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The Impact of Deep Learning-Based Chatbot Intervention on Students' Cognitive Load and Narrative Writing Literacy in Indonesian Language Learning at SD 030 Bagan Jaya

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ABSTRACT

Objective: This study aims to analyze the effect of a deep learning–based chatbot intervention on narrative writing literacy and cognitive load among elementary school students. It specifically examines how chatbot-assisted learning can enhance student engagement in the writing process, support critical thinking development, and reduce cognitive and affective barriers during learning. **Research Method:** This study employed a quasi-experimental design using a Pretest–Posttest Control Group approach. The sample consisted of 40 fourth-grade students from SD 030 Bagan Jaya who were divided into an experimental group and a control group. The experimental group received a deep learning–based chatbot intervention, while the control group received conventional writing instruction. Data were collected through narrative writing literacy tests and a cognitive load assessment rubric. Data analysis was conducted using an independent t-test to determine the effect of the intervention on both variables. **Research Findings:** The findings revealed that the experimental group showed a significant improvement in narrative writing literacy and a reduction in cognitive load compared to the control group. Posttest scores indicated higher mean values and lower standard deviations, suggesting more consistent student performance. The chatbot functioned as a digital tutor by providing adaptive scaffolding, real-time feedback, and structured guidance that supported idea generation, text organization, and revision skills. The intervention also increased student motivation and engagement during the learning process. **Novelty:** This study highlights that deep learning–based chatbots are effective not only in secondary education but also at the elementary level, offering an innovative pedagogical strategy that simultaneously supports literacy development, critical thinking, and student motivation.

INTRODUCTION

Narrative writing is an essential competence in the Indonesian Language curriculum at the elementary school level, as it forms the foundation for students' comprehensive literacy development. Narrative writing activities not only train students to express ideas and experiences in written form but also enhance critical thinking, creativity, imagination, and integrated language skills. Romansyah et al. (2025) emphasize that writing proficiency involves vocabulary mastery, language structure, and higher-order cognitive skills. Graham (2021) highlight that evidence-based writing practice coupled with formative feedback is crucial for improving writing quality. Khomsah et al. (2024) affirm that strong writing literacy builds students' academic and social foundations holistically.

In practice, narrative writing instruction still faces significant challenges. Many students struggle to generate story ideas, select appropriate vocabulary, and organize coherent plotlines. Saddhono and Slamet (2020) note that elementary writing instruction often focuses on the final product, resulting in insufficient guidance throughout the

writing process. Sabila et al. (2024) add that teachers' strategies to develop students' writing skills remain limited, reducing motivation. Nurmalina and Pebriana (2025) show that interactive digital media, such as AI chatbots, can increase student engagement, minimize cognitive load, and enhance the quality of the narrative writing process.

Difficulty in narrative writing is also influenced by high cognitive load. Romansyah et al. (2025) and Paas and Merriënboer (2021) explain that cognitive load occurs when mental resources in working memory exceed capacity, making learning less effective. In writing, students must simultaneously consider story ideas, text structure, language, and spelling, increasing task complexity. Relmasira (2025) emphasizes that technology-based interventions, such as deep learning, can provide adaptive guidance, reduce cognitive load, and allow students to focus on creative idea development, thereby significantly improving writing literacy.

Cognitive load theory categorizes mental load into intrinsic, extraneous, and germane types (Mayer, 2021). Intrinsic load relates to content complexity, extraneous load is influenced by presentation and instructional strategies, and germane load involves efforts to construct knowledge schemas. In narrative writing, extraneous load often increases due to monotonous methods and limited instructional media. Safar (2025) highlights that chatbots can minimize extraneous load by providing direct, contextual guidance. Rissi and Sinaga (2025) add that such technology supports the development of students' knowledge schemas, enhances writing comprehension, and optimizes germane load.

