



EFFECTS OF STRUCTURED DEEPSEEK-ASSISTED LEARNING ON HIGH SCHOOL STUDENTS' READING COMPREHENSION

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abstract

This study investigates the effectiveness of Structured AI-Assisted Learning using DeepSeek in enhancing high school students' English reading comprehension. It specifically examines whether integrating artificial intelligence within a systematically guided learning framework can produce meaningful improvements in students' ability to comprehend English narrative texts. A quantitative approach with a quasi-experimental design was employed. The participants were tenth-grade students from a senior high school in Cirebon, West Java. The experimental group consisted of 31 students, while the control group included 35 students. Students in the experimental group received reading instruction through Structured AI-Assisted Learning using DeepSeek, whereas those in the control group were taught using conventional reading instruction. Data were collected using a reading comprehension test comprising 20 multiple-choice items based on narrative texts. Both groups completed pre-tests and post-tests, and the resulting data were statistically analyzed using SPSS version 29 to determine differences in students' reading comprehension performance. The results revealed a statistically significant improvement in reading comprehension among students exposed to Structured AI-Assisted Learning using DeepSeek. Among the assessed reading indicators, the most substantial improvement occurred in students' comprehension of text content. These findings demonstrate that AI integration can contribute positively to reading comprehension when incorporated through structured instructional procedures. The study further emphasizes the importance of teacher-guided and pedagogically structured AI use to promote active student engagement while minimizing passive reliance on AI-generated responses during English reading activities.

INTRODUCTION

Reading comprehension is an essential skill in English language learning because it enables students to understand, interpret, and construct meaning from written texts. In the context of English as a Foreign Language (EFL), reading also provides learners with access to vocabulary, grammar, information, and academic knowledge. In Indonesia, English is taught as a foreign language and plays an important role in preparing students to participate in academic and global communication (Fitriati and Rata 2020; Yusra et al. 2022; Zein et al. 2020). However, many Indonesian students still face difficulties in comprehending English texts. These difficulties are often related to limited vocabulary, low motivation, limited background knowledge, and the dominance of conventional teacher-centered reading instruction (Nanda and Azmy 2020). In

such conditions, students may become passive readers who depend heavily on teachers' explanations rather than actively constructing meaning from texts.

The problem of reading comprehension is also reflected in the broader literacy condition of Indonesian students. The Programme for International Student Assessment shows that Indonesia's reading performance remains below the global average, indicating that reading comprehension is still a major challenge in the Indonesian educational context (OECD 2023). Previous studies also show that Indonesian students experience difficulties in understanding, interpreting, and evaluating written texts (Bilad et al. 2024; Ismawati et al. 2023). In classroom practices, students' reading difficulties can be seen in their limited ability to understand text content, identify main ideas, make inferences, and interpret information across paragraphs. Therefore, reading instruction needs to provide more interactive, adaptive, and supportive learning experiences that can help students engage with texts more actively.

The development of educational technology has created new opportunities for supporting English learning, including reading comprehension. Artificial intelligence (AI)-assisted learning tools can provide students with adaptive feedback, personalized support, and interactive learning environments (Masri et al. 2023; Lan 2024). These features may help students clarify difficult vocabulary, check their understanding, and receive guidance while reading English texts. Nevertheless, the use of AI in learning does not automatically improve students' comprehension. Without clear instructional guidance, AI tools may encourage passive learning behaviors, such as relying on AI-generated summaries or answers instead of actively engaging with the text. Therefore, the pedagogical use of AI requires careful consideration to ensure that it supports students' cognitive engagement rather than replacing their thinking process. This suggests that the effectiveness of AI-assisted learning depends not only on the technology itself but also on how students interact with it during the learning process.

One AI tool that has potential to support reading comprehension is DeepSeek. DeepSeek is an AI-based conversational system that can provide explanations, answer questions, and offer contextual information related to texts. Through its interactive features, students can ask questions and receive immediate responses while working with reading materials. However, in this study, DeepSeek is not used as a tool for giving direct answers. Instead, it is integrated into a structured learning protocol that includes guided prompts, controlled AI interaction, and teacher supervision. Structured AI-Assisted Learning refers to the integration of AI into learning through planned, guided, and pedagogically controlled procedures, including guided prompts, adaptive feedback, teacher monitoring, and controlled interaction. In this way, DeepSeek functions as a learning scaffold that supports students' comprehension process while still encouraging active and independent learning.

