

CHAPTER II

LITERATURE REVIEW

This chapter outlines the theoretical basis underlying the research. The discussion begins with Cognitive Load Theory (CLT) as the main theory in managing students' cognitive load. Next, it presents a review of writing skills and AI-Assisted Language Learning (AALL). These theories are used to support the use of structured material synthesized by Gemini AI in this study. This chapter concludes with previous studies, a conceptual framework, and research hypotheses.

A. Cognitive Load Theory (CLT)

Cognitive Load Theory (CLT) as presented by Plass, et al. (2010) forms the main theoretical basis of this study. This theory focuses on optimizing students' cognitive capacity so that the process of information processing and storage runs effectively. CLT is based on three core assumptions regarding human cognitive architecture that underlie the use of structured material synthesized by Gemini AI.

1. Limited Working Memory

Human working memory has a very limited capacity for processing new information (Plass, et al., 2010). When writing, students often feel overwhelmed because they have to manage both ideas and grammar at the same time. Gemini AI's structured material is designed to simplify these tasks so that they do not exceed the limits of students' working memory.

2. Unlimited Long-Term Memory

Long-term Memory has unlimited capacity to store schemas (knowledge patterns). The goal of writing instruction is to help students build schemas about how to compose coherent texts. If the learning material is well structured, information will be more easily transferred from working memory to long-term memory for permanent storage.

3. Schema Acquisition and Automation

Learning occurs through schema acquisition, where information is grouped into meaningful units. Through repeated exposure to structured material from Gemini AI, students are helped to reach the stage of automation. When writing patterns become automatic, the cognitive load is reduced, allowing students to write more fluently.

Plass et al. (2010) also detail three types of cognitive load that determine student learning success:

1. **Intrinsic Load:** The inherent difficulty of the material (grammar and text structure). Gemini AI material presents this difficulty gradually to make it easier to manage.
2. **Extraneous Load:** “Pointless” load resulting from poor instructional design. Gemini AI’s structured material minimizes this load by eliminating irrelevant information, allowing students to focus directly on the writing task.
3. **Germane Load:** Beneficial load for building schemas. With the reduction of extraneous load, students can devote all their mental energy to deeply understanding and mastering writing skills.

Overall, Cognitive Load Theory explains why the structured material synthesized by Gemini AI is highly relevant for improving writing skills. The alignment between systematic material and cognitive load management makes CLT a strong foundation that logically connects AI technology with improvements in students' language production abilities.

B. Writing Skill in English Language Teaching

The reason writing stands out as a highly sophisticated productive skill in English education is that it forces learners to combine cognitive, social, and linguistic skills all at once. According to Weigle (2002), this process goes far beyond mechanical execution; it is fundamentally an act of meaning-construction that demands conscious problem-solving. In the context of learning, mastery of this skill requires a deep understanding of the stages of the writing process and appropriate instructional support so that students are able to produce coherent texts.

1. The Nature of Writing Ability

Writing ability is essentially a dynamic interaction between language knowledge and an individual's strategic process of managing information. Cognitively, writing is a demanding task because writers must continuously plan, organize, and revise their ideas (Weigle, 2002). This view is in line with teaching methodologies that emphasize that writing should be seen as a process, in which students focus on the stages of idea development before producing the final product (Harmer, 2004).

2. Writing as a Social and Cognitive Activity

When students write, they are essentially engaging in a problem-solving task directed at a particular audience, a process that Weigle (2002) notes heavily increases their cognitive load as they balance vocabulary choices with social text expectations. This burden is particularly acute in EFL settings, where Hyland (2003) argues that learners require external scaffolding to navigate unfamiliar text structures. By providing structured, Gemini AI-synthesized materials, this research introduces that exact necessary support—functioning as a strategic scaffold that helps students manage text organization without losing track of their core ideas.

3. Descriptive Text in Writing Instruction

By providing structured, Gemini AI-synthesized materials, this research introduces that exact necessary support—functioning as a strategic scaffold that helps students manage text organization without losing track of their core ideas. In this study, descriptive text was selected as the writing genre because it is part of the senior high school curriculum and requires students to organize ideas, apply appropriate vocabulary, and construct grammatically accurate sentences. These characteristics make descriptive text suitable for examining students' writing performance and the potential contribution of AI-synthesized structured materials in writing instruction.