Digital technology enables a more adaptive, student-centered transformation of learning. Wang (2025) asserts that AI integration in education improves learning effectiveness and personalization. The OECD (2022) stresses that appropriate digital technologies help teachers tailor learning experiences to student needs. Labade (2023) demonstrates that AI chatbots support adaptive interaction and real-time feedback, allowing students to learn at their own pace. Janah et al. (2025) further confirm that chatbots enhance student motivation and engagement. Consequently, AI interventions provide writing guidance whenever needed, reduce cognitive pressure, and improve narrative literacy quality.

Deep learning-based chatbots function as virtual tutors interacting through natural language and providing contextual responses (Holmes et al. 2022). In narrative writing, chatbots serve as digital scaffolding that assists students in structuring text frameworks, generating story ideas, and providing real-time language improvement suggestions. Kohnke et al. (2023) report that chatbot use significantly enhances student engagement and writing quality. Romansyah et al. (2025) emphasize that digital assistance enables students to process creative ideas without being burdened by technical aspects. This intervention reduces cognitive pressure while allowing teachers to focus on students requiring additional guidance.

The use of deep learning-based chatbots contributes to improving students' writing literacy. Graham (2021) underline the importance of formative feedback in enhancing writing quality. Nurmalina and Pebriana (2025) show that chatbots allow students to revise their work independently, reflectively, and consistently. Sabila, Hanniyah Farhah, and Prasetyo (2024) note that digital strategies boost creativity and logical idea organization. Relmasira (2025) highlights that AI assists students in processing information and channeling ideas into structured writing, aligning with elementary students' need for adaptive guidance.

Although AI applications in education are growing, empirical studies on the impact of deep learning-based chatbots on cognitive load and narrative writing literacy in elementary schools remain limited. Existing studies often focus on secondary education, reading, or foreign languages (Romansyah et al., 2025) . Safar (2025) emphasizes that chatbots enhance writing literacy through personalized interaction and real-time guidance. Wang (2024) adds that AI integration simplifies managing complex writing processes, enabling students to express creative ideas without technical burdens. Janah et al. (2025) note that positive student perceptions of AI improve motivation and active engagement.

This study emphasizes the importance of deep learning-based chatbot interventions as a solution for narrative writing instruction in elementary schools. Romansyah et al. (2025) note that AI allows students to focus on developing creative ideas and text structure without technical distractions. Nurmalina and Pebriana (2025) highlight that chatbots provide continuous, personalized feedback, enhancing writing skills while reducing cognitive load. Graham and Harris (2018) stress that evidence-based practices remain critical for writing quality. Thus, using chatbots supports teachers in implementing adaptive, innovative, and student-centered narrative writing instruction.

This study aims to analyze the impact of deep learning-based chatbot interventions on cognitive load and narrative writing literacy among fourth-grade students at SD 030 Bagan Jaya. The findings are expected to provide theoretical contributions to technology-based writing instruction research and practical guidance for teachers to implement innovative and effective strategies. AI integration in learning can optimize the writing process, reduce cognitive load, and sustainably enhance students' literacy skills, positioning deep learning-based chatbots as a significant innovation in elementary education.

RESEARCH METHOD

Research Design

This study employed a quasi-experimental design with a Pretest–Posttest Control Group approach. This design was selected because full randomization of participants was not feasible, yet it still allowed for a comparison of the effectiveness of deep learning-based chatbot interventions on students' cognitive load and narrative writing literacy compared to conventional instruction. In this design, both groups received a pretest before the intervention and a posttest after the intervention, enabling a comparative analysis of students' learning outcomes.

Table 1. Research Design

Group	Pretest	Intervention	Posttest
Experimental	O1	Deep Learning Chatbot	O2
Control	O3	Conventional Method	O4

Note:
O1, O3 = Pretest (initial assessment before intervention)
O2, O4 = Posttest (final assessment after intervention)

Population and Sample

The population of this study comprised all fourth-grade students at SD 030 Bagan Jaya in the 2025/2026 academic year. The sample was selected using purposive

sampling based on class representativeness and students' willingness to participate. A total of 40 students were involved and divided into two groups:

a. Experimental group: 20 students receiving narrative writing instruction with a deep learning-based chatbot intervention.
b. Control group: 20 students receiving conventional narrative writing instruction.