Previous studies have discussed the benefits of AI-assisted learning in language education, including its potential to increase engagement, provide personalized support, and improve learning outcomes. Studies on AI-assisted language learning suggest that AI can support language learning efficiency, engagement, and skill development (Akbarani 2023; Feng 2025; Kim and Sim 2024; Song and Song 2023). More specifically, studies on AI chatbots show that they can facilitate interactive learning and support reading comprehension by helping learners engage with texts and understand information more effectively (Andoko et al. 2025; Dinh et al. 2025; Pandey et al. 2024). However, many previous studies mainly focus on whether AI improves students' performance, while limited attention has been given to how students should interact with AI during reading activities. This issue is important because unstructured AI use may lead to passive dependence on AI-generated responses.

In addition, research on AI-assisted reading comprehension has mostly been conducted in higher education contexts, while studies involving high school EFL learners remain limited.

High school students may have different learning needs from university students because they are still developing vocabulary knowledge, reading strategies, and learning autonomy. Therefore, findings from higher education contexts cannot be directly generalized to secondary-level classrooms. This creates a research gap regarding the use of structured AI guidance in high school EFL reading instruction. In this context, Structured AI-Assisted Learning using DeepSeek may offer an alternative approach for supporting students' reading comprehension through guided interaction and teacher supervision.

Reading comprehension in this study is theoretically viewed as an active process of meaning construction. Reading is not merely the recognition of written symbols, but a complex cognitive process that involves decoding, interpretation, and interaction between the reader and the text. Grabe and Stoller conceptualize reading as a meaning-building process in which readers actively construct understanding by integrating linguistic input with prior knowledge (Grabe and Stoller 2020). Similarly, Rumelhart explains that reading occurs through continuous interaction between textual information and the reader's background knowledge, expectations, and cognitive strategies (Rumelhart 2013). Therefore, effective reading comprehension requires students to process information actively, make inferences, and construct meaning rather than passively receive information.

However, AI-assisted learning should be implemented through structured guidance to ensure that it supports students' thinking process rather than replacing it. Structured AI-assisted learning refers to the integration of artificial intelligence into learning through planned, guided, and pedagogically controlled procedures. In reading comprehension, this approach may involve guided prompts, adaptive feedback, teacher monitoring, and controlled interaction to help students understand texts more effectively. Previous studies suggest that AI can support reading comprehension when it is embedded in scaffolded learning environments and used to guide students' learning processes rather than simply provide answers (Fan 2025; Rad 2025). Therefore, in this study, DeepSeek is positioned as a scaffolding tool that assists students in clarification, verification, and feedback while students remain responsible for constructing their own understanding of the text.

Based on this gap, the present study investigates the effect of Structured AI-Assisted Learning using DeepSeek on high school students' reading comprehension. Specifically, this study aims to determine whether there is a statistically significant difference between students' pre-test and post-test reading comprehension scores after the implementation of Structured AI-Assisted Learning using DeepSeek. It also aims to identify which reading comprehension indicator shows the greatest improvement among students who learn through this approach. By examining the use of DeepSeek through structured guidance, this study is expected to provide empirical evidence on how AI can be integrated responsibly and effectively into EFL reading instruction.

METHOD

This study employed a quantitative approach with a quasi-experimental design to examine the effect of Structured AI-Assisted Learning using DeepSeek on students' reading comprehension. The design used in this study was a pre-test and post-test nonequivalent group design because the participants were selected from existing classes rather than through random assignment. This design was considered appropriate for educational research because classroom groups had already been formed before the study was conducted (Fraenkel et al. 2023).

