



DeepL as Scaffolding in Academic Writing: A Zone of Proximal Development Theoretical Review

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Article Info

Submitted: December 2025

Accepted : January 2026

Published : April 2026

Keywords:

Scaffolding:

DeepL:

ZPD:

Academic Writing:

Vygotsky.

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Abstract

This study presents a conceptual analysis aimed at investigating the potential of DeepL as a scaffolding tool for English as a Foreign Language (EFL) learners in academic writing. Amidst the ethical debate regarding the use of Artificial Intelligence (AI) in education, this article offers an alternative perspective using Vygotsky's Zone of Proximal Development (ZPD) theoretical lens. The method employed was a comparative conceptual analysis and critical literature synthesis of 20 published articles (2021–2025) to map DeepL's functions in reducing students' cognitive load. Theoretical findings indicate that DeepL meets the criteria of an artificial More Knowledgeable Other (MKO) based on its ability to provide immediate lexicogrammatical micro-scaffolding. Through the proposed "Write-Translate-Compare" integration model, guided use of DeepL allows students to produce texts above their current competence level, which are gradually internalized into independent competence. The conclusion suggests a paradigm shift from total prohibition to critical AI literacy, where the teaching focus shifts from pure text production to managing technological assistance for sustainable learning.

INTRODUCTION

In Indonesia, one of the most significant challenges faced by EFL students is using the English language as a medium of academic writing. Among others, this challenge is predominantly cognitive. An advanced student in one's first language (L1) can generate complex, critical, and original ideas; however, they typically face significant challenges in abstracting these ideas into the L2 target

language. The disparity between one's cognitive capability and language proficiency often results in academic frustration. For instance, a student may possess brilliant arguments, but their quality is critically limited by weaknesses in grammar, limited vocabulary, and a lack of knowledge regarding the rhetorical moves required for international journals.

To understand this friction, one must consider Cognitive Load Theory (CLT), which suggests that the mental effort required for lower-level linguistic tasks often exhausts the working memory needed for higher-order thinking. In the preceding decade, machine translation (MT) instruments, exemplified by Google Translate, have been employed by learners in endeavors to navigate this challenge (Abdelhalim et al., 2025; Asscher, 2025). However, the introduction of Neural Machine Translation (NMT) technology, particularly DeepL, has substantiated the argument for its use (Klimova et al., 2023). Unlike Statistical Machine Translation (SMT), DeepL utilizes statistical deep learning to provide greater accuracy, fluency, and naturalness than previous devices (Radhakrishnan et al., 2023; Sidiq & Syafryadin, 2024).

This raises a pedagogical challenge for higher education institutions. Some educators worry that the dependence on DeepL may adversely affect students' critical thinking, language learning, and increase the risk of plagiarism (Octaberlina et al., 2024; Yasmin Khairani Zakaria et al., 2025). In response, many educational providers impose bans, stating that students should not use translation tools when writing dissertations or articles. Other educators, however, see the bans as futile. Due to publication constraints and deadlines, students often use DeepL as their primary tool surreptitiously (Laksana & Komara, 2024; Arnita et al., 2025).

Some might say these restrictive approaches fail to consider the NMT technology's pedagogical promise. Instead of seeing DeepL as a threat to academic honesty, one can consider DeepL to lie within the orbit of Lev Vygotsky's social learning theory, particularly the Zone of Proximal Development (ZPD). This research seeks to answer the following conceptual question: How can DeepL go beyond the role of an instant translation tool to become a genuine scaffold that aids students' cognitive and linguistic growth? This article answers this question by providing a conceptual framework based on DeepL conceived as a tool of Academic Writing pedagogy. The analysis is based on DeepL's

cognitive load alleviation, its function as an artificial More Knowledgeable Other (MKO), and designed independence.

