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Effectiveness of Artificial Intelligence and Data Literacy in Case-Based Learning on the Ability to Write Toulmin-Model Argumentative Essays

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ABSTRACT

This study aims to examine the effectiveness of integrating Artificial Intelligence (AI) and data literacy in Case-Based Learning (CBL) on students' ability to write argumentative essays using the Toulmin model. The research design used a pre-experimental One-Group Pretest-Posttest Design with 22 student participants. The data were collected through argumentative essay writing tests administered before and after the treatment, and analyzed using the Paired-Samples t-Test. The results of the study showed a significant increase between the pretest score (M=53.59) and the posttest score (M=71.27), with a Sig. (2-tailed) value of 0.000<0.05. All Toulmin indicators increased, especially backing (56.1%) and rebuttal (46.8%), indicating that students' ability to construct arguments based on evidence and critical analysis became stronger. The study concludes that integrating CBL, AI (ChatGPT), and data literacy effectively strengthens students' academic argumentative abilities while supporting learning outcomes aligned with Outcome-Based Education (OBE) and the demands of twenty-first-century skills.

Keywords: artificial intelligence, data literacy, argumentative

INTRODUCTION

The development of artificial intelligence (AI) technology has brought significant changes to higher education, including learning practices in universities. Artificial intelligence (AI) now functions not only as an administrative tool but also as an exploratory tool to support a more critical, reflective, and contextual learning. This transformation aligns with the demands of the Industrial Revolution 4.0 and Society 5.0 eras, which require graduates to possess twenty-first-century skills, such as critical thinking, digital literacy, and academic communication ability [1], [2], [3].

Several previous studies have shown the potential of utilizing artificial intelligence (AI) in learning, particularly as a tool for writing assistance, providing feedback, and improving the efficiency of the learning process [4], [5]. In this context, ChatGPT, a natural language-based generative AI developed by OpenAI, serves as a learning assistant that helps students explore ideas, identify supporting evidence, and construct coherent arguments. However, several studies have also highlighted its limitations when not accompanied by critical thinking skills, as students tend to simply copy the generated output without developing solid argumentative abilities [6], [7]. This condition underscores the need for a more structured integration of AI in learning, particularly to strengthen data literacy and argumentative writing skills.

Data literacy is an essential component of digital literacy. For students in non-science study programs, particularly Indonesian Language Education, data literacy does not always take the form of numbers. Still, it can instead appear as narrative texts, articles, or sociocultural discourses. In this context, text-based data literacy includes the ability to understand, access, evaluate, and use textual data critically [8], [9], [10]. This literacy serves as an important foundation in writing argumentative essays because students are required to construct arguments based on valid evidence rather than mere opinion [11], [12].

The ability to write argumentative essays is an essential skill for language students. One argumentation model that is highly relevant for use is the Toulmin argument model. The Toulmin model can guide students in constructing arguments logically and systematically through its six main components: claim, grounds or evidence, warrant, backing, qualifier, and rebuttal [13], [14]. Nevertheless, initial observations indicate that most students still struggle to link claims with evidence, show weaknesses in using warrants, and rarely include rebuttals in their essays.

To address these challenges, a learning model is needed that not only transfers knowledge but also develops analytical skills, problem-solving abilities, and the application of theory in real contexts. Case-Based Learning (CBL) is a highly relevant approach because it positions students as active learners who analyze real

cases presented as narratives, sociocultural issues, or linguistic discourses, which are then solved through discussion, data analysis, and the writing of argumentative essays [15]. The integration of AI and data literacy into Case-Based Learning (CBL) is expected not only to provide instant answers but also to strengthen students' ability to construct evidence-based arguments and produce well-structured academic language.

Based on this description, the scientific novelty of this study lies in integrating artificial intelligence (ChatGPT) and text-based data literacy into a Case-Based Learning model to improve students' ability to write argumentative essays using the Toulmin model. The purpose of this study is to examine the effectiveness of integrating artificial intelligence (AI) and data literacy into Case-Based Learning to enhance students' ability to write argumentative essays in accordance with the Toulmin model.

RESEARCH METHOD

1. Type of Research

   This study used a quantitative pre-experimental design to examine the effectiveness of integrating Case-Based Learning (CBL) with artificial intelligence (AI) and data literacy on students' ability to write argumentative essays.