Research Variables

a. Independent variable:
   Instructional intervention using a deep learning-based chatbot.
b. Dependent variables:
   1) Students' cognitive load during narrative writing instruction.
   2) Students' narrative writing literacy.

Research Instruments

The research instruments consisted of two components:

a. Narrative Writing Literacy Test
   1) Comprising 5 essay questions, each designed to assess different aspects of students' narrative writing skills, ensuring alignment with the intended constructs of creativity, coherence, and linguistic accuracy:
      a) Question 1: Orientation Construction – Students were asked to write the opening of a story, introducing characters, setting, and situation. This item measured the ability to establish a clear narrative context.
      b) Question 2: Complication Development – Students described a problem or conflict in the story, assessing their ability to develop a coherent plot with logical sequencing.
      c) Question 3: Resolution Crafting – Students wrote the ending of a story, evaluating their skills in providing a satisfying conclusion and linking it to prior events.
      d) Question 4: Vocabulary and Language Accuracy – Students were prompted to rewrite a short narrative with improved vocabulary, grammar, and sentence structure. This item measured linguistic precision and expressive language use.
      e) Question 5: Creativity and Idea Expansion – Students were asked to continue a partially completed story with imaginative ideas, assessing originality, idea elaboration, and narrative flexibility.
   2) Validity and reliability were tested through a pilot study with 10 students from another class. The reliability coefficient (Cronbach's alpha) = 0.84, indicating high internal consistency.
b. Cognitive Load and Writing Skills Rubric
   Students' writing literacy was assessed using a rubric measuring:
   1) Narrative structure and completeness.
   2) Vocabulary usage and language accuracy.
   3) Ability to express ideas logically and creatively.
   4) Scores were rated on a 1–4 scale (very low–very high). Content validity was reviewed by three Indonesian language education experts.

Research Procedures

a. Pretest:
   Conducted in both groups to measure baseline narrative writing ability and cognitive load.
b. Intervention:
   1) Experimental Group:
      The experimental group received four weeks of narrative writing instruction assisted by a deep learning–based chatbot integrated into a web-based learning platform. The chatbot was designed using a large language model capable of natural language processing and interactive dialogue. During the learning sessions, students interacted with the chatbot through a text-based interface to receive guidance in developing story ideas, organizing narrative structures (orientation, complication, and resolution), improving sentence construction, and correcting basic language errors. The chatbot also provided real-time feedback and adaptive scaffolding, encouraging students to revise and expand their narratives. Each session lasted approximately 60 minutes and was conducted twice a week, allowing students to practice writing with continuous digital support.
   2) Control Group:
      The control group received conventional instruction consisting of teacher-led lectures, writing exercises, and routine guidance. The teacher explained narrative text structures, provided examples, and asked students to write narratives individually. Feedback was given through traditional classroom discussion and written comments from the teacher.
c. Posttest:
   Conducted after the intervention to assess changes in narrative writing literacy and cognitive load.

Data Analysis Techniques

a. Descriptive analysis:
   Using mean, median, mode, standard deviation, and score range to describe the distribution of learning outcomes.
b. Inferential analysis:
   Independent-samples t-tests were performed to determine differences in posttest mean scores between the experimental and control groups.
c. Significance level:
   p-value < 0.05 was used as the criterion for statistical significance.
d. Software:
   Data analysis was conducted using SPSS version 25 to facilitate statistical calculations.

RESULTS AND DISCUSSION

Results

A. Descriptive Data of Pretest and Posttest

This study involved 40 fourth-grade students at SD 030 Bagan Jaya, divided into two groups: 20 students in the experimental group who received narrative writing instruction with a deep learning-based chatbot intervention, and 20 students in the control group who followed conventional instruction. Students' ages ranged from 9 to 11 years, corresponding to the developmental characteristics of primary school children.