Literature Review

Academic Writing Challenges and Cognitive Load

Academic writing involves complexity, even for the most experienced writers, as it requires juggling multiple constraints simultaneously. However, the writing process becomes even more difficult for EFL writers, as even more cognitive load writing a paper adds more overall cognitive load (Jiang & Kalyuga: 2022; Xu & Zhang, 2023). However, Cognitive Load Theory (CLT) categorizes load that various cognitive tasks as being intrinsic load (the difficulty of the material itself), and extraneous load (the more an instructor makes the task more cognitively burdensome, due to trivial, possibly irrelevant, task demands. Specifically, in L2 writing, the constant effort to retrieve vocabulary (lexical retrieval) and create more complex sentences (syntactical encoding) becomes an extraneous load that dissipates the student's working memory (Sasaki et al., 2025). Consequently, less straightforward tasks tend to engage higher-order thinking skills, such as constructing arguments, developing thematic depth, and maintaining logical coherence—features that are characteristic of a more advanced authorial voice. In writing, there becomes a paradoxical cognitive load when lower-level linguistic elements are too complex, and the higher-level aspects are not; it is a given that the overall quality of writing will not be high (Chen, 2025).

The Evolution of Machine Translation in Education

The impact of Machine Translation (MT) in Computer-Assisted Language Learning (CALL) is undergoing a paradigm shift aligned with sociocultural learning needs. During the Grammar-Translation period, MT was seen as a cheating device that did not facilitate learning. However, with the improvement of Neural Machine Translation (NMT), MT is now used for qualifying purposes. Current investigations (Klimova, 2025; Sasaki et al., 2025) demonstrate that MT has developed beyond simple language transfer to become a cognitive tool. MT assists learners in exercising control over their understanding, correcting spelling, and discovering novel word formations. In Indonesia, Munawwarah & Martriwati (2024) report students describing DeepL as a "personal assistant".

Such digital tools facilitate the understanding of complex academic material and, consequently, promote students' academic motivation.

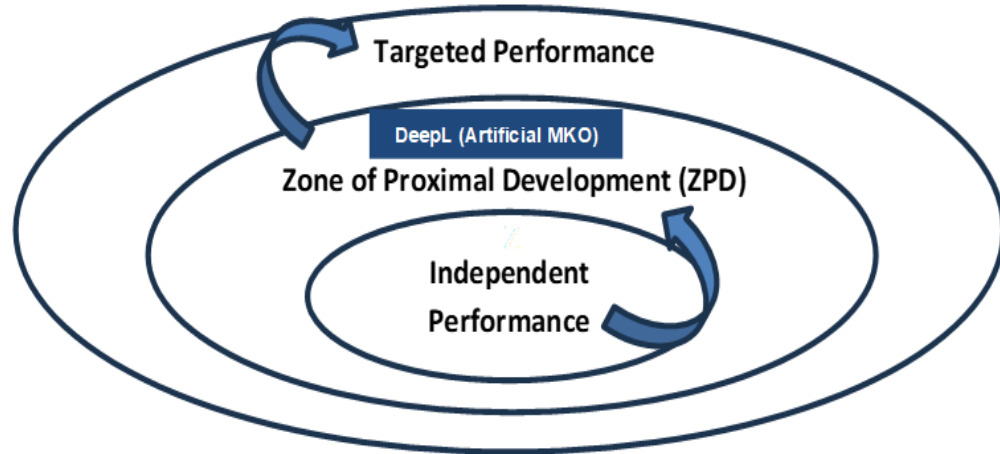
Vygotsky's ZPD and Scaffolding in the AI Era

The overwhelming majority of the theories that inform this conceptual framework are Vygotsky's Sociocultural Development theory (1978) and the most important term in it, which is the Zone of Proximal Development (ZPD). ZPD is the gap between the actual and the potential developmental levels of a learner. The actual level is determined through the learner's autonomous engagement with the learning material, while the potential level is assessed through collaboration with a more knowledgeable learner or a teacher. The support given to learners in this zone is referred to as scaffolding.

