<i>jâ: pʰà sôm</i>	Grass on the roof or grass	1	1



	<i>lāŋ khā:</i>	roof		
<i>kun</i>	<i>pràthū: khè:p khèt</i>	Gate or boundary	3	2

The analysis of the first-level interpretation translations of the four culture-loaded words shows significant deficiencies in both accuracy and cultural adaptability in ChatGPT's translations. Specifically, *xietian* refers to irregularly shaped fields in The Nine Chapters on the Mathematical Art, but it was translated as illegal farmland, which fails to convey its mathematical and agricultural context. Both accuracy and cultural adaptability received a score of 1. *sheguang*, originally referring to the width of a geometric shape, was translated as eloquent, which clearly deviates from its intended mathematical meaning. Again, accuracy and cultural adaptability scored 1. *chumeng* refers to a wedge-shaped body, but the translation grass roof did not capture the geometric concept, resulting in scores of 1 for both accuracy and cultural adaptability. *kun*, although translating the literal meaning of gate or boundary, actually refers to the horizontal timber beneath a doorframe, i.e., the threshold. Its accuracy score was 3, but its cultural adaptability was only 2, indicating a partial understanding of its deeper cultural significance. The statistical analysis shows that these translations have low average scores in both accuracy (1.5) and cultural adaptability (1.25), indicating that most translations fail to adequately convey the deep meanings of the terms within their specific cultural and historical contexts. The goal of the first-level interpretation is to solve the "understanding" problem, i.e., to comprehend both the literal and non-literal meanings of culture-loaded words. The analysis shows that ChatGPT's translations did not accurately convey the meanings of these culture-loaded terms. To improve, it is suggested that more detailed contextual information be provided to ChatGPT to optimize the translations and improve accuracy.

5.2.2 Second-Level Interpretation

Table 4 Second-Level Interpretation Translation

Sample	Translation	ChatGPT's Understanding	Accuracy	Cultural Adaptability
<i>xietian</i>	<i>tʰī: nā dā:n ʔi:ay rūu tʰī: nā māj sà?màt sàmér</i>	Meaning tilted or irregular farmland, which aligns with the academic usage of <i>xietian</i> as a geometric term in The Nine Chapters on the Mathematical Art, while also reflecting the Thai expression for terrain and	3	2



		area calculation.		
sheguang	<i>kʰwām kwā:ŋ kʰɔ:ŋg pʰu:n tʰî:</i>	Meaning "the width of an area," commonly used in geometry to describe the horizontal dimension of fields or geometric bodies. This translation conforms to Thai academic conventions and reflects the geometric background of the term sheguang	4	4
chumeng	<i>lāy kʰā pēn rû:p pîrā mít</i>	Meaning "shaped like a pyramid roof," which captures the geometric form of chumeng emphasizing the sloped surfaces and ridge. This translation suits Thai academic expression and conveys the geometric features of this structure in practical use.	2	3
kun	<i>mái kʰwā:ŋ pràtʰū:</i>	Refers to the horizontal timber beneath a doorframe, typically describing a threshold or the bottom beam of a door. This translation aligns with standard Thai expressions in architecture and daily language.	4	3

The overall analysis of the second-level interpretation translation shows that while there has been some improvement in accuracy and cultural adaptability, there are still certain shortcomings. Specifically, the translation of xietian as tilted or irregular farmland aligns with the geometric term in The Nine Chapters on the Mathematical Art, but it fails to clearly define its mathematical meaning (such as trapezoidal fields) and does not reflect its specific application in ancient Chinese agriculture and mathematics. Therefore, there is room for improvement in both accuracy (3 points) and cultural adaptability (2 points). The translation of sheguang as the width of an area has relatively high accuracy (4