4. Components of Writing

To objectively measure writing ability, Weigle (2002) adopted an analytical scoring system that divides writing into five essential

components. These five components are interrelated and determine the coherence of a piece of writing:

- a. **Content:** Assesses the substance of the writing, including a clear thesis, the relevance of supporting details, and the depth of idea development.
- b. **Organization:** Focuses on the smooth flow of communication, the effectiveness of topic introduction, and the logical sequence of ideas that support the text structure.
- c. **Vocabulary:** Assesses students' ability to choose the right vocabulary, use appropriate idioms, and master word forms to convey specific meanings.
- d. **Language Use:** Related to the accuracy of grammatical construction in sentences, including the use of tenses, subject-verb agreement, and sentence complexity.
- e. **Mechanics:** Technical aspects that include mastery of spelling, punctuation, capitalization, and neatness of layout.

C. Writing Assessment

According to Sara Cushing Weigle (2002), writing assessment is a complex process that evaluates various dimensions of language ability. Writing performance cannot be measured through a single aspect because effective written communication involves the integration of ideas, organization, vocabulary, grammatical accuracy, and technical conventions.

In assessing writing ability, analytic scoring is widely used because it allows different components of writing to be evaluated separately. This approach evaluates actual writing performance by breaking it down into

specific criteria, thereby providing a much more detailed analysis than holistic assessment, which assigns only a single overall grade (Weigle, 2002). By using analytical assessment, teachers can easily identify specific areas where students' writing is still inadequate and focus improvement efforts on those areas.

This framework breaks down writing ability into several essential components for analysis, specifically content, organization, vocabulary, language use, and mechanics. Taken together, these core elements determine how clearly and effectively a piece of writing communicates its message. Evaluating these specific areas allows for a much more well-rounded and thorough measure of a student's actual writing proficiency.

D. Technology in Education

The rapid rise of digital technology has reshaped the landscape of modern education, fundamentally altering traditional classroom dynamics. By weaving technological tools into learning environments, institutions can now offer broader access to educational materials while fostering highly adaptable and interactive spaces. This shift is echoed by Bahrudin (2026), who notes that the digital era has triggered a foundational overhaul in how knowledge is shared, acquired, and managed. The development of information and communication technology (ICT) not only expands access to learning resources but also drives a paradigm shift from conventional learning toward more interactive, collaborative, and technology-based learning.

The rapid development of digital technology also demonstrates that educational transformation is part of a long historical process of disruption and

innovation. According to Bahrudin (2026), the evolution of education is marked by a series of constant disruptions. This shift began five millennia ago when the development of the written word allowed human knowledge to be documented outside the mind. Later, roughly six centuries ago, Gutenberg's printing press broke the monopoly on information, opening up access to learning that was once confined strictly within monastic walls. This perspective indicates that technological innovation has continuously influenced how knowledge is produced, accessed, and distributed in educational contexts.

Consequently, incorporating technology into instruction is no longer a choice but has turned into a vital element of contemporary education. The blend of digital platforms, virtual learning tools, and interactive media allows educators to create more dynamic and adaptable learning experiences for learners. In language learning, technology-based learning media can help students understand the structure and language features more effectively through interactive and digital learning activities.

E. Generative Artificial Intelligence

To understand its role in language acquisition, one must first outline the broader concept of Generative Artificial Intelligence (GenAI). This technology represents a specific branch of AI dedicated to producing novel, original content—including text, visuals, sound, and code—by learning from extensive datasets. While conventional AI tools are built to analyze or categorize pre-existing data, GenAI leverages Large Language Models (LLMs) to construct entirely new, human-like responses (Koraishi, 2023).

The core mechanism of AI-generated content lies in its ability to process massive datasets and understand the nuances of human language. In the context of education, GenAI tools like Gemini or ChatGPT operate through several key characteristics:

1. Natural Language Processing (NLP): This allows the AI to interpret complex human instructions (prompts) and respond in a way that is grammatically correct and contextually relevant.
2. Generative Capacity: The AI does not simply “copy and paste” information. Instead, it predicts the next most likely word or sequence to create a unique narrative or explanation tailored to the user’s specific request (Styati et al., 2026).
3. Adaptability and Personalization: One of the most significant features of AI-generated content is its ability to adjust the complexity of the output. For instance, it can rewrite a difficult scientific text into a simple story for high school students, making it a versatile tool for creating differentiated learning materials.

However, the use of AI-generated content also presents challenges related to "hallucinations" (the creation of false information) and ethical considerations such as academic integrity. Therefore, although GenAI offers immense potential for optimizing educational workflows, its outputs require critical evaluation and human oversight to ensure their accuracy and pedagogical value (Koraishi, 2023).

F. AI-Assisted Language Learning

By establishing smart learning environments, Artificial Intelligence-Assisted Language Learning acts as a transformative driver that significantly speeds up customized language acquisition. Rather than functioning as a mere supplementary tool, this technology provides a dynamic framework that fine-tunes instructional pathways to meet the distinct requirements of individual learners (Dou et al., 2025).