Traditionally, assistance is rendered by a More Knowledgeable Other, or MKO, and is provided by humans, such as lecturers or fellow students. Advances in artificial intelligence, however, require one to broaden their conception of this idea. Cai et al., (2025) suggest the idea of the artificial MKO. They suggest that AI tools, such as DeepL, possess the features of an MKO since they have a considerably greater mastery of the language than the student and are accessible 24/7 and able to give tailored answers/assistance to the student's queries. The primary concern, however, is whether a machine's assistance is as effective as that of a human in facilitating the internalization of knowledge. Tanjung & Kusmaryani (2025) notes that the value of MT as an MKO stems from the engagement level of the user; passive interaction (copy-pasting) leads to no learning gains while active interaction (post-editing) can advance the learner's zone of proximal development.

Figure 1. Conceptual framework of AI-mediated ZPD. DeepL functions as an artificial MKO within the ZPD, bridging the gap between students' current linguistic capabilities and the demands of academic writing through the provision of instant scaffolding.

(Adapted from Vygotsky, 1978, and Cai et al., 2025).



RESEARCH METHODOLOGY

Although this article relies on a critical literature review and theoretical synthesis, it is indeed a conceptual study aimed at building a new pedagogical framework. The research process consisted of three structured stages. In the initial phase, we conducted a systematic review of the literature by consulting reputable national (SINTA-indexed) and international (Scopus/WoS-indexed) journals published between 2021 and 2025. The search strategy used specific key phrases, including "DeepL in education," "Machine Translation scaffolding," "ZPD and AI," and "EFL academic writing." To ensure methodological rigor, specific inclusion and exclusion criteria were applied; articles focusing solely on computational architecture or older statistical models were excluded, while those explicitly discussing Neural Machine Translation in EFL contexts were included, yielding a final collection of 20 core articles. In the second stage, the articles were subject to a hybrid thematic analysis. An inductive approach was initially employed to isolate four major emerging themes: perceptions, cognitive impacts, strategies of use, and the ethics of use. The bedrock of this analysis consisted of major studies by Laksana & Komara (2024); Tanjung (2023); and Cai et al., (2025). The final stage involved a deductive conceptual synthesis, which called for the integration of these empirical findings with the ZPD theoretical framework by Vygotsky. This process involved a detailed comparison of the features of DeepL and scaffolding principles (fading, transfer of responsibility, contingent support) to develop a model of ideal use.

Table 1. Summary of Key Studies on DeepL and AI Scaffolding in EFL Context (2023-2025)

Author(s) & Year	Focus of Study	Key Findings Relevant to ZPD/Scaffolding
(Tanjung & Kusmaryani, 2025)Tanjung (2023)	Machine Translation & Vygotsky	MT functions as a writing partner that provides immediate linguistic feedback, aligning with the concept of ZPD.
Laksana & Komara (2024)	Student Perception in Indonesia	Students perceive DeepL as a tool that enhances vocabulary acquisition and reduces anxiety in understanding difficult texts.
Cai et al. (2025)	Theoretical Framework	Proposes the concept of "Artificial MKO" where AI tools simulate the guidance traditionally provided by human teachers.
Wang et al. (2025)	Cognitive Load	Human-machine collaboration significantly reduces extraneous cognitive load during translation tasks.
Fathinah et al. (2025)	Translanguaging	DeepL facilitates translanguaging, allowing students to bridge their L1 complex ideas into L2 academic structures.

RESEARCH FINDINGS AND DISCUSSION

Reconceptualizing the MKO: DeepL as a Cognitive Partner

The literature analysis affirms a rebranding of DeepL from a "code-switching machine" to a "cognitive partner". Within the ZPD, students require some form of assistance to shift from independent to potential performance. Complex sentence construction stalling is a specific hindrance, as noted by Tanjung & Kusmaryani (2025). In such cases, DeepL can serve as an immediate option that reassembles and offers an alternative grammatical structure to a given sentence. This provides an instance of direct scaffolding.