All students underwent two assessment stages, namely pretest and posttest, designed to measure cognitive load and narrative writing literacy before and after the intervention. The pretest was conducted to assess students' initial abilities and ensure competency equivalence between the two groups. The posttest was administered after the intervention to measure changes and improvements in students' skills.

Descriptive analysis of pretest and posttest data used mean, median, and standard deviation to provide an overview of score trends and data distribution within each group. This descriptive analysis served as a preliminary foundation before inferential statistical analysis.

Table 2. Descriptive Statistics of Narrative Writing Literacy Scores

Group	N	Mean	Median	Std. Dev.	Min	Max
Experimental Pretest	20	58.20	58.00	4.45	50	65
Experimental Posttest	20	81.10	82.00	4.00	74	88
Control Pretest	20	59.00	59.00	4.60	51	66
Control Posttest	20	69.15	69.00	4.55	60	75

The descriptive statistics show a significant difference between pretest and posttest scores in both groups. The experimental group, which received the deep learning-based chatbot intervention, showed a mean increase from 58.20 (pretest) to 81.10 (posttest), with the median rising from 58.00 to 82.00. The standard deviation decreased from 4.45 to 4.00, indicating a more centralized and consistent distribution in the posttest. The minimum and maximum scores also increased significantly from 50–65 to 74–88.

Meanwhile, the control group experienced a smaller improvement, with mean scores increasing from 59.00 to 69.15 and median scores from 59.00 to 69.00. The standard deviation remained relatively stable (4.60 to 4.55), showing consistent score distribution, and the minimum–maximum range increased moderately (51–66 to 60–75).

These results indicate that the deep learning–based chatbot intervention had a more significant impact on students' narrative writing literacy compared to conventional instruction. The larger increase in scores observed in the experimental group suggests that the chatbot-assisted learning approach effectively supported students in developing narrative ideas, organizing story structures, and improving overall writing performance. The adaptive guidance and real-time feedback provided by the chatbot allowed students to receive immediate support during the writing process, which helped them refine their narratives more systematically.

The independent samples t-test result ($t = 7.45$) further confirms that the difference in narrative writing literacy between the experimental and control groups was statistically significant. This finding demonstrates that the integration of a deep learning–based chatbot in narrative writing instruction can contribute positively to improving students' writing literacy outcomes compared to conventional classroom instruction.

Table 3. Descriptive Statistics of Students' Cognitive Load

Group	N	Mean	Median	Std. Dev.	Min	Max
Experimental Pretest	20	62.40	62.00	5.00	55	70
Experimental Posttest	20	45.15	45.00	3.80	38	50
Control Pretest	20	61.85	62.00	4.90	55	69
Control Posttest	20	55.50	55.00	4.25	48	62

The cognitive load scores indicate a significant decrease in both groups. The experimental group showed a mean reduction from 62.40 to 45.15, with the median decreasing from 62.00 to 45.00. The standard deviation decreased from 5.00 to 3.80, reflecting more concentrated and uniform posttest scores. Minimum and maximum scores dropped substantially from 55–70 to 38–50.

The control group also experienced a decrease in cognitive load, albeit to a lesser extent. Mean scores decreased from 61.85 to 55.50, median from 62.00 to 55.00, and standard deviation slightly decreased from 4.90 to 4.25. Minimum and maximum scores reduced from 55–69 to 48–62.

This shows that the deep learning-based chatbot was more effective in reducing students' cognitive load compared to conventional methods. The larger reduction in the experimental group suggests that adaptive guidance, real-time feedback, and scaffolding provided by the chatbot allowed students to process information more efficiently and focus on creative idea development.

B. Inferential Analysis

Before conducting the independent t-test, the researchers first performed tests of normality and homogeneity on the pretest and posttest data. This step was essential to ensure that the data met the fundamental assumptions of parametric analysis, so that the statistical results would be valid and reliable. The normality test aimed to determine whether the distributions of students' narrative writing literacy scores and cognitive load scores followed a normal distribution. Normally distributed data are a key requirement for the use of parametric tests, as these methods rely on the characteristics of the normal distribution when comparing group means.