points), conveying its use in geometry, but it could further elaborate on its specific application in The Nine Chapters on the Mathematical Art. The cultural adaptability score is 4, which is relatively good. The translation of chumeng as shaped like a pyramid roof describes the geometric shape but fails to clearly define its mathematical meaning (such as a wedge-shaped body), resulting in an accuracy score of 2 and a cultural adaptability score of 3. This translation does not fully convey its application in mathematics and architecture. The translation of kun as the horizontal timber beneath the doorframe is accurate in the literal sense, but horizontal timber does not equate to threshold in Thai, and the accuracy score is 4, indicating the literal translation is correct. However, the cultural adaptability score is 3, showing that the translation does not fully convey the cultural background of the term in the original text. Overall, the second-level interpretation translation has improved the accuracy and cultural adaptability to some extent but still fails to fully convey the deep cultural meanings behind the terms. To enhance translation quality, it is recommended to include mathematical definitions and cultural background annotations during the translation process, further optimizing the translation to better align with the cultural norms and acceptability of the target language. For xietian and chumeng, more specialized geometric terminology should be used, along with additional cultural explanations. For kun, its cultural symbolic meaning should be included, and more appropriate vocabulary should be chosen to enhance cultural adaptability.

5.2.3 Third-Level Interpretation

Table 5 Third-Level Interpretation Translation

Sample	Translation	ChatGPT's Understanding	Accuracy	Cultural Adaptability
xietian	<i>bple:ŋ nā be:p sì: liàm mūm chà:k</i>	Irregular farmland, usually a right-angled trapezoid. This accurately describes xietian which refers to farmland with an irregular shape, where the boundaries form right angles.	4	4
sheguang	<i>kʰwām kwā:ŋ kʰɔ:ŋ tʰà:n jā:w nái rù:p sì: liàm kʰā:ŋ mū: nà: teùa</i>	Sheguang refers to the width of the long base of an isosceles trapezoid or similar irregular geometry. This is an important parameter used in ancient Chinese	5	5



mathematics for calculating the area of trapezoids.

chumeng	<i>rû:p tʰɔŋ klái lǎŋ kʰā:jā:</i>	chumeng refers to a wedge-shaped body, resembling a grass roof or wedge-shaped prism. In ancient China, this term reflected the integration of architecture and mathematics, particularly in the precise calculation of roofs and other geometric shapes.	4	4
kun	<i>tʰɔ:rā ní: pràtʰū:</i>	In The Nine Chapters on the Mathematical Art, kun might be used to describe geometric issues related to the threshold, including the width, height, or other architectural measurements of a door.	5	5

The third-level interpretation translation has shown significant improvement in both accuracy and cultural adaptability, being able to more accurately convey the meanings of culture-loaded words. However, there is still room for further enhancement. First, concerning the translation of chumeng, while the shape is described, its mathematical definition is not clearly defined. A more accurate translation could be *sōglímkláilčŋkʰā:jā:* wedge-shaped geometry resembling a grass roof, which would better convey its meaning as a wedge-shaped geometric body. The accuracy score is 4, indicating that the translation reflects the original meaning quite well, but the cultural adaptability score of 4 suggests that it still does not fully capture the application of chumeng in ancient Chinese architecture. Therefore, it is recommended to add cultural annotations, further explaining its practical use in architecture to enhance cultural adaptability. For Xietian, the translation is relatively accurate, with an accuracy score of 4, aligning with the definition in The Nine Chapters on the Mathematical Art. However, it does not fully explain the application of Xietian in ancient Chinese agriculture. The cultural adaptability score of 4 indicates that part of the background is conveyed, but its importance in land measurement is not fully reflected. To further improve cultural adaptability, it is suggested to supplement



the translation with cultural context, particularly focusing on its use in agricultural measurement and geometric calculations. For Sheguang and Kun, the translations are highly accurate, both receiving a full score of 5 for accuracy and cultural adaptability. The translations align well with Thai academic expression habits and clearly convey the mathematical and cultural meanings of these terms, with no further improvements needed. Overall, while significant improvements have been made in both accuracy and cultural adaptability in the third-level interpretation translations, especially for sheguang and kun, there is still potential for further refinement. By using more specialized geometric terminology and supplementing with deeper cultural context, the understanding of these terms' cultural connotations can be further enhanced, ultimately improving the accuracy and cultural fit of the translations.