However, comparisons regarding the superiority of AI must be nuanced. While DeepL possesses a distinct advantage in terms of availability being-accessible 24/7 unlike human MKOs who are constrained by class schedules and physical endurance, it does not possess the pedagogical intentionality or intuition of a teacher. The value of DeepL lies in its function as a "safety net"

that encourages students to challenge themselves and experiment with words of higher difficulty. In this setting, student anxiety-an affective factor-is alleviated, thus enabling student language acquisition. Yet, this accessibility should not be mistaken for holistic superiority. As Cai et al. (2025) suggest, a "Hybrid Scaffolding Model" is necessary because AI lacks the socio-cultural context and logical reasoning that a human MKO provides. DeepL is thus suitable for technical micro-scaffolding (grammar, spelling, collocation), while the human lecturer remains indispensable for macro-scaffolding (rhetoric, logic, and originality). This offers students a form of comprehensive support while operating within their ZPD.

Mechanisms of Cognitive Offloading

A cognitive perspective of DeepL remains unaddressed. Cognitive load comes from the complex characteristics of academic journal writing. These characteristics include the use of the Academic Word List (AWL) and the frequent construction of lengthy passive sentences. Such writing qualities could lead to cognitive overload for Indonesian EFL students. Cognitive overload happens when such low practice cognitive rules are so frequently merged and are necessary to be memorized and cognitively recalled. Cognitive offloading happens (DeepL) here. By letting DeepL do the construction of the sentences, the students' cognitive load is alleviated. The space in the working memory, decongested, can be utilized for higher-order thinking (metacognition) such as assessment of evidence scope, coherence in writing, and tone adjustment to the respective journal. This indicates that DeepL did not make students "lazy thinkers"; they made students "think more strategically". By comparing DeepL and ChatGPT, Fitria (2023) stated that DeepL is more beneficial because students still have to provide the source text (input), which means they have to own the main ideas.

Pedagogical Model: "Write-Translate-Compare-Refine"

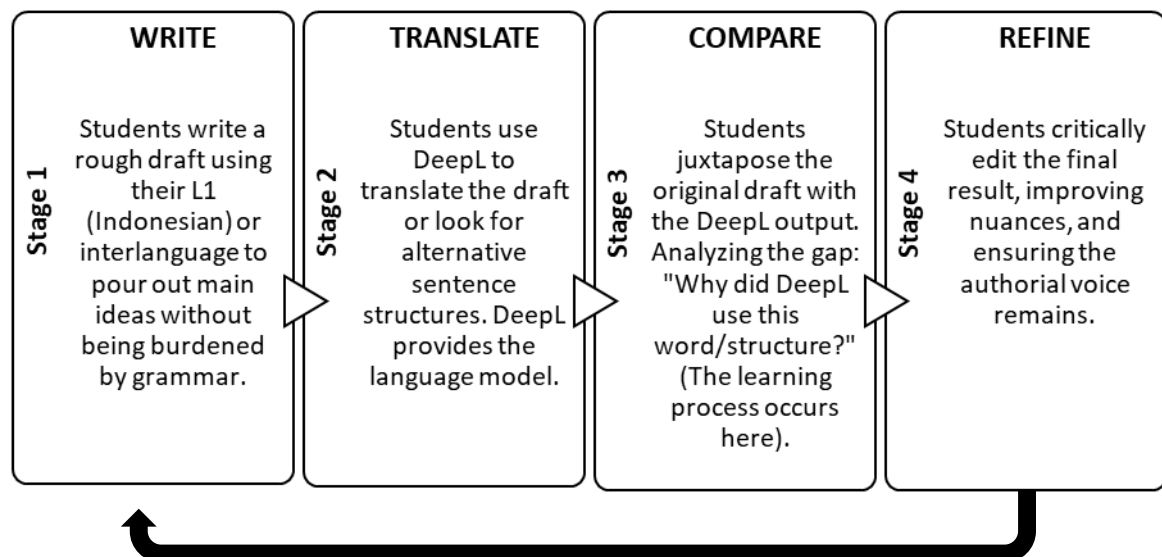
Drawing on a synthesis of prior studies (particularly Kirana et al., 2024; Klimova, 2025), this paper advances an operational framework for integrating DeepL into writing instruction that promotes genuine learning rather than simple reproduction. The proposed framework is structured as a four-stage cyclical process.