Furthermore, the homogeneity test was conducted to verify that the variances between the experimental and control groups were relatively equal. Homogeneity of variance is an important assumption for the independent samples t-test, because the test assumes that score variability in each group does not differ significantly. By performing these two preliminary tests, the researchers ensured that the subsequent statistical analysis did not violate parametric assumptions, allowing the interpretation of the t-test results to be valid and to accurately reflect the true differences between the experimental and control groups.

a. Normality Test

The normality test in this study was conducted using the Kolmogorov–Smirnov method, which is a statistical procedure used to determine whether sample data come from a normally distributed population. Data normality is a crucial prerequisite in parametric analysis, including the independent samples t-test, because these methods assume that score distributions within each group follow a normal pattern. In this test, the criterion applied was a significance value (p-value) > 0.05, indicating that the data do not differ significantly from a normal distribution. In other words, when the p-value is

greater than 0.05, the data are considered normally distributed and suitable for inferential analysis.

In this study, the normality test was applied to all research variables, namely narrative writing literacy and cognitive load, for both the experimental and control groups. The results showed that all datasets had p-values greater than 0.05; therefore, it can be concluded that the data followed a normal distribution. This confirms that the data were appropriate for further analysis using parametric statistical tests, allowing valid and reliable comparisons of pretest and posttest scores between groups.

Table 4. Results of the Normality Test (*Kolmogorov–Smirnov*)

Variable	Group	N	p-value	Conclusion
Narrative Writing Literacy	Experimental	20	0.200	Normal
	Control	20	0.185	Normal
Cognitive Load	Experimental	20	0.172	Normal
	Control	20	0.190	Normal

Based on the Kolmogorov–Smirnov normality test results, all research data were found to follow a normal distribution. For the narrative writing literacy variable, the experimental group with a sample size of 20 students obtained a p-value of 0.200, while the control group with the same number of students obtained a p-value of 0.185. Both values exceed the 0.05 significance level, indicating that the literacy score distributions in both groups are normal.

Furthermore, for the cognitive load variable, the experimental group obtained a p-value of 0.172 and the control group obtained a p-value of 0.190. These p-values, which are greater than 0.05, show that students' cognitive load scores in both groups also follow a normal distribution.

These normality test results confirm that the fundamental assumption of parametric analysis has been satisfied. Therefore, the narrative writing literacy and cognitive load data are appropriate for further analysis using parametric statistical tests, including the independent samples t-test, allowing valid and accurate comparisons between the experimental and control groups. Meeting the normality assumption also strengthens the reliability of the study's interpretation, as it ensures that the observed score differences are not influenced by deviations from a normal data distribution.

b. Homogeneity Test

After confirming that the research data were normally distributed, the next step was to conduct a homogeneity of variance test using Levene's Test. This test aimed to determine whether the variances of scores in the two groups the experimental group and the control group were relatively equal. Homogeneity of variance is an important assumption in parametric analysis, including the independent samples t-test, because significant differences in variances between groups can affect the accuracy of statistical results.

In this test, the narrative writing literacy and cognitive load data were analyzed to examine whether the dispersion of scores across groups showed similar levels of variability. The criterion used was a significance value (p-value) greater than 0.05, which indicates that the variances between groups do not differ significantly and that the data can be considered homogeneous. In other words, when the p-value exceeds 0.05, the homogeneity assumption is satisfied, allowing valid comparisons of mean scores between the experimental and control groups using the independent samples t-test.

The results of the homogeneity test serve as an essential foundation before hypothesis testing, as they ensure that any differences observed between the experimental and control groups are truly attributable to the treatment or intervention, rather than to initial differences in score variability. Thus, the subsequent inferential analysis can provide a valid interpretation of the effectiveness of the deep learning–based chatbot in reducing cognitive load and improving students' narrative writing literacy.