The study was conducted at a senior high school in Cirebon, West Java, Indonesia. The participants were tenth-grade students consisting of 31 students in the experimental group and 35 students in the control group. The experimental group was taught using Structured AI-

Assisted Learning with DeepSeek, while the control group received conventional reading instruction. Both groups received the same reading materials and learning objectives, but the experimental group used DeepSeek through structured guidance, controlled prompts, and teacher supervision. The treatment was conducted in three meetings, with each meeting lasting 120 minutes.

The research instrument was a reading comprehension test consisting of 20 multiple-choice questions based on narrative texts. The test was administered as a pre-test and post-test to measure students' reading comprehension achievement before and after the treatment. The collected data were analyzed using SPSS version 29. Descriptive statistics were used to describe students' scores, while a normality test was conducted to determine the data distribution. Since the data were not normally distributed, the Wilcoxon Signed Rank Test was used to examine the significance of students' improvement. In addition, an indicator-based analysis was conducted to identify which reading comprehension indicator showed the greatest improvement.

FINDINGS AND DISCUSSION

Statistical Difference Between Pre-test and Post-test Scores in the Experimental Group

This section presents the statistical analysis conducted to answer the first research question, which examined whether there was a statistically significant difference between students' pre-test and post-test reading comprehension scores after the implementation of Structured AI-Assisted Learning using DeepSeek. The analysis includes descriptive statistics, normality test, and Wilcoxon Signed Rank Test.

Descriptive Statistics of Pre-test and Post-test Scores

Table 1. Descriptive Statistics of Pre-test and Post-test Scores

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Pre-test Experimental Group	31	20	100	2280	73.55	23.423
Post-test Experimental Group	31	30	100	2770	89.35	17.830
Pre-test Control Group	35	30	100	2650	75.71	18.635
Post-test Control Group	35	35	100	3245	92.71	13.951

The findings showed that students' reading comprehension improved after the implementation of Structured AI-Assisted Learning using DeepSeek. In the experimental group, the mean score increased from 73.55 in the pre-test to 89.35 in the post-test. The standard deviation also decreased from 23.423 to 17.830, indicating that students' scores became more consistent after the treatment. The control group also showed improvement, with the mean score increasing from 75.71 to 92.71. However, the main statistical analysis in this study focused on the experimental group to determine whether the improvement after using Structured AI-Assisted Learning with DeepSeek was statistically significant.

Normality Test

Before conducting the hypothesis test, the normality test was carried out using the Shapiro–Wilk test because the number of participants in each group was fewer than 50 students.

Table 2. The Results of the Normality Test

Class	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test (Control Group)	.121	35	.200	.935	35	.041
Post-test (Control Group)	.337	35	<.001	.537	35	<.001
Pre-test (Experimental Group)	.178	31	.013	.898	31	.006
Post-test (Experimental Group)	.305	31	<.001	.669	31	<.001

The results showed that the significance values of all data in the Shapiro–Wilk test were lower than 0.05. The significance values for the pre-test and post-test of the control group were 0.041 and <0.001 respectively. Meanwhile, the significance values for the pre-test and post-test of the experimental group were 0.006 and <0.001 respectively. Therefore, the data were not normally distributed, and the Wilcoxon Signed Rank Test was used as a non-parametric test to examine the difference between the pre-test and post-test scores. This procedure was appropriate because the Wilcoxon Signed Rank Test is used to analyze paired data that do not meet the assumption of normality (Field 2024).

Wilcoxon Signed Rank Test

The Wilcoxon Signed Rank Test was conducted to determine whether there was a significant difference between the pre-test and post-test scores within each group. Since the data were not normally distributed, this non-parametric test was used as an alternative to the paired sample t-test. The level of significance used in this study was 0.05.

Table 3. The Results of The *Wilcoxon Signed Rank Test*

		N	Mean Rank	Sum of Ranks
Post-test – Pre-test (Experimental Group)	Negative Ranks	3 ^a	5.67	17.00
	Positive Ranks	24 ^b	15.04	361.00
	Ties	4 ^c		
	Total	31		

a. Posttest < Pretest

b. Posttest > Pretest

c. Posttest = Pretest

The Wilcoxon Signed Rank Test showed a statistically significant difference between students' pre-test and post-test scores in the experimental group. The result showed that 24 students obtained higher post-test scores than their pre-test scores, while 3 students obtained lower scores and 4 students had the same scores.