Table 2. The "Write-Translate-Compare-Refine" Scaffolding Model Stages

Stage	Student Activity	Role of DeepL (Artificial MKO)	Cognitive Goal (ZPD)
Write	Draft ideas in L1 or Interlanguage without worrying about grammar.	Inactive.	Reducing cognitive load (Focus on content).
Translate	Input the draft into DeepL to generate English sentences.	Provides immediate lexicogrammatical modeling and vocabulary options.	Assessing potential performance level.
Compare	Compare the original draft with DeepL output. Analyze differences.	Acts as a comparative benchmark (Standard vs. Learner language).	Noticing the gap & Metalinguistic awareness.
Refine	Edit the final text to ensure voice and context accuracy.	Used for final proofreading (checking specific phrases).	Internalization of knowledge (Fading support).

In the first stage (Write), learners must record their thoughts in either imperfect English (interlanguage) or Indonesian (L1) in order to preserve the richness of the ideas. For the second stage (Translate), the students themselves translate or improve on the drafts, using DeepL as an advanced language instrument. In the third stage (Compare), which is the most critical due to the learning that occurs within the ZPD, students must synchronize the original text with the translation produced by DeepL and identify contents that are missing (e.g., Why DeepL decided to use the word 'conduct' in place of 'do?'). This activity makes students aware of the use of language and structure (Sasaki et al., 2025). In the last stage, Refine, students mustn't take the outputs from DeepL as final since post-editing needs to be done to the outputs to improve the errors in the nuances, bias caused by the machine, and to ensure that the author's voice remains clear. Arnita et al., (2025) state that students who reach this stage have improved the quality of their scientific articles significantly.

Figure 2. The "Write-Translate-Compare-Refine" pedagogical integration model. This cyclical model emphasizes the comparison (Stage 3) and refining (Stage 4) phases to ensure active student cognitive engagement and prevent passive dependence on the machine translator



Ethical Challenges and Academic Integrity

The acceptance of DeepL as a scaffolding tool does not negate ethical risks. The line between scaffolding and plagiarism or academic dishonesty becomes blurred if unregulated. Polakova & Klimova (2023) emphasize the importance of transparency. Institutions need to establish that using AI for language polishing (proofreading/editing) is acceptable, but using AI to generate ideas is a violation. In the ZPD model, scaffolding is temporary (fading). This means the ultimate goal of using DeepL is for students to eventually no longer need it. If students consistently rely on DeepL without making any effort to internalize knowledge, then scaffolding has failed and become a dependency. Therefore, assessment in writing courses must evolve. Grading should not be based solely on the final product (clean text), but also on the process-evidence of revision, translation comparison logs, and student reflections on what they learned from DeepL corrections.

CONCLUSION AND SUGGESTION

The presence of DeepL in academic writing training has been examined in this paper and analyzed based on the principles of Vygotsky, concluding that the tool meets the criteria of pedagogical trustworthiness within a learner's Zone of Proximal Development. Theoretically, this study contributes to the field by expanding the traditional notion of the More Knowledgeable Other (MKO) to officially include non-human entities that provide real-time lexicogrammatical

assistance. By offering immediate linguistic modeling, DeepL effectively relieves extraneous cognitive overload, enabling students to navigate the complexities of academic writing and concentrate on formulating their arguments rather than struggling with lower-level syntax.

Pedagogically, the findings imply that the "anti-AI" prohibition approach should cease in favor of the active "Write-Translate-Compare" integration model, which ensures high-level cognitive interaction rather than superficial use. This shift requires incorporating Machine Translation Post-Editing (MTPE) techniques into the syllabus and reconstructing assessments to go beyond simple essay submissions. Instead, educators should oblige students to present portfolios that include original drafts, DeepL results, and a comprehensive analysis of changes, thereby cultivating critical literacy regarding machine biases and register errors.

Finally, suggestions for future research emphasize the need for the acquisition of longitudinal data to determine the extent to which DeepL affects actual language retention versus temporary performance ability. It would also be beneficial to investigate the specific academic productivity impacts resulting from the use of DeepL in its free versus paid (Pro) versions to understand the full scope of its utility in higher education.

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