Table 5. Results of the Homogeneity Test (*Levene's Test*)

Variable	Levene Statistic	df1	df2	p-value	Conclusion
Writing Literacy	0.521	1	38	0.475	Homogeneous
Cognitive Load	0.689	1	38	0.410	Homogeneous

Based on the results of the homogeneity test using Levene's Test, all research variables showed homogeneous variances across groups. For the writing literacy variable, the Levene statistic was 0.521 with degrees of freedom df1 = 1 and df2 = 38, and a significance value (p-value) of 0.475. Since the p-value is greater than 0.05, this indicates that the variance of writing literacy scores between the experimental and control groups does not differ significantly, and the data can therefore be categorized as homogeneous.

For the cognitive load variable, the Levene statistic was 0.689 with df1 = 1 and df2 = 38, and a p-value of 0.410. This p-value, which is also greater than 0.05, confirms that the variance of cognitive load scores between the experimental and control groups is homogeneous.

These results confirm that the basic assumption of parametric analysis namely, equal variances between groups is satisfied. Accordingly, the next step, the independent samples t-test, can be conducted to compare differences in writing literacy and cognitive load scores between the experimental and control groups. Meeting the homogeneity assumption is important because it ensures that any differences found are truly attributable to the deep learning–based chatbot intervention, rather than to initial differences in score dispersion between groups.

c. Hypothesis Testing / Independent Samples t-Test

After ensuring that the research data met the assumptions of parametric analysis through the normality and homogeneity tests, the next step was to conduct hypothesis testing to determine whether there were significant differences between the experimental and control groups. The statistical test used in this study was the independent samples t-test. This test aims to compare the mean scores of the two groups and to determine whether the given intervention—namely, the deep learning–based chatbot—had a significant effect on the research variables: students' narrative writing literacy and cognitive load.

In conducting the independent samples t-test, a significance level of 5% ($\alpha = 0.05$) was applied as the decision criterion. This means that if the p-value (sig.) obtained from the t-test calculation is less than 0.05, the difference between group means is considered statistically significant, leading to the acceptance of the alternative hypothesis and rejection of the null hypothesis. Conversely, if the p-value is greater than 0.05, no significant difference is found between the groups, and the null hypothesis is accepted.

The independent samples t-test in this study was applied to the posttest data of both groups, as the posttest reflects the final outcomes after the treatment/intervention had been implemented. Using this procedure, the researcher was able to objectively assess whether the use of a deep learning–based chatbot truly had a positive impact on reducing

students' cognitive load and improving their narrative writing literacy compared to conventional teaching methods. The results of this t-test serve as the primary basis for drawing conclusions about the effectiveness of the applied intervention.

Table 6. Results of the Independent Samples t-Test

Variable	t	df	p-value	Conclusion
Writing Literacy	7.45	38	0.000	H_0 rejected, H_1 accepted
Cognitive Load	6.88	38	0.000	H_0 rejected, H_1 accepted

Based on the results of the independent samples t-test, significant differences were found between the experimental and control groups for both research variables. For the writing literacy variable, the obtained t value was 7.45 with 38 degrees of freedom (df) and a p-value of 0.000. Since the p-value is less than 0.05, this indicates that the difference in mean writing literacy scores between the experimental and control groups is statistically significant. Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted, meaning that the deep learning–based chatbot intervention significantly improved students' narrative writing literacy compared to conventional methods.

For the cognitive load variable, the t value was 6.88 with df = 38 and a p-value of 0.000. This p-value, which is far below 0.05, shows that there is a significant difference between the experimental and control groups in terms of students' cognitive load. In other words, the use of a deep learning–based chatbot successfully reduced students' cognitive load significantly, leading to the rejection of H_0 and acceptance of H_1.