1. The Role of Artificial Intelligence as a Cognitive Tool

To optimize student learning outcomes, artificial intelligence in educational settings is often categorized into various domains, with personalized tutoring and adaptive learning systems leading the way (Wang et al., 2024). When applied to productive domains such as writing, AI serves as a practical cognitive asset that offers tailored feedback and enhances vocabulary growth. This technological intervention is crucial because, as Lai (2025) demonstrates, it substantially reduces the cognitive load students face when managing multiple complex linguistic elements simultaneously. Once this mental strain is alleviated, learners are free to direct their energy toward deepening their ideas and constructing arguments effectively.

2. Personalization and Learning Autonomy

One of the key advantages of integrating artificial intelligence is its ability to facilitate highly personalized learning. The system recommends learning materials and pathways tailored to each individual's cognitive style, interests, and skill level (Dou et al., 2025). Through interaction with

artificial intelligence agents, students not only receive technical assistance, but also experience increased confidence and resilience when facing difficult writing tasks (Lai, 2025). This allows students to build their language knowledge systems independently and effectively.

3. Synergy of Artificial Intelligence in Language Production

The integration of artificial intelligence in language learning provides strategic support at the writing stage and improves linguistic accuracy. Artificial intelligence helps students expand their vocabulary and ensures grammatical accuracy through dynamic scaffolding mechanisms (Lai, 2025). Overall, the use of this technology has been reported to significantly improve academic performance while helping to reduce student learning anxiety (Wang et al., 2024). Thus, artificial intelligence-supported language learning bridges the gap between students' initial competency limitations and higher writing proficiency targets.

G. Gemini AI-Synthesized Structured Materials in Teaching Writing

1. The Role of Gemini AI in Synthesizing Writing Materials

Gemini AI is a multimodal large language model (LLM) developed by Google DeepMind with the capability to process and synthesize information from multiple sources and formats. In the context of English Language Teaching (ELT), Gemini AI is not positioned as a general-purpose assistant, but is specifically utilized as a tool for generating and synthesizing structured writing materials.

In this study, the function of Gemini AI is limited to the material development stage, where it transforms unstructured and scattered

information into organized and pedagogically meaningful learning resources. It does not function as a feedback provider or evaluation tool. This limitation is essential to maintain alignment with the research focus, which examines the effect of AI-synthesized structured materials on students' writing skills.

Through its multimodal capabilities and integration with various information sources, Gemini AI enables the creation of content that is not only linguistically accurate but also contextually meaningful. As a result, the generated content can help students develop their writing skills through better feedback and structured guidance.

2. Process of Material Synthesis through Prompt Engineering

Creating structured content using Gemini AI relies heavily on prompt engineering, which refers to the process of designing clear, specific, and focused instructions to guide the AI's output.

In this study, the material synthesis process was conducted using several structured instruction strategies. First, a context-based instruction strategy was implemented by assigning Gemini AI to play specific instructional roles, such as that of an English as a Foreign Language (EFL) materials developer. This enabled the AI to generate outputs aligned with pedagogical needs and appropriate for students' proficiency levels (Koraishi, 2023).

Second, this process follows an iterative approach, in which content is developed in stages. It begins with outlining the topic, continues with identifying relevant vocabulary, and concludes with drafting example

sentences or short texts. This step-by-step development ensures that the material is organized logically and structured systematically.

Third, scaffolding prompts are used to generate supporting elements such as opening sentences, transitional phrases, and structured expressions. These elements serve as a framework that guides students in organizing their writing more effectively. Additionally, Gemini AI leverages its ability to integrate information from various sources to ensure that the generated content is rich and contextually relevant.

3. Characteristics and Pedagogical Functions of Synthesized Materials

The materials generated by Gemini AI in this study is adaptive, structured, and supportive, and directly contributes to the development of students' writing skills.

First, when it comes to adaptive content synthesis, Gemini AI is capable of filtering through large amounts of linguistic information and transforming it into concise, focused components. Instead of presenting raw or unstructured text, this AI generates structured output, such as example sentences, lists of topic-related vocabulary, and organized phrases. This makes the material more flexible and tailored to students' specific needs compared to conventional textbooks.

Second, these materials serve as a form of digital guidance. The content provides clear examples, vocabulary usage guides, and structured patterns that help students get started and develop their writing. With this support, students are not left to generate ideas and language entirely on their own, but are guided through a structured framework. This framework

helps bridge the gap between students' current abilities and the expected writing outcomes, while maintaining their active role in the learning process (Lai, 2025).