2. Research Design

   The design used in this study was a One-Group Pretest-Posttest Design, in which the research subjects were first given an initial test (pretest) to measure their ability to write argumentative essays before the treatment [16]. Subsequently, the treatment was administered in the form of implementing CBL integrated with AI and data literacy. After the treatment was completed, a final test (posttest) was administered to assess changes in students' argumentative essay writing ability. The research design scheme is as follows:

   $$O_1 \rightarrow X \rightarrow O_2$$

   Description:
   O_1=Pretest of argumentative essay writing ability
   X= Treatment (CBL integrated with AI and data literacy)
   O_2=Posttest of argumentative essay writing ability

3. Data Sources and Research Subjects

   This study was conducted in the Indonesian Language Education Study Program with 22 third-semester students enrolled in the Factual Writing course as the research subjects. The selection of subjects was carried out using purposive sampling, namely, selecting students who had taken writing courses but still experienced difficulties in writing data-based argumentative essays. This selection ensured alignment between the subjects' characteristics and the study's objectives.

4. Data Collection Techniques and Instruments

   The research data were collected through an argumentative essay writing test administered twice, namely during the pretest (O_1) and posttest (O_2) stages. The instrument used was an argumentative essay test developed based on the Toulmin model [17]. The test consisted of 6 essay items representing the following main indicators:

Table 1. Indicators of Argumentative Essay Writing Using the Toulmin Model [18]

Indicator	Definition
Claim	The main statement or opinion to be proven.
Grounds (data or evidence)	Evidence or facts that support the claim.
Warrant (reasoning)	The logic or rationale that connects the evidence (grounds) to the claim.
Backing (support for the warrant)	Additional information that strengthens the warrant, which may consist of theories, expert opinions, or general principles.
Qualifier (limitation)	A word or phrase that indicates the extent to which the claim applies, so that the impression of an absolute claim can be avoided.
Rebuttal (counterargument or exception)	Recognition of possible objections, exceptions, or different perspectives.

   Each indicator was assigned a score based on the level of achievement in students' argumentative writing.

5. Data Analysis Techniques

   The pretest and posttest data were analyzed using SPSS version 12. The analysis procedure was carried out in several stages as follows:

   a. Descriptive Statistical Analysis

      The initial stage of the analysis was conducted using descriptive statistics to describe the general condition of the data. At this stage, the main focus was to observe the mean scores of the pretest and posttest across all indicators of the Toulmin model (claim, grounds or data, warrant, backing, qualifier, rebuttal).

      Through this comparison of mean scores, the researcher obtained an initial overview of the direction of improvement in students' ability to construct arguments. This stage did not yet assess whether the improvement was statistically significant, but merely provided an initial indication of the tendency of changes in students' abilities before further analysis was conducted using parametric tests [19].

b. Normality Test

The next stage was the normality test, which aimed to determine whether the research data were normally distributed. In this study, the Shapiro–Wilk test was selected because the sample size was relatively small, consisting of only 22 students. According to Ahadi [20], the Shapiro–Wilk test is more appropriate for small sample sizes (n < 50) because it has a high level of accuracy and is sensitive in detecting deviations in data distribution.

The decision-making criterion was that the data were considered normally distributed if the significance value (p-value> 0.05). Thus, the results of the Shapiro–Wilk test served as the basis for determining whether the subsequent analysis could use parametric tests (such as the t-Test) or needed to shift to nonparametric tests.

c. Homogeneity Test

The next stage was to conduct a homogeneity test to ensure that the variances between the pretest and posttest scores were equal. This test used Levene's Test, which functions to examine the equality of variances between the two data groups [21].

If the significance value (p-value) is > 0.05, the data are declared homogeneous. This means that the differences in the results are not due to differences in variance but truly reflect the influence of the learning treatment.

d. Significance Test (Paired Sample t-Test)

The main stage of the analysis was conducted using the Paired Sample t-Test, a statistical test used to determine whether there is a significant difference between two paired measurements, namely the pretest and posttest scores in the experimental class. This test was selected because the research design involved only one group measured twice, namely, before and after the treatment [22].

The decision-making process was carried out based on the significance value (sig. 2 tailed) produced by the t-Test, with the following criteria: If p < 0.05, it means that there is a significant difference, so the treatment (the integration of AI and data literacy in case based learning) is considered to have a real influence on improving students' argumentative writing ability. If p ≥ 0.05, there is no significant difference; thus, the treatment is considered not to have a meaningful effect.

e. Analysis of Scores for Each Indicator

The average score of each indicator of argumentative essay writing based on the Toulmin model was calculated for the pretest and posttest using the following formula [23]:

$$\bar{X}_{\text{indikator}} = \frac{\sum_{i=1}^{N} X_i}{N \times X_{\max}} \times 100$$

Description:
$\bar{X}_{\text{indikator}}$= the average percentage score of the indicator
X_i= the score of the i-th student on the indicator
N= the number of students
$X_{\max}$= the maximum score that can be obtained by each student for the indicator
$\sum_{i=1}^{N} X_i$= the total score of all students for the indicator

RESULTS AND DISCUSSION

1. Descriptive Statistical Analysis

The descriptive analysis of students' argumentative essay writing ability before and after the treatment is presented in Table 2.

Table 2. Results of Descriptive Statistical Test for the Argumentative Essay Writing Variable

		Mean	N
Pair 1	Pretest	53.5909	22
	Postes	71.2727	22

The descriptive analysis showed an increase in students' average argumentative essay writing ability from 53.59 (pretest) to 71.27 (posttest). The students' argumentative essay texts after the treatment demonstrated a clearer argument structure, more accurate use of academic diction, and more relevant supporting evidence or data. This change reflects a shift in cognitive ability, from argumentative essays that were reproductive and based on intuition or opinion, to writing that is reflective, structured, and evidence-based.

Based on observations during the treatment, several contributing factors that explain the improvement in students' ability to write argumentative essays include the integration of Case-Based Learning (CBL), which provided real contexts and cases that encouraged students to apply concepts, analyze evidence, and consider various perspectives before constructing arguments [24]. The authentic case contexts facilitated students' understanding, enhanced knowledge transfer, and fostered motivation to write more analytically. In addition, the role of artificial intelligence (AI) as a reflective companion functioned not only to provide instant answers, but also as a tool that helped construct argument frameworks, suggested options for academic diction to students, and provided examples of logical use of data [25]. The repeated interactions students had with AI generated internal reflection, making students more critical in constructing arguments.

In addition to these factors, integrating data literacy enabled students to better assess the validity of their data sources, select appropriate data as evidence, and interpret the data to strengthen their claims. This ability enhanced the quality of their argumentative essay writing.

The results of this study are consistent with those of [26], which found that Case-Based Learning (CB) is effective in improving students' critical thinking skills by engaging them in deep processing and evaluation of real-world problems. In addition, the results are also aligned with the findings of [27], which reported that the use of AI-based writing assistants helps students produce stronger arguments.

Thus, this study not only reinforces previous findings but also makes a new contribution by combining Case-Based Learning (CBL), artificial intelligence (AI), and data literacy as a holistic approach to teaching students to write argumentative essays.

However, this study also has several limitations. First, the small sample size (22 students) means the results cannot yet be generalized. Second, the use of AI still requires intensive guidance to ensure that students do not rely entirely on AI-generated outputs. Nevertheless, the strength of this study lies in its innovative learning design, which integrates Case-Based Learning (CBL) with artificial intelligence (AI) in a structured manner to develop students' academic writing skills.

Practically, the results of this study have important implications for the development of learning models in higher education. The integration of AI and data literacy can serve as an alternative strategy in language learning and academic writing instruction. Lecturers can utilize AI not as a replacement for the instructor's role, but as a reflective partner to enrich students' thinking processes. In addition, this study contributes to strengthening the Outcome-Based Education (OBE) approach by emphasizing learning outcomes in the form of measurable critical thinking skills, digital literacy, and scientific argumentation.

2. Normality, Homogeneity, and Significance Tests

To ensure that the statistical analyses used in this study met the fundamental assumptions, normality, homogeneity, and significance tests were conducted. These tests were necessary to determine whether the pretest and posttest data were suitable for analysis using parametric statistical techniques, particularly the Paired Samples t-Test. Therefore, Table 3 below presents the results of each test.

Table 3. Results of Normality, Homogeneity, and t-Test

Data	Shapiro–Wilk (Sig.)	Levene's Test (Sig.)	Paired Sample t-Test (Sig. 2 tailed)
Pretest	0.110 (normal)	0.798 (homogen)	0.000
Posttest	0.095 (normal)	-	0.000

Based on Table 3, the Shapiro–Wilk test results indicate that the pretest and posttest data are normally distributed, as their p-values are above 0.05. This condition means that the data do not deviate from a normal distribution, thereby fulfilling one of the requirements for using parametric analysis. In addition, the Levene's Test value of 0.798 (>0.05) indicates that the data variance is homogeneous, indicating that the difference in variability between the pretest and posttest is not significant.

Furthermore, the results of the Paired Sample t-Test show a Sig. (2-tailed) value of 0.000, which is below 0.05. This finding indicates that there is a significant difference in scores between the pretest and posttest. Thus, it can be concluded that implementing the Case-Based Learning (CBL) model, integrated with artificial intelligence (AI) and data literacy, significantly improved students' ability to write argumentative essays.

This finding provides concrete evidence that the positive changes identified descriptively were not merely coincidental but were a direct result of the implemented learning model. The significant improvement indicates that the combination of Case-Based Learning (CBL), artificial intelligence (AI), and data literacy not only enriched students' learning experiences but also had a real impact on their academic achievement.

In general, this improvement occurred because Case-Based Learning (CBL) placed students in real-world problem-solving situations, allowing them to practice critical and systematic thinking [28]. When this approach was combined with artificial intelligence (AI) such as ChatGPT, students obtained guidance that helped them construct arguments in a coherent and academic manner [28]. When this approach was combined with artificial intelligence (AI) such as ChatGPT, students received guidance that helped them construct arguments coherently and academically. Artificial intelligence (AI) served as a reflective partner, providing direct feedback on the logic of students' arguments in their argumentative essays, while data literacy helped students select accurate and relevant information to support their claims. This combination created a reflective learning cycle, enabling students not only to write but also to evaluate, revise, and validate their arguments using data and the case context.

These results also reinforce several previous studies, including the findings of [29] and [30], which states that the integration of artificial intelligence (AI) in writing activities can improve students' argument structures (including aspects of argumentation and coherence). In addition, they are aligned with the findings of [31], which shows that data literacy skills influence students' academic essay writing.

Thus, this study not only aligns with previous findings but also offers a new synthesis of the synergy or integration among these three approaches within the context of writing instruction in higher education.

This study shows that the combination of innovative and contextual approaches, in the form of Case-Based Learning (CBL), has provided students with opportunities to practice critical thinking in real-world situations. At the same time, artificial intelligence (AI) has played a role in providing instant reflective feedback to students. The application of data literacy ensured that the arguments constructed by students were based on valid facts.

However, this study also has limitations, namely the relatively small sample size (22 students) and the need for intensive lecturer supervision to ensure that the use of artificial intelligence (AI) remains within the corridor of academic ethics and does not create dependency.

Implicitly, these findings provide an important contribution to the development of learning strategies in higher education, namely by positioning artificial intelligence (AI) as a reflective learning partner that helps students refine their critical and argumentative thinking skills. The implementation of this model is also aligned with the principles of Outcome-Based Education (OBE), which emphasize learning outcomes in the form of digital literacy, analytical ability, and measurable scientific argumentation [32].

3. Analysis of Toulmin Indicators

To obtain a more specific overview of improvements in students' argumentative essay quality, an analysis was conducted using indicators from the Toulmin framework. This analysis aimed to examine changes in each component of the argument, which includes claim, data, warrant, backing, qualifier, and rebuttal. The average improvement for each indicator is shown in Figure 1.

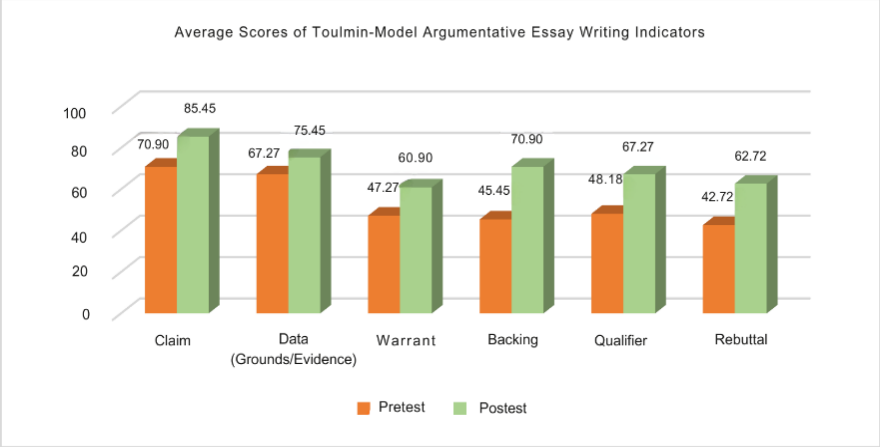

Figure 1. Distribution of Average Indicators of Argument Writing Using the Toulmin Model

Based on Figure 1, the study's results show an increase in students' ability to write argumentative essays across all indicators of the Toulmin argument model after the implementation of Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy. For the claim indicator, the average score increased from 70.90 in the pretest to 85.45 in the posttest, indicating an improvement in students' ability to express their opinions clearly and purposefully. For the grounds (data or evidence) indicator, an increase was also observed from 67.27 to 75.45, indicating that students became more capable of presenting evidence or facts to support their claims. For the warrant indicator, improvement went from 47.27 to 60.90, indicating an increase in students' ability to explain the logical connection between the data and the claim. Next, the backing indicator increased significantly from 45.45 to 70.90, indicating that students' ability to provide additional support for the arguments presented strengthened. The qualifier indicator also increased from 48.18 to 67.27, indicating that students began to use limiting or reinforcing expressions to strengthen their arguments. Finally, the rebuttal indicator increased from 42.72 to 62.72, indicating that students became more skilled at anticipating and responding to counterarguments to their own arguments. Overall, these results show that students' critical thinking in writing argumentative essays using the Toulmin model improved after participating in the learning process. These findings show that implementing the integrative approach effectively strengthened students' argumentative writing abilities, particularly in constructing a complete and logical Toulmin argument structure.

The following section presents the discussion of each Toulmin indicator (claim, data, warrant, backing, qualifier, and rebuttal)*:*

a. Claim Indicator

Students' ability to present the main statement (claim) increased from 70.90 to 85.4. After the treatment, students were better able to formulate firm, focused, and well-directed claims. This is in line with Toulmin's view [33], which states that a strong argument begins with a clear and well-directed claim. The integration of artificial intelligence (AI) helped students recognize argument patterns systematically, while data literacy trained them to base their claims on valid information [34].

b. Grounds (Data/Evidence) Indicator

The grounds indicator measures students' ability to provide evidence or facts that support the claims presented in their argumentative

essays. At the pretest, the students' average score was 67.27, and it increased to 75.45 in the posttest. This improvement indicates that students became increasingly accustomed to including data, concrete examples, and factual information to support their claims. Before treatment, their arguments tended to be subjective and dominated by personal opinions. After implementing Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy, students began to demonstrate an awareness of the importance of presenting evidence as the foundation of their arguments. The role of AI in this context is evident in its ability to help students search for, sort, and verify relevant data sources, resulting in arguments that are more evidence-based and accurate. The integration of data literacy into the learning process during treatment also strengthened the accuracy of arguments by encouraging students to be more selective in choosing relevant information [35], [36].

c. Warrant (Reasoning) Indicator

The warrant indicator measures students' ability to connect the data (grounds) with the claim through logical reasoning. After the treatment was implemented, the students' average score increased from 47.2 in the pretest to 60.9 in the posttest. This improvement shows that students became increasingly able to construct a coherent connection between the evidence they presented and the claim they proposed. Before the treatment, students' reasoning tended to be weak because the arguments they wrote often did not show a clear connection between the data and the claim they presented, making the arguments appear fragmented. After implementing Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy, students improved their logical reasoning, as the real cases they encountered prompted them to connect factual information to their argumentative positions. The role of artificial intelligence (AI), particularly ChatGPT, appeared significant in helping students explore various argumentation patterns, provide logical feedback, and offer more systematic alternative lines of reasoning. Thus, the arguments produced became more coherent and convincing. This is in line with the view of Rapanta and Macagno [37], who state that artificial intelligence (AI) can strengthen the reasoning process by providing a structured argumentation framework, while data literacy ensures that the reasoning is supported by valid information.

d. Backing (Support for the Warrant) Indicator

The backing indicator functions as additional information that strengthens the warrant, which may consist of theories, expert opinions, or general principles. In the pretest, the average score was only 45.45, while in the posttest it increased significantly to 70.90. This increase indicates an important shift in the way students constructed their argumentative essays. Before the treatment, students composed their argumentative essays by relying mainly on intuition or personal opinions; after the treatment, the argumentative texts they produced became more academic, supported by relevant theories and literature. Before the treatment, students' arguments tended to be superficial because of the limited use of references that could strengthen their reasoning. After the implementation of Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy, students began to develop the habit of searching for, selecting, and integrating research findings or expert opinions as part of their argumentation. The integration of artificial intelligence (AI), particularly ChatGPT, played an important role in expanding students' access to relevant academic sources and providing examples of how theories can be used as backing to strengthen the warrant. On the other hand, data literacy-trained students are not only taught to cite information but also to validate the information they use so that it aligns with the context of the argument [38]. Thus, the quality of the arguments became more credible and scientifically accountable. This finding is consistent with the results of [39], which found that backing in the form of strong theories or conceptual explanations helps make the warrant more explicit and strengthens students' argumentation.

e. Qualifier (Limitation) Indicator

The qualifier indicator measures students' ability to indicate the extent to which their claims apply, thereby avoiding the impression of absolute claims. In the pretest, the students' average score in using qualifiers was only 48.18, while in the posttest it increased to 67.27. This increase shows an important change in the way students constructed their argumentative essays, namely from a tendency to make absolute (full) claims to a more proportional, controlled approach. Before the treatment, students' argumentative essays were often subjective and not supported by sufficient evidence. After the implementation of Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy, students began to develop the habit of using limiting words or phrases such as "generally", "most", or "tend to". This made their argumentative essays more objective and flexible, and reduced the risk of faulty generalization. The integration of artificial intelligence (AI), particularly ChatGPT, made it easier for students to identify appropriate examples of Toulmin-model argumentative writing and to observe how claim limitations are used in scientific contexts.

Meanwhile, data literacy helped them evaluate the context and relevance of the data before including limiting expressions in their argumentative essays. Thus, the use of qualifiers became not merely a linguistic formality but a way to strengthen the scientific credibility and accuracy of the arguments. This is in accordance with the view of Swales and Feak [40], who emphasize the importance of limiting claims to maintain the objectivity and scientific validity of argumentative writing.

f. Rebuttal (Counterargument/Exception) Indicator

The rebuttal indicator measures the acknowledgment of possible objections, exceptions, or differing perspectives within an argument. The students' average pretest score was 42.72, which increased to 62.72 on the posttest. This increase demonstrates an important shift in students' ability to write more critical, mature argumentative essays.

Before the treatment, the rebuttal element was almost absent in students' argumentative essays. They tended to present claims without considering other perspectives. After implementing Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy, students began to identify potential objections or differing views to their claims, while also providing reasons why their main argument remained relevant. For example, they acknowledged data limitations or specific conditions that might affect the results, yet still affirmed the validity of their conclusions proportionally. In this context, the integration of artificial intelligence (AI), particularly ChatGPT, helped students observe examples of effective rebuttals in academic arguments, while data literacy encouraged them to critically evaluate evidence before responding to potential counterarguments. Thus, the ability to formulate rebuttals enhanced the depth of analysis and the reliability of their arguments.

This finding is consistent with [41], which emphasizes that rebuttal skills are an important indicator of students' critical thinking maturity, and reinforces the view that acknowledging differing perspectives is an essential element in constructing a credible argumentative essay. Overall, the increase in scores across the six indicators of the Toulmin-model argumentative essay confirms the effectiveness of Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy in strengthening students' ability to write argumentative essays. Case-Based Learning (CBL) presents real contexts through cases that encourage students to think critically [42], while artificial intelligence (AI), such as ChatGPT, functions as a learning assistant that can enrich data exploration, provide examples of argumentation patterns, and help students construct arguments more systematically. The integration of data literacy in this learning process strengthens students' ability to use evidence-based information, resulting in arguments that are more convincing and academically well-founded.

CONCLUSION

This study concludes that the implementation of Case-Based Learning (CBL) integrated with artificial intelligence (AI) and data literacy is effective in improving students' ability to write argumentative essays based on the Toulmin Model. Significant improvements occurred across all indicators, particularly in backing and rebuttal, showing students' ability to construct theory-based arguments and to respond to differing perspectives critically.

The integration of AI helped students construct arguments systematically and reflectively, while data literacy strengthened the validity of the evidence used. Conceptually, the combination of these three components contributes to the development of evidence-based learning supported by intelligent technologies that foster students' critical thinking, digital literacy, and scientific communication skills. Thus, this model is relevant for developing twenty-first-century competencies in the era of Society 5.0.

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REFERENCES

[1] S. Rifky, "Dampak Penggunaan Artificial Intelligence Bagi Pendidikan Tinggi," *Indones. J. Multidiscip. Soc. Technol.*, vol. 2, no. 1, pp. 37–42, Feb. 2024, doi: 10.31004/ijmst.v2i1.287.

[2] A. Z. Akfal, I. E. Solekh, and P. M. Saefiansyah, "Digital Transformation in Education: Challenges and Opportunities in Improving the Quality of Learning in the Era of Revolution".

[3] Rr. S. Murtiningsih, I. Ariani, H. W. Nugroho, and A. H. Utomo, "Strengthening Character Through Digital Pedagogy in Facing the Era of Society 5.0," *Digit. Press Soc. Sci. Humanit.*, vol. 9, p. 00017, 2023, doi: 10.29037/digitalpress.49449.

[4] S. L. Jen and A. R. Hj Salam, "A Systematic Review on The Use of Artificial Intelligence in Writing," *Int. J. Acad. Res. Progress. Educ. Dev.*, vol. 13, no. 1, p. Pages 1819-1829, Feb. 2024, doi: 10.6007/IJARPED/v13-i1/20584.
[5] H. Aljuaid, "The Impact of Artificial Intelligence Tools on Academic Writing Instruction in Higher Education: A Systematic Review," *Arab World Engl. J.*, vol. 1, no. 1, pp. 26–55, Apr. 2024, doi: 10.24093/awej/ChatGPT.2.
[6] W. Ridwan, F. Purnamasari, I. Hamsar, and A. A. Handayani, "EFEKTIVITAS CHATGPT SEBAGAI ASISTEN VIRTUAL DALAM PROSES PEMBELAJARAN MAHASISWA JURUSAN PKK FT UNM".
[7] R. Maharani, P. Arzuna, N. A. D. Nasution, S. Setyorini, and R. Zulpianto, "Pelatihan Penggunaan ChatGPT Sebagai Asisten Pembelajaran Bagi Mahasiswa," vol. 5, no. 1, 2025.
[8] C. Ridsdale *et al.*, "Strategies and Best Practices for Data Literacy Education".
[9] A. N. Aruan, A. N. Nabila, K. Hutagalung, and R. Wijaya, "DEVELOPMENT OF A TEXT-BASED REPORT LEARNING MODEL TO IMPROVE INFORMATION LITERACY".
[10] L. Fesler, T. Dee, R. Baker, and B. Evans, "Text as Data Methods for Education Research," *J. Res. Educ. Eff.*, vol. 12, no. 4, pp. 707–727, Oct. 2019, doi: 10.1080/19345747.2019.1634168.
[11] N. Efendi, "PEMBELAJARAN BERPIKIR KRITIS DALAM MENULIS ESAI ARGUMENTATIF MAHASISWA".
[12] F. Inggriyani, "PENGGUNAAN MODEL PROBLEM BASED LEARNING UNTUK MENINGKATKAN KETERAMPILAN MENULIS ARGUMENTASI MAHASISWA," vol. 14, no. 1, 2024.
[13] S. E. Toulmin, *The Uses of Argument*, 2nd ed. Cambridge University Press, 2003. doi: 10.1017/CBO9780511840005.
[14] M. Turós, A. Z. Kenyeres, G. Balla, E. Gazdag, E. Szabó, and Z. Szűts, "A Toulmin Model Analysis of Student Argumentation on Artificial Intelligence," *Educ. Sci.*, vol. 15, no. 9, p. 1226, Sept. 2025, doi: 10.3390/educsci15091226.
[15] A. Rahmat, M. Mirnawati, and dkk, *Desain Pembelajaran Berbasis Kasus*, Cetakan pertama. Gorontalo: Ideas Publishing, 2023.
[16] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Bandung: Alfabeta, 2017.
[17] Y. Y. Dharmawan, H. V. Ali, Bayu Andika Prasatyo, and A. Amaliah, "Comparing The Argumentative Essay Formats of Indonesian and Korean Students Using the Toulmin Model," *J. Onoma Pendidik. Bhs. Dan Sastra*, vol. 9, no. 2, pp. 1099–1114, Sept. 2023, doi: 10.30605/onoma.v9i2.2922.
[18] R. Yang, "An empirical study of claims and qualifiers in ESL students' argumentative writing based on Toulmin model," *Asian-Pac. J. Second Foreign Lang. Educ.*, vol. 7, no. 1, p. 6, Dec. 2022, doi: 10.1186/s40862-022-00133-w.
[19] M. Ikbal, R. Ramlawati, and D. E. Pratiwi, "Pengaruh Integrasi Toulmin Argumentation pada Model Pembelajaran Learning Cycle 5E Terhadap Keterampilan Berpikir Kritis Peserta Didik Kelas VIII SMP Negeri 8 Makassar (Studi pada Matari Pokok Zat Aditif, Zat Adiktif, dan Psikotopika)," *ChemEdu*, vol. 2, no. 2, Aug. 2021, doi: 10.35580/chemedu.v2i2.32511.
[20] G. D. Ahadi and N. N. L. E. Zain, "Pemeriksaan Uji Kenormalan dengan Kolmogorov-Smirnov, Anderson-Darling dan Shapiro-Wilk," *Eig. Math. J.*, pp. 11–19, June 2023, doi: 10.29303/emj.v6i1.131.
[21] S. Santoso, *Menguasai Statistik dengan SPSS 25*. Jakarta: PT Elex Media Komputindo., 2018.
[22] C. Montolalu and Y. Langi, "Pengaruh Pelatihan Dasar Komputer dan Teknologi Informasi bagi Guru-Guru dengan Uji-T Berpasangan (Paired Sample T-Test)," *d'CARTESIAN*, vol. 7, no. 1, p. 44, May 2018, doi: 10.35799/dc.7.1.2018.20113.
[23] R. Ananda, *Statistik Pendidikan (Teori Dan Praktik Dalam Pendidikan)*, I. Medan: CV. Widya Puspita, 2018.
[24] Enjelita Sormin and Muhammad Surip, "Pengaruh Model Pembelajaran Case Based Learning Terhadap Kemampuan Menulis Teks Eksplanasi Pada Siswa Kelas XI SMA Negeri 3 Medan," *J. Bintang Pendidik. Indones.*, vol. 2, no. 2, pp. 258–269, May 2024, doi: 10.55606/jubpi.v2i2.2985.
[25] S. Marhaban, T. Sulistyo, and O. Widiastuti, "Artificial Intelligence in Writing: Students' Writing Competencies and Voices," *JEELS J. Engl. Educ. Linguist. Stud.*, vol. 12, no. 1, pp. 403–425, May 2025, doi: 10.30762/jeels.v12i1.3927.
[26] E. Silitubun, M. Mustaji, and U. Dewi, "The Effectiveness of Case-Based Learning in Enhancing Students' Critical Thinking Skills," *J. Neonatal Surg.*, vol. 14, no. 2, pp. 136–141, Feb. 2025, doi: 10.52783/jns.v14.1844.
[27] A. Adiyono, A. Said Al Matari, and F. Ferdian Dalimarta, "Analysis of Student Perceptions of the Use of ChatGPT as a Learning Media: A Case Study in Higher Education in the Era of AI-Based Education," *J. Educ. Teach. JET*, vol. 6, no. 2, pp. 306–324, Mar. 2025, doi: 10.51454/jet.v6i2.538.
[28] R. N. Putri, R. Y. Santoso, and M. A. Hajuan, "Pengaruh model pembelajaran case based learning berbantuan LKPD terhadap kemampuan berpikir kritis Siswa pada mata pelajaran Ppkn di SMK Kosgoro," *Dharma Pendidik.*, vol. 19, no. 2, pp. 99–107, Oct. 2024, doi: 10.69866/dp.v19i2.534.
[29] R. S. I. Dewi, S. R. Kusumaningrum, A. E. Anggraini, M. I. Effendi, and J. Nugraha, "Students' Perception of the Artificial Intelligence Jenni AI," vol. 8, no. 2.
[30] N. Triwayatno, N. Irawan, A. Ghofur, and A. Pramujiono, "ENHANCING STUDENTS' ENGLISH ESSAY WRITING PROFICIENCY AI-BASED AUTOMATIC FEEDBACK SYSTEMS," *J. Penelit. Hum.*, Mar. 2025, doi: 10.23917/jph.v26i1.9041.
[31] A. Haliq, R. D. Mahande, and A. Akhiruddin, "Exploring the impact of critical thinking and digital literacy on students' academic essay writing

skills," *Diksi*, vol. 33, no. 2, Sept. 2025, doi: 10.21831/diksi.v33i2.88078.
[32] M. I. Muzakir and Susanto, "Implementasi Kurikulum Outcome Based Education (Obe) Dalam Sistem Pendidikan Tinggi Di Era Revolusi Industri 4.0," *Edukasiana J. Islam. Educ.*, vol. 2, no. 1, pp. 118–139, May 2023, doi: 10.61159/edukasiana.v2i1.86.
[33] M. Turós, A. Z. Kenyeres, G. Balla, E. Gazdag, E. Szabó, and Z. Szűts, "A Toulmin Model Analysis of Student Argumentation on Artificial Intelligence," *Educ. Sci.*, vol. 15, no. 9, p. 1226, Sept. 2025, doi: 10.3390/educsci15091226.
[34] Suryadi, I. K. Mahardika, Supeno, and Sudarti, "Data literacy of high school students on physics learning," *J. Phys. Conf. Ser.*, vol. 1839, no. 1, p. 012025, Mar. 2021, doi: 10.1088/1742-6596/1839/1/012025.
[35] "View of Pengaruh 4 Literasi dalam Proses Pembelajaran terhadap Kemampuan Bernalar Kritis Mahasiswa."
[36] A. S. R. Putri and R. M. Azhar, "EKSPLORASI INTEGRASI LITERASI DATA, INOVASI, DAN KOMUNIKASI DALAM PENULISAN ARTIKEL RISET PEMERINTAHAN," vol. 5, no. 3, 2025.
[37] C. Rapanta and F. Macagno, "Evaluation and Promotion of Argumentative Reasoning Among University Students: The Case of Academic Writing," *Rev. Lusófona Educ.*, p. v. 45 n. 45 (2019): REVISTA LUSÓFONA DE EDUCAÇÃO, Jan. 2020, doi: 10.24140/ISSN.1645-7250.RLE45.09.
[38] Dasmo and S. Wati, "Penguatan Literasi Data Dalam Meningkatkan Efektivitas Pembelajaran," *Pros. Semin. Nas. Sains SINASIS 4, 1, 2023, vol. 4, no. 1*.
[39] C. Miller, J. Menke, and A. Conner, "Collective Argumentation in Integrated Contexts: A Typology of Warrants Contributed in Mathematics and Coding Arguments," *J. STEM Educ. Res.*, vol. 6, no. 2, pp. 275–301, Aug. 2023, doi: 10.1007/s41979-023-00091-z.
[40] J. M. Swales and C. B. Feak, "Academic Writing for Graduate Students: Essential Tasks and Skills," *Coll. Compos. Commun.*, vol. 47, no. 3, p. 443, 2012, doi: 10.2307/358319.
[41] S. M. Hapid and Helendra, "Analisis Kemampuan Argumentasi Ilmiah Peserta Didik Menggunakan Pola Toