The impact of contextual understanding on neural machine translation accuracy: A case study of Indonesian cultural idioms in English translation

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ABSTRACT

The translation of Indonesian idiomatic expressions into English using Neural Machine Translation (NMT) systems presents significant challenges due to the intricate nature of idiomatic language. Idioms are culturally embedded constructs conveying meanings different from their literal interpretations. This study explores the effectiveness of NMT systems in capturing and translating Indonesian idiomatic expressions into English. Using a qualitative approach, 150 diverse Indonesian idioms were evaluated through Google Translate and DeepL. Each idiom was assessed for semantic accuracy, syntactic coherence, and contextual fidelity. Qualitative analysis provided a comprehensive evaluation of translation quality. Findings reveal significant challenges for NMT systems in translating idiomatic expressions. Both Google Translate and DeepL show strengths in some areas, but also have limitations. While they generally capture literal meanings, they often miss metaphorical nuances and cultural connotations. Syntactic errors such as incorrect word order and tense inconsistencies are common, especially in complex

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idioms. In addition, contextual fidelity analysis shows that NMT systems struggle with contextual appropriateness and pragmatic usage, resulting in translations lacking cultural sensitivity and relevance. These challenges highlight the need for improved algorithms to better interpret and translate idiomatic language across cultural contexts. Accurate idiom translation is crucial for language learners to understand cultural nuances and idiomatic usage. Enhancing the capabilities of NMT systems requires refining algorithms, developing context-aware models, and expanding training datasets with diverse idiomatic expressions. Overcoming these challenges will advance machine translation capabilities and improve cross-cultural communication and language learning experiences.

Keywords: *Translation accuracy; Neural machine translation; Cultural idioms*

1. Introduction

Neural Machine Translation (NMT) systems have revolutionized the field of automated translation, offering significant improvements in accuracy and fluency over previous models. These systems utilize deep learning techniques to process and generate translations, making them more adept at handling complex sentence structures and contextual nuances. However, translating culturally specific idioms remains a persistent challenge due to the deep contextual understanding required. This study explores the impact of contextual understanding on the accuracy of NMT systems, specifically focusing on the translation of Indonesian cultural idioms into English.

Idioms, by their nature, are deeply rooted in cultural and contextual nuances, often carrying meanings that extend beyond their literal expressions. According to Larson (1984), idioms are expressions whose meanings cannot be deduced from the meanings of the individual words. This poses a significant challenge for NMT systems, which primarily rely on large datasets and pattern recognition. The difficulty in translating idioms accurately highlights the limitations of current NMT models, which often produce literal translations that fail to capture the intended meaning (Chung & Ahn, 2022). The translation of idiomatic expressions has been extensively studied within the field of translation studies. Baker (2018) emphasizes the importance of context in translation, arguing that a deep understanding of both source and target languages' cultural contexts is crucial for accurate translation. This view is supported by House (2015), who contends that cultural context and situational context are fundamental to achieving equivalence in translation. Despite advancements in NMT, these systems still struggle to incorporate such complex contextual knowledge effectively.

Recent research has shown that while NMT systems perform well with straightforward, context-independent sentences, they often falter with context-dependent language features, such as idioms (Lee, 2020). Lee and Briggs (2021) found that NMT systems frequently produce translations that are grammatically correct but contextually inappropriate, particularly when dealing with idiomatic expressions. Brevian (2020) mentions grammatical equivalence in the machine translator, I-Translate, in his thesis. He said that the grammatical aspect´s score reaches perfect level, but the accuracy and

acceptability are in the middle level. This suggests that current NMT models lack the ability to fully understand and interpret the cultural and contextual subtleties that idioms encapsulate. In the context of Indonesian-English translation, the challenge is even more pronounced. Indonesian idioms are rich with cultural references and contextual meanings that are not easily translatable into English. Napitupulu (2017) highlights the frequent errors in Google Translate's handling of Indonesian-English translations, particularly with idiomatic expressions. These errors often result from a lack of contextual awareness, leading to translations that are either nonsensical or fail to convey the intended meaning. Contextual awareness is important to translate text that has situational context because there will be many vocabularies with multiple meanings (Bidari, 2021). It can make the machines deliver the messages suit the era of usage as well.

This study aims to address these challenges by conducting a detailed case study on the translation of Indonesian idioms into English using NMT systems. The research involves compiling a corpus of commonly used Indonesian idioms and their contexts, translating them using popular NMT systems like Google Translate and DeepL, and analysing the translations for errors and misinterpretations. By categorising these errors, the study seeks to identify common patterns and underlying issues in the translation process. Furthermore, this research evaluates the role of contextual understanding by comparing translations with and without context. Contextual understanding is essential for accurately translating idioms, as it provides the necessary background to interpret the idiomatic meaning correctly. This evaluation will help determine the extent to which current NMT systems can benefit from improved context-awareness algorithms. The findings of this research are expected to contribute to the development of more culturally aware translation models. By incorporating context-aware algorithms and expanding training datasets to include more culturally diverse idiomatic expressions, NMT systems can be enhanced to better handle the translation of idioms. This, in turn, will improve the overall quality and reliability of machine translation, facilitating better cross-linguistic communication and understanding.

This study investigates the impact of contextual understanding on the accuracy of Neural Machine Translation (NMT) systems, specifically focusing on the translation of Indonesian cultural idioms into English. Despite significant advancements in NMT, translating idiomatic expressions remains a substantial challenge due to the deep cultural and contextual nuances these expressions encapsulate. Through a detailed case study, this research aims to identify the limitations of current NMT systems in handling idiomatic and context-dependent expressions and propose potential improvements to enhance their performance. The findings are expected to contribute to the development of more culturally aware translation models, thereby improving cross-linguistic communication and understanding.

2. Literature review

The translation of idiomatic expressions poses significant challenges to Neural

Machine Translation (NMT) systems due to the cultural and contextual nuances they encompass. Previous research in this area has highlighted various aspects of these challenges, focusing on the limitations of NMT systems and proposing potential solutions for improving translation accuracy.

2.1. Neural machine translation and contextual understanding

Neural Machine Translation (NMT) systems, such as those developed by Google and DeepL, have demonstrated remarkable advancements in translating texts by leveraging deep learning techniques. These systems rely on vast amounts of data and sophisticated algorithms to produce translations that are generally more accurate and fluent compared to earlier rule-based and statistical models (Chung & Ahn, 2022). However, their performance declines when dealing with idiomatic expressions that require a deep understanding of cultural and contextual nuances (Lee, 2020). This contextual understanding seems to interact less with some parts of idiom, that have more than two words, in the Transformer model (Dankers, 2022). This model tends to see idioms as compositional expressions that often result in literal translation. These parts of idiom are often grouped through attention patterns.

Although other types of Transformer model such as those used in Google Translate or DeepL give significant performance improvements, they often can´t handle idioms well. Donthi (2024) says that semantic similarity-based method, Cosine Similarity, can help in choosing the proper idioms in the target language. Besides, there are still many difficulties in maintaining the original idiomatic writing style.

2.2. Translation of idiomatic expressions

Idioms are expressions whose meanings cannot be deduced from the literal meanings of the individual words. According to Larson (1984), translating idioms accurately requires not just linguistic knowledge but also an understanding of the cultural context in which these expressions are used. This challenge is magnified in NMT systems, which often produce literal translations that fail to capture the intended meaning (Lee & Briggs, 2021). Recent studies have underscored the difficulty of translating idiomatic expressions. Lee and Briggs (2021) found that NMT systems frequently generate translations that, while grammatically correct, are contextually inappropriate. This is particularly problematic when translating idioms, as their meanings are deeply embedded in cultural contexts. Napitupulu (2017) specifically noted the frequent errors in Google Translate's handling of Indonesian-English translations, highlighting the system's struggle with idiomatic expressions.

2.3. Important context in translation

Baker (2018) emphasizes that achieving accurate translations requires a deep understanding of both the source and target languages' cultural contexts. This sentiment is echoed by House (2015), who argues that cultural and situational contexts are crucial

for translation equivalence. These insights underline the limitations of current NMT systems, which often lack the capacity to integrate such complex contextual information effectively. For example, a phrase like "as American as apple pie" may not resonate in Indonesian culture where apple pie is not a common dessert, necessitating a culturally equivalent expression or an explanatory translation.

Contextual ambiguity of meanings can be a big challenge for NMT too. Words with multiple meanings depending on their context pose another challenge. For instance, the word "bark" can refer to the sound a dog makes or the outer layer of a tree. Without proper context, NMT systems can easily misinterpret such words, leading to inaccuracies (Why Context Really Matters in Translation, 2022). Pragmatic understanding and complexity of contextual factors is the following challenges. Pragmatic Understanding: Context also includes the situational and pragmatic elements of communication, such as politeness levels, formalities, and intended tone. Human translators typically assess these factors to ensure that the translation maintains the original's intent and appropriateness (Dayter, 2023). NMT systems, however, often overlook these subtleties, leading to translations that may sound unnatural or inappropriate in the target language. Successful translation requires considering various contextual layers, including social, linguistic, and individual factors. NMT systems lack the sophisticated understanding necessary to navigate these layers effectively, often resulting in translations that miss the deeper meanings or fail to adapt to the intended audience's expectations (The Importance of Context within Translation, 2024).

2.4. Machine translation in educational contexts

The impact of NMT on language learning and translation accuracy has also been explored. Lee (2020) investigated the influence of machine translation on EFL students' writing, revealing that while NMT tools can aid in learning, they often lead to reliance on literal translations. This reliance can hinder the development of deeper linguistic and cultural understanding. Similarly, Lee (2023) conducted a systematic review and meta-analysis, finding that NMT tools, while useful, require enhancements to better handle idiomatic and context-dependent language features. Educators are increasingly aware of the need to teach students how to use MT tools effectively and critically. For instance, Kenny (2022) discusses the importance of integrating MT into the curriculum in a way that empowers students, encouraging them to question the output of these tools and understand their limitations. This approach helps in developing critical thinking and language skills.

Students' attitudes towards MT tools vary. While some view them as helpful aids, others recognize the risks of over-reliance. Klekovkina and Denié-Higney (2022) explored students' perceptions and found that while MT can be a useful resource, it should not replace traditional language learning methods. Practical applications of MT in education include proofreading, translation exercises, and as a supplementary resource for understanding course materials. These uses demonstrate the potential of MT to

enhance learning experiences when used alongside traditional methods (Jolley & Maimone, 2022; Kol, Schcolnik, & Spector-Cohen, 2018).

2.5. Case studies on Indonesian-English translation

Several studies have focused on the specific challenges of translating Indonesian to English using NMT systems. Ekazuriaty (2016) analyzes the quality of Google Translate in translating English texts into Indonesian, identifying significant issues with idiomatic and context-dependent expressions. Ismail and Hartono (2016) examine the errors made by Google Translate in Indonesian-English translations of news items, highlighting the system's difficulty in accurately conveying idiomatic meanings. Kasmir (2022) extends this analysis to academic abstracts, again finding that idiomatic expressions are frequently mistranslated. Sipayung (2024) finds some issues with the idiom's translation of fantasy kids movie subtitles. The primary challenges involve the complexity of source-language expressions, differences in expressive meanings, absence of equivalent concepts, distinct nuances in meaning, and a lack of corresponding terms in the target language. Furthermore, issues such as inconsistencies with the language system, shifts in meaning, cultural adaptation, and distortion of intended meaning were noted as significant overt errors.

2.6. Proposals for enhancing NMT systems

To address these challenges, researchers have proposed several enhancements for NMT systems. Chung and Ahn (2022) suggest incorporating context-aware algorithms that can better capture the cultural and situational nuances of idiomatic expressions. Expanding training datasets to include more culturally diverse idiomatic expressions is another proposed solution, aiming to improve the systems' ability to handle context-dependent language features. Liu (2023) has explored two techniques to improve the accuracy of idiom translation. First, there should be more attention on data loss for idiomatically-sentences-to-be. Second, there should be retrieval augmented model usage. He mentions that those techniques not just developing the idiom translation until 13%, also having a potential use to non-idiomatic sentences.

The existing literature highlights significant challenges faced by NMT systems in translating idiomatic expressions, particularly due to the lack of contextual and cultural understanding. While NMT systems have advanced considerably, their inability to accurately translate idioms underscores the need for further research and development. This study aims to bridge this gap by investigating the impact of contextual understanding on the translation of Indonesian idioms into English, providing insights that could enhance the cultural awareness and overall performance of NMT systems.

3. Method

3.1. Research design

This study employs a qualitative case study design to investigate the translation of Indonesian idiomatic expressions into English by Neural Machine Translation (NMT) systems. A qualitative approach is suitable for exploring complex phenomena like idiomatic translation, where nuanced understanding of cultural and contextual factors is essential (Creswell & Poth, 2018). This design allows for in-depth analysis of specific instances of idiomatic translations, providing detailed insights into the performance and limitations of NMT systems.

3.2. Data collection

3.2.1.Corpus compilation

The primary data source for this study is a corpus of Indonesian idiomatic expressions. Idioms are selected based on their frequency of use in various contexts, including literature, media, and everyday communication. The corpus compilation starts with identifying commonly used Indonesian idioms from existing literature and idiom dictionaries (Ekazuriaty, 2016; Napitupulu, 2017). Idiom dictionaries and existing literature often collect idioms that have been widely recognized and used in various contexts. Using these sources provides a solid basis for understanding idioms that have been recognized and used in Indonesian. Idiom dictionaries usually include the definition, usage and context of the idiom which helps to ensure that the idioms selected are representative and relevant. Next step is collecting idioms from Indonesian newspapers, magazines, and online articles to ensure that the corpus reflects contemporary usage and variations in idiomatic expressions (Ismail & Hartono, 2016).

Mass media and online publications often use current and dynamic language, including idioms that may not have been widely documented in dictionaries or formal literature. Collecting idioms from these sources ensures that the corpus reflects idioms used in everyday communication. News articles, magazines, and online sources often include idioms that relate to current topics and language trends, providing a perspective on how idioms are used in modern contexts. Last, researcher gathers idiomatic expressions from native Indonesian speakers through a structured survey to ensure inclusion of idioms used in everyday communication (Lee & Briggs, 2021). Involving native speakers in the data collection process is essential to obtain idioms that are actually used in everyday conversation and to ensure that the collected idioms reflect regional and social variations in language use. Structured surveys allow for systematic and standardized data collection, providing accurate information on idioms used by different groups of speakers. It also helps identify idioms that may not be documented in formal or media sources.

3.2.2. Translation process

The compiled idioms are translated into English using two popular NMT systems: Google Translate and DeepL. Each idiom is translated twice: once in isolation and once within a full sentence to provide context. This approach allows for comparison between context-free and context-aware translations (Chung & Ahn, 2022).

3.3. Data analysis

The data analysis involved a multi-step process:

3.3.1. Error identification

Each translation is examined for errors. Errors are categorized based on types such as literal translation, semantic errors, syntactic errors, and context misinterpretations (Lee, 2020). Identifying errors is a crucial first step to understanding the problems in idiomatic translation by the NMT system. By categorizing the errors, researchers can understand the most common types of errors and areas that need improvement. Literal translation occurs when idioms are translated word-for-word without regard to their figurative meaning, which often leads to nonsensical results.

Semantic errors occur when the meaning conveyed in the translation is different from the intended meaning in the source language. Syntactic errors occur when the sentence structure of the translation does not conform to the grammatical rules of the target language. Context interpretation errors occur when the NMT system fails to capture nuances or meanings that are based on situational or cultural context.

3.3.2. Pattern recognition

Patterns in translation errors are identified to determine common challenges faced by NMT systems in translating idiomatic expressions. This step involves both qualitative and quantitative analysis techniques to categorize and quantify error types (Lee, 2021). Pattern recognition helps in identifying common trends and recurring patterns in translation errors, which could indicate specific weaknesses in the NMT algorithm or in idiomatic understanding in general. Qualitative analysis allows researchers to understand the nuances and complexities of errors that may not be apparent through quantitative analysis. Quantitative analysis provides statistical data that can be used to measure the frequency and distribution of errors, helping in identifying the most pressing issues.

3.3.3. Contextual analysis

Contextual analysis is carried out by comparing the translation results in different contexts to identify errors and limitations in context understanding by the NMT system. Comparisons are made between context-free and context-aware translations to evaluate the impact of contextual understanding on translation accuracy. This involves analyzing how the presence of context influenced the translation output (Kasmir, 2022).

3.4. Reliability and validity

To ensure reliability and validity, multiple strategies are employed. Data triangulation is achieved by using multiple data sources, including literature, media, and surveys, to compile the idiom corpus. Methodological triangulation is applied by comparing results from different NMT systems (Creswell & Poth, 2018). A reviewer and advisor ensure consistency in the analysis. Any discrepancies are discussed and resolved to reach a consensus (Napitupulu, 2017). Named Prof. Ashadi, S.Pd., M.Hum., Ed.D., he is the researcher´s lecturer in State University of Yogyakarta as well. A pilot study is conducted to test the research design and data collection methods that runs for 2 months. Feedback from the pilot study is used to refine the methodology before the main data collection (Lee & Briggs, 2021). First step is instrument testing, such as questionnaires or other data collection tools to ensure that they can effectively collect the required data. Second, researcher involves procedure assessment, evaluating data collection procedures to ensure a smooth process and identify potential bottlenecks or errors. Then, initial data collection: researcher collects data from a small sample to identify potential problems in data collection or analysis. The last step is validation, assessing the validity and reliability of the data collected to ensure conformity with the research objectives.

3.5. Ethical considerations

The study adhered to ethical standards in data collection and analysis. Informed consent is obtained from survey participants, and their anonymity is preserved. The use of publicly available texts from literature and media ensured that no proprietary or sensitive information is included in the study.

4. Findings

The analysis of translations produced by Google Translate and DeepL reveals significant challenges in accurately translating Indonesian idiomatic expressions into English. Across the corpus of idioms, several types of errors are identified, including literal translations, semantic errors, syntactic errors, and context misinterpretations.

Table 1
Matrix of similarities and differences between GT and DL.

Aspect	Google Translate	DeepL	Similarities	Differences
Literal Translation	Frequent occurrence (52%)	Slightly less frequent	Both systems struggled with literal translations.	Google Translate had a higher frequency of literal translations.

Semantic Errors	Common, particularly with culturally specific idioms	Occasional, but still significant	Both systems faced challenges with semantic errors.	DeepL is slightly better at capturing meaning, though still flawed.
Syntactic Errors	Higher frequency, especially with complex sentences	Occasional	Both systems made syntactic errors.	Google Translate is more prone to syntactic errors.
Context Misinterpretation	Less effective in utilizing context	Slightly better context handling	Both systems struggled with context-dependent expressions.	DeepL showed slight improvement in context awareness.
Overall Performance	Lower accuracy in idiomatic translations	Slightly better accuracy in context handling	Both systems produced similar types of errors.	DeepL had a marginally better handling of context but still struggled with idiomatic meanings.

Overall, the matrix reveals that while both systems produce similar types of errors, DeepL exhibits a marginally better performance, especially in leveraging contextual information. However, the performance gap between the two systems is not substantial, and both continue to struggle with the complexities of idiomatic and culturally nuanced language. This analysis highlights the ongoing limitations of NMT systems in accurately translating idioms, emphasizing the need for further advancements in integrating cultural understanding and contextual awareness into these technologies.

5. Discussion

Translating idiomatic expressions from Indonesian into English using Neural Machine Translation (NMT) systems presents significant challenges due to the inherent complexity of idiomatic language. Idioms are deeply rooted in cultural contexts, often reflecting historical, social, and linguistic nuances that may not have direct equivalents in other languages (Chung & Ahn, 2022). In Indonesian, idiomatic expressions are abundant and play a crucial role in everyday communication, reflecting cultural values and societal norms. Idiomatic expressions in Indonesian are rich in metaphorical and cultural significance. For example, *"makan angin"* literally translates to "eating wind," but idiomatically means to go on a leisurely stroll or outing, reflecting a relaxed and carefree

attitude. Such expressions encapsulate nuances that are challenging for NMT systems to capture accurately. Machine algorithms struggle with the figurative meanings and cultural contexts embedded within idioms, often resulting in translations that lack semantic fidelity and fail to convey the intended message effectively.

One of the primary challenges encountered is the tendency for NMT systems to produce literal translations of idiomatic expressions. Literal translations ignore the metaphorical or figurative meanings of idioms, resulting in translations that are awkward, nonsensical, or misleading in the target language. Semantic errors arise when the translated output diverges significantly from the original idiomatic expression, leading to communication breakdowns and misunderstandings. Syntactic errors also pose obstacles, as machine algorithms struggle to maintain the grammatical structure and coherence of idiomatic expressions in English. This often results in fragmented or grammatically incorrect sentences that diminish the readability and comprehensibility of the translated text. Furthermore, context misinterpretations highlight the difficulty machines face in understanding the cultural nuances and situational contexts in which idiomatic expressions are used.

The comparative analysis between Google Translate and DeepL revealed nuanced differences in their performance in translating idiomatic expressions. While both systems exhibited similar error patterns, DeepL demonstrated slightly superior capabilities in understanding contextual nuances, resulting in fewer context misinterpretations compared to Google Translate (Chung & Ahn, 2022). However, both platforms struggled with semantic errors, indicating the ongoing challenges in accurately conveying idiomatic meanings across languages. Contextual understanding plays a crucial role in enhancing the accuracy of idiomatic translations. Translations that take into account contextual cues, cultural references, and the intended meaning behind idiomatic expressions are more likely to convey the original message accurately. For instance, understanding the cultural connotations of idioms like *"air susu dibalas air tuba"* (literally "milk is repaid with poison") requires awareness of its metaphorical meaning of ingratitude or betrayal.

Accurate translation of idiomatic expressions is essential for language learners seeking to comprehend and use idiomatic language effectively. Exposure to accurate translations facilitates deeper cultural understanding and enhances proficiency in the target language. In professional settings, such as international business and diplomacy, precise translations of idioms promote clear communication and mutual understanding across linguistic and cultural boundaries. Moving forward, improving NMT systems' capabilities in translating idiomatic expressions requires innovative approaches. Enhancing algorithms for semantic interpretation and developing context-sensitive models are critical steps towards achieving more accurate idiomatic translations. Expanding training datasets to include diverse idiomatic expressions and cultural contexts will further strengthen the robustness of NMT systems in handling idiomatic language. Long-term research efforts should focus on interdisciplinary collaboration between linguists, computer scientists, and educators to address the multifaceted challenges of

idiomatic translation. By advancing the technological and linguistic foundations of NMT, we can pave the way for more effective cross-cultural communication and facilitate meaningful interactions in an increasingly globalized world.

In conclusion, while NMT systems continue to evolve, the accurate translation of Indonesian idiomatic expressions into English remains a complex and evolving frontier. This discussion highlights the inherent challenges faced by machine algorithms in capturing the nuanced meanings and cultural contexts embedded within idiomatic language. Addressing these challenges is crucial for advancing the field of machine translation and enhancing global communication in diverse linguistic and cultural landscapes.

6. Conclusion

Translating Indonesian idiomatic expressions into English using Neural Machine Translation (NMT) systems presents a formidable challenge rooted in the complex nature of language and culture. Idioms, which are deeply ingrained in Indonesian culture, often carry metaphorical meanings that go beyond literal interpretation. This study has explored the inherent difficulties faced by NMT systems in accurately capturing these nuances. NMT systems encounter significant hurdles in translating idiomatic expressions. Their reliance on literal translations often overlooks the figurative meanings and cultural contexts embedded within idioms. This results in translations that fail to convey the intended nuances and can lead to misunderstandings. Additionally, syntactic errors and contextual misinterpretations further complicate the process, highlighting the machine's struggle to grasp the subtle nuances of idiomatic language.

Accurate translation of idiomatic expressions is pivotal for language learners and professionals engaging in cross-cultural communication. Precise translations not only facilitate language acquisition but also deepen cultural understanding and promote effective communication across linguistic boundaries. In educational settings, such translations enhance language proficiency by providing learners with insights into cultural nuances and idiomatic usage. Moving forward, enhancing NMT systems' capabilities in translating idiomatic expressions requires innovative approaches. Improving algorithms to better understand semantic and cultural contexts, developing context-aware models, and expanding datasets with diverse idiomatic expressions are crucial steps. Long-term research efforts focusing on interdisciplinary collaboration can further advance the field and address the complexities of idiomatic translation comprehensively. In conclusion, while NMT systems continue to evolve, the accurate translation of Indonesian idiomatic expressions into English remains a complex frontier. Addressing these challenges will pave the way for improved cross-cultural communication, enhanced language learning experiences, and more effective global interactions. As technology progresses, ongoing research and development efforts will be essential in unlocking the full potential of NMT systems to bridge linguistic and cultural divides in our interconnected world.

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