Third, the use of structured instructional materials plays a crucial role in reducing students' cognitive load. Writing requires students to manage various aspects simultaneously, including idea generation, organization, and language use. By breaking these aspects down into smaller, more manageable parts, structured instructional materials allow students to focus on one aspect at a time. As a result, students can allocate their cognitive resources more efficiently and avoid feeling overwhelmed during the writing process.

H. Previous Studies

Previous research on language learning with the help of artificial intelligence (AI) shows consistent evidence that AI tools contribute positively to students' vocabulary development and writing skills. Waziana et al. (2024) investigated the application of AI chatbots like ChatGPT and Gemini in English as a foreign language (EFL) writing, with their results indicating notable advancements in lexical diversity, vocabulary richness, and a decrease in word repetition within written compositions. Students reported that AI chatbots provided diverse expressions and clearer sentence structures, although the study emphasized that AI-generated suggestions were sometimes insensitive to context, thus still requiring teacher guidance to ensure contextual accuracy.

Furthermore, Triasmoro and Rakhmawati (2025) carried out a quantitative study utilizing a one-group pre-experimental method involving pre- and post-testing to evaluate how effectively Gemini AI works in instructing second-semester learners to compose chronological essays. Their data revealed a notable rise in post-test performance, where the mean score jumped from 66.50 up to 85.00. This outcome demonstrates that Gemini AI serves well in assisting students to elevate their writing proficiency—particularly regarding grammatical precision, sentence formation, lexical choice, and textual flow—while highlighting the necessity of a well-proportioned integration of AI tools to foster self-reliance and critical analysis.

Styati et al. (2026) conducted a research and development study on artificial intelligence (AI)-based academic writing instructional materials for EFL students in Indonesia. Using the ADDIE model, this study designed instructional materials that integrate AI features to assist students with grammar, vocabulary, and writing coherence. The results showed that these AI-based teaching materials were highly effective in significantly improving students' academic writing skills and have been validated by experts as a practical learning tool.

Another study conducted by Koraishi (2023) explores the use of ChatGPT as an innovative tool for EFL teachers to optimize the development of instructional materials and learning assessments. This article highlights how Large Language Models (LLMs) can be used in versatile ways to create personalized instructional materials that align with the varied requirements of learners in the globalization era. Koraishi emphasizes that integrating

ChatGPT into the English language education process allows for greater efficiency in designing language tasks, yet still requires critical understanding from teachers so that the technology can be appropriately adapted to the existing pedagogical context.

From a qualitative perspective, Salisa (2025) investigates the advantages and constraints of utilizing Gemini AI to assist English writing skills through a case study of final-year students. The results show that Gemini AI helps students generate ideas, construct paragraphs logically, enrich their vocabulary, and reduce grammatical and mechanical errors throughout the writing process, from planning to publication. However, this study identifies several limitations, such as the risk of spreading misinformation and a lack of support for deep critical thinking, leading to the conclusion that Gemini AI should be used wisely as a complementary tool, not as a substitute for human judgment.

A separate investigation by Baskara (2025) analyzed the instructional utility of ChatGPT and Google Gemini among tertiary students acquiring English as a foreign language (EFL), showing that both models enhance active learning through simulated conversations. Gemini was specifically noted for its superior performance in multilingual tasks, while ChatGPT excelled at generating contextual conversation exercises. However, the study also identified limitations such as rigid conversation patterns and occasional linguistic complexity, emphasizing that the integration of AI tools must be tailored to learners' proficiency levels.

In addition, Hutaurok et al. (2025) found that artificial intelligence (AI)-based chatbots effectively improve students' vocabulary mastery by providing instant feedback, guidance, and opportunities for self-directed learning. Students feel more enthusiastic and motivated thanks to the interactive features and ease of access to these tools, particularly when it comes to understanding the meanings of words in practical tasks such as writing journals and composing paragraphs. Overall, these studies show that although Gemini AI greatly supports writing development, there are still gaps because few studies specifically examine the use of structured material synthesized by Gemini AI to improve students' writing skills within a controlled pedagogical framework.

Overall, the above studies show that artificial intelligence (AI) tools, particularly Gemini AI, consistently support vocabulary development, motivation, and linguistic accuracy in writing. However, most of these studies still have limitations, namely: (1) a focus on the broad and unguided utilization of AI by learners (student-based), (2) a reliance on free interaction that risks producing contextually inaccurate content, and (3) the lack of targeted exploration into instructional materials that have been synthesized and structured in advance by researchers using AI. Consequently, this study seeks to address this gap by focusing on the use of Structured Materials Synthesized by Gemini AI. This approach aims to offer a more systematic framework to minimize students' cognitive barriers and ensure that the materials provided are tailored to the pedagogical needs of the classroom in a measurable way.