6. Discussion

In the comparative analysis of the first-level, second-level, and third-level interpretation translations, it is clear that as the translation levels deepen, both accuracy and cultural adaptability have significantly improved. From the first-level to the third-level interpretation, the translation of culture-loaded words gradually shifts from a literal level to a more culturally nuanced and academically valuable level, resulting in a noticeable enhancement in both accuracy and cultural adaptability. In the first-level interpretation, the translation focuses more on literal understanding, failing to fully consider cultural background and mathematical applications. For example, xietian was translated as *tʰî: nā tʰû:an* irregular or illegal farmland, which only conveys the surface meaning and neglects its mathematical background as a geometric term in The Nine Chapters on the Mathematical Art, resulting in low scores for both accuracy and cultural adaptability. Similarly, sheguang was translated as *lín kwâ:ŋ* wide tongue, which is accurate in its literal sense, but it does not address its specific meaning in geometry, and cultural adaptability is also poor. The translations of chumeng and kun also remained at the literal level, failing to convey their deeper mathematical or architectural applications.

Moving into the second-level interpretation, translations began to introduce more cultural and academic context. For instance, xietian was translated as *tʰî: nā dâ:n ʔi:ŋ rû:u tʰî: nā máj sâ?mât sâmér* tilted or irregular farmland, which is more aligned with the definition in The Nine Chapters on the Mathematical Art, but still lacks a detailed explanation of its application in ancient Chinese agriculture. While the accuracy and cultural adaptability scores improved, further refinement is needed. For sheguang, the translation *kʰwâm kwâ:ŋ kʰv:ng pʰu:n tʰî:* the width of an area accurately conveyed its geometric context, aligning with Thai academic expression conventions, earning high scores for both accuracy and cultural adaptability. chumeng was translated as *lâŋ kʰâ pê:n rû:p pîrâ mît* shaped like a pyramid roof, which conveys the geometric form but does not specify its mathematical definition, so accuracy remains at 2 and cultural adaptability at 3. kun was translated as *mâi kʰwâ:ŋ prâ:tʰû:* horizontal timber beneath a doorframe, which begins to address the architectural expression but still does not fully capture the term's cultural symbolism.



In the third-level interpretation, the translations became more sophisticated, not only accurately conveying the literal meanings of each term but also incorporating more mathematical background and cultural connotations. For xietian, the translation *bpl̥ε:ŋ nā be:p s̥i: liàm mām chà:k* right-angled trapezoidal farmland accurately describes its geometric characteristics, while also incorporating its application in The Nine Chapters on the Mathematical Art, demonstrating a deeper understanding of its cultural and historical context. sheguang was translated as *k̥wām kwā:ŋ k̥hā:ŋ t̥hā:n jā:w nái rū:p s̥i: liàm k̥hā:ŋ mū: nā: teūa* the width of the long base of an isosceles trapezoid, which accurately conveys the mathematical definition of sheguang as a geometric term, and it aligns with academic expression in Thai culture. The translation of chumeng as *rū:p t̥hāŋ klái lāŋ k̥hā: jā:* a geometric body resembling a grass roof begins to address both the cultural and geometric aspects but still does not fully explain its mathematical definition, resulting in a cultural adaptability score of 4. Finally, kun was translated as *t̥hā:rā nī: prāt̥hū:* threshold, which accurately conveys the literal meaning while also considering its potential application in The Nine Chapters on the Mathematical Art, earning full scores of 5 for both accuracy and cultural adaptability.

Overall, as the interpretation level progressed, the translations moved from a literal understanding to a deeper interpretation of cultural background and mathematical definitions. The third-level interpretation has significantly improved both accuracy and cultural adaptability, especially for sheguang and kun, where the translations reached a relatively perfect level. However, there is still room for further refinement for chumeng and xietian, particularly by adding more detailed cultural annotations about their historical and cultural applications, which would further improve their accuracy and cultural adaptability. In future translation work, further clarification of the mathematical definitions and cultural symbols of these terms will enhance overall translation quality.

7. Conclusion

Based on the Three-Level Analysis of Language Use method, we can conclude that this approach holds significant application potential in ChatGPT's human-machine collaborative translation, especially when dealing with complex culture-loaded words and terminology with deep academic backgrounds. Three-Level Analysis of Language Use not only improves the quality of ChatGPT's translations but also effectively assists human translators in gaining a deeper understanding of the cultural and historical nuances of the source language, ultimately leading to high-quality translations.

Three-Level Analysis of Language provides a multi-dimensional, in-depth interpretation of translations through successive layers of analysis, starting from the literal meaning of the source language, cultural background, and academic definitions. This method is particularly important in human-machine collaborative translation as it enables the system to gradually deepen its understanding of the cultural context, historical significance, and academic applications of terms, ultimately providing human translators with more precise



and culturally relevant translation suggestions. For example, for a term like xietian, the first-level interpretation might only convey its literal meaning as irregular or illegal farmland, which does not reflect its geometric context in The Nine Chapters on the Mathematical Art. The second-level interpretation incorporates more background, mentioning tilted or irregular farmland, but still does not address its application in ancient Chinese agriculture and mathematics. The third-level interpretation, however, can accurately describe it as right-angled trapezoidal farmland and tie it to its specific use in The Nine Chapters on the Mathematical Art, offering a thorough cultural and academic understanding. Similarly, for sheguang, the first-level interpretation might only translate it as wide tongue, missing its geometric significance. The second-level interpretation enhances the translation by aligning it with its definition in geometry, as the width of an area. The third-level interpretation accurately conveys it as the width of the long base of an isosceles trapezoid, emphasizing its application in ancient Chinese mathematics and its academic value within the source language culture.

Through the application of Three-Level Analysis of Language Use, ChatGPT plays an assistive and enhancing role in human-machine collaborative translation. ChatGPT's model can provide initial literal translations, and then, through continuous learning and analysis of the source language's cultural background, academic usage, and historical significance, gradually deepens the translation's accuracy and cultural adaptability. The human translator can then modify and adjust based on ChatGPT's suggestions to ensure that the translation not only meets language standards but also faithfully conveys the deep cultural values and context of the source language. For instance, in translating chumeng, the first-level interpretation might simply translate it as grass on the roof, but in the third-level interpretation, ChatGPT would provide a translation like wedge-shaped geometric body resembling a grass roof, accurately conveying its mathematical concept while also incorporating cultural and historical background.

Based on the Three-Level Analysis of Language Use approach, translators must conduct a thorough pre-interpretation and analysis of culture-loaded terms, particularly those that involve complex concepts related to mathematics, history, and culture. Literal translation alone is often insufficient in conveying the deeper cultural connotations of these terms. Therefore, translators need to deeply understand the cultural background, academic definitions, and application scenarios of the source language, ensuring that the translation goes beyond surface meaning and accurately conveys the multidimensional knowledge systems, social structures, and historical backgrounds inherent in the source language culture. The application of the Three-Level Analysis of Language Use in ChatGPT's human-machine collaborative translation demonstrates great potential. Through TLA, ChatGPT not only accurately conveys the literal meaning of the source language but also integrates the mathematical, cultural, and academic contexts, aiding translators in deepening their understanding of the cultural background and providing more precise, professional translation suggestions. In this process, translators, working collaboratively with ChatGPT have advanced translation support, not only improved the accuracy of the

translation but also enhanced its cultural adaptability, ensuring the translation aligns with the target language's cultural conventions. Therefore, the Three-Level Analysis method offers powerful support for ChatGPT in translating culture-loaded words, highlighting the advantages of human-machine collaborative translation.

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