These t-test results confirm that the AI-based intervention had a meaningful effect on both improving narrative writing literacy and reducing cognitive load. To further illustrate the impact on cognitive load, Figure 1 visually represents the three categories of mental load (intrinsic, extraneous, and germane) discussed in the study's framework:

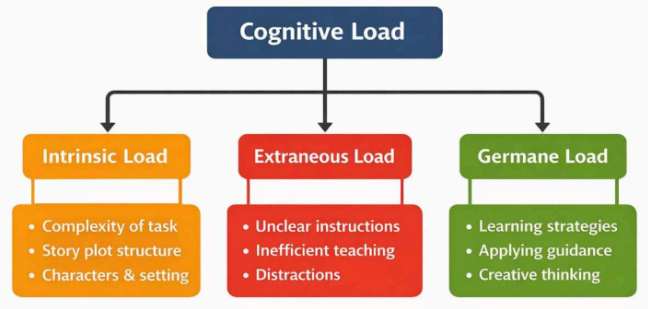

Figure 1. Categories of Cognitive Load in Narrative Writing Instruction

1. Intrinsic Load: The complexity of narrative writing tasks themselves, such as constructing a coherent plot and developing characters.
2. Extraneous Load: The unnecessary cognitive effort caused by unclear instructions or inefficient traditional teaching methods.
3. Germane Load: The mental effort dedicated to learning and understanding narrative writing strategies, which is enhanced by the chatbot's adaptive guidance and real-time feedback.

Thus, the significant differences found between the experimental and control groups reinforce that the deep learning–based chatbot effectively reduced extraneous load while supporting intrinsic and germane load, enabling students to process information more efficiently, focus on creative idea development, and enhance the quality of their writing. Consequently, the deep learning–based chatbot is proven to be an effective and innovative instructional strategy in elementary education, particularly for teaching narrative writing.

Discussion

The findings of this study indicate that the use of a deep learning–based chatbot significantly improves elementary school students' narrative writing literacy compared to conventional instructional models. This improvement is reflected in higher posttest scores and a reduced standard deviation, indicating more consistent student performance among students in the experimental group. The chatbot functions as a digital tutor that assists students in generating ideas, organizing narrative structures, and receiving rapid feedback during the writing process. The availability of immediate feedback enables students to revise their writing more efficiently, thereby reducing recurring errors and supporting gradual improvement in writing quality. In addition, the interactive nature of the chatbot helps create a supportive learning environment that encourages students to participate more actively in writing activities. This condition may also reduce students' hesitation and anxiety when expressing ideas in written form, allowing them to engage more confidently in the narrative writing process (Agustina, 2023; La Mido, 2024).

These results are consistent with the study by Pariyanto and Tungka (2025) which shows that AI-based writing assistants enhance narrative quality through structured formative feedback. The chatbot helps students understand story organization, including setting, conflict, and resolution, while also reducing emotional barriers such as anxiety and fear of making mistakes (affective filter). A non-judgmental digital learning environment provides a safe space for experimentation and gradual improvement in writing quality.

The increase in posttest scores in the experimental group highlights the potential of chatbots as a differentiated learning strategy. In conventional classrooms, teachers often face difficulties in providing personalized feedback equally to all students. AI technology offers fast and consistent individualized feedback. Fitriani and Kurniawan (2024) emphasize that AI-based intelligent feedback systems enhance the effectiveness of revision and support the overall quality of narrative texts.

The integration of AI in learning enables automated feedback that accelerates the revision process and reduces students' cognitive barriers. In traditional instruction, teachers are often constrained by time in delivering individual feedback. The study by Koe et.al (2025) shows that AI can provide corrections, recommendations, and linguistically based explanations in real time, supporting the iterative revision process that is essential in modern literacy development.

The greater reduction in cognitive load observed in the experimental group indicates that digital interaction functions as a form of cognitive regulation. Students who do not receive scaffolding must complete all stages of the writing process independently, which places a heavy burden on working memory. In contrast, chatbot assistance allows the process to be carried out in manageable steps, in line with Cognitive Load Theory, which

seeks to minimize extraneous cognitive load and maximize resources for meaningful information processing (Sari et al. 2024).

Beyond cognitive aspects, the chatbot also enhances students' learning motivation. An interactive and responsive system makes students more interested and engaged in writing activities. Intrinsic motivation is positively correlated with literacy achievement. Zulfikar et al. (2023) found that increased motivation drives student engagement, while the chatbot provides an experience similar to having a private tutor, making students feel guided, valued, and unafraid of making mistakes.

These positive effects are consistent with the findings of Nurmalina and Pebriana (2025) who reported that chatbots improve students' motivation, creativity, and engagement through fast and personalized feedback. AI systems based on natural language processing support literacy development in elementary school students, with appropriate adjustments, and have proven effective for learners aged 9–11 years who are still in the concrete operational stage of cognitive development.

Despite its effectiveness, chatbot implementation faces challenges. Teacher readiness is a key factor, including digital literacy skills and institutional support. Yuliana and Maryani (2024) emphasize that without digital pedagogical competence, chatbots become merely supplementary tools rather than integrated instructional components. Curriculum adaptation and organizational support are also required to ensure that AI aligns with student-centered literacy learning principles.

This study also makes a theoretical contribution to the application of intelligent adaptive systems in elementary education. Previous literature has focused mainly on secondary and higher education. These findings expand the empirical base regarding the effectiveness of deep learning systems for young learners, demonstrating significant impacts on both literacy development and cognitive load. Thus, chatbots represent a pedagogical alternative for supporting data-driven and personalized learning.

Overall, the use of a deep learning–based chatbot is proven to be effective in improving students' narrative writing literacy and reducing cognitive load. This effectiveness results from a combination of scaffolding, adaptive feedback, cognitive regulation, and increased motivation. AI technology has the potential to strengthen literacy instruction in elementary schools when integrated pedagogically, rather than replacing the role of the teacher. Future research may expand the measurement of narrative quality, revision skills, and affective factors to gain a more comprehensive understanding of AI-supported writing instruction.

CONCLUSION

Fundamental Finding: The findings of this study indicate that the implementation of a deep learning–based chatbot significantly improves narrative writing literacy and reduces cognitive load among elementary school students. The experimental group that received the chatbot intervention showed substantially higher posttest scores than the control group, which followed conventional writing instruction. This improvement was evident not only in the higher mean posttest scores but also in the reduced standard deviation, indicating more consistent student performance. The chatbot functioned as a digital tutor by providing scaffolding, real-time feedback, and adaptive guidance to support idea development, story structure, vocabulary choice, and the revision process. In addition, the intervention enhanced students' motivation and engagement, created a

safe and interactive learning environment, and reduced affective barriers such as fear of making mistakes. **Implications:** To maximize the benefits of AI-assisted learning, teachers should integrate chatbot-based interventions as supportive tools in narrative writing instruction. This integration should emphasize adaptive scaffolding, personalized feedback, and activities that encourage iterative revision. Educators are encouraged to combine digital tools with pedagogical strategies that address both cognitive and motivational aspects, while also fostering creativity, critical thinking, and students' writing competence. This approach provides an empirical foundation for the development of innovative, technology-integrated literacy programs in elementary education. **Limitations:** This study has several limitations. First, the sample size was relatively small, consisting of only 40 students. Second, the research was conducted in a single school, namely SD 030 Bagan Jaya, which may limit the generalizability of the findings to other educational contexts. In addition, variations in students' initial writing abilities, familiarity with technology, and classroom dynamics may have influenced the effectiveness of the chatbot intervention. Moreover, the use of this specific web-based learning platform may affect the generalizability of the results to schools with different technological infrastructures or limited access to reliable internet and devices. **Future Research**: Future studies may explore the implementation of chatbot-assisted writing interventions across multiple schools, larger student populations, and diverse grade levels. Longitudinal research is recommended to examine the long-term impact of AI-based scaffolding on writing literacy, cognitive load management, and motivational engagement. Further research may also investigate the combination of AI chatbots with other digital learning technologies to optimize students' creativity, collaboration, and higher-order thinking skills.

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