Table 4. The Results of The *Statistics Test*

Test Statistics ^a

	Post-test – Pre-test (Experimental Group)
Z	-4.148 ^b
Asymp. Sig. (2-tailed)	<.001
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks.	

The Asymp. Sig. (2-tailed) value was <0.001, which was lower than the significance level of 0.05. This result indicates that Structured AI-Assisted Learning using DeepSeek significantly improved students' reading comprehension achievement.

Reading Comprehension Indicators Analysis

The analysis was based on four reading comprehension indicators adapted from Fikriyah et al. (2021), namely identifying main ideas, understanding explicit information, drawing inferences, and comprehending text content. The analysis was conducted by grouping test items based on each indicator and comparing the mean scores of the pre-test and post-test results.

Table 5. Reading Comprehension Indicators

Reading Comprehension Indicator	Pre-test Mean	Post-test Mean	Improvement
Identifying Main Ideas	3.3	4.2	0.9
Understanding Explicit Information	4.3	4.6	0.3
Drawing Inferences	3.8	4.6	0.8
Comprehending Text Content	2.5	4.6	2.1

The indicator analysis also showed that all reading comprehension indicators improved after the implementation of Structured AI-Assisted Learning using DeepSeek. The improvement was found in identifying main ideas, understanding explicit information, drawing inferences, and comprehending text content. Among these indicators, the greatest improvement occurred in comprehending text content, which increased by 2.1 points from the pre-test to the post-test. This finding suggests that the use of DeepSeek through structured guidance particularly helped students understand the overall meaning and content of reading texts.

The improvement may be related to the role of DeepSeek as a scaffolding tool in reading activities. During the treatment, students used DeepSeek through guided prompts, controlled interaction, and teacher supervision. They were required to write their own interpretation before using AI assistance and were not allowed to request direct answers or full summaries. This procedure encouraged students to clarify vocabulary, verify interpretation, and monitor their understanding while still engaging actively with the text. Therefore, DeepSeek did not replace students' thinking process but supported it through structured interaction.

These findings are in line with previous studies showing that AI-assisted learning can support reading comprehension when students interact with AI tools actively and purposefully. AI tools can provide immediate feedback, contextual vocabulary support, and opportunities for

clarification during reading activities (Andoko et al. 2025; Dinh et al. 2025; Pandey et al. 2024). However, the findings also emphasize that AI use should be guided by clear pedagogical procedures. Without structured guidance, students may become dependent on AI-generated responses. Therefore, the effectiveness of AI-assisted reading instruction depends not only on the technology itself but also on how the teacher structures students' interaction with the AI tool.

The findings imply that Structured AI-Assisted Learning using DeepSeek can be considered an alternative instructional strategy for supporting reading comprehension in EFL classrooms. For teachers, DeepSeek may be integrated into reading activities through controlled prompts, clear learning rules, and teacher supervision so that students use AI for clarification and verification rather than for obtaining direct answers. For students, this approach encourages more active engagement with texts because they are required to construct their own understanding before using AI assistance. Therefore, the use of DeepSeek as a structured scaffolding tool can support students' reading comprehension while promoting more independent and responsible learning.

CONCLUSION

Based on the findings, this study concludes that Structured AI-Assisted Learning using DeepSeek contributed positively to the improvement of high school students' reading comprehension, as shown by the statistically significant difference between students' pre-test and post-test scores in the experimental group. The indicator analysis also showed that all reading comprehension indicators improved, with the greatest improvement found in comprehending text content, indicating that the intervention particularly helped students understand the overall meaning and information in reading texts. However, this study was limited by its relatively small sample size, the use of one educational setting, and the short duration of the intervention, which may affect the generalizability of the findings. Therefore, teachers are encouraged to integrate AI tools such as DeepSeek through clear guidance, controlled prompts, and teacher supervision, while future researchers are recommended to conduct studies with larger samples, longer treatment periods, and different text genres to obtain broader and more comprehensive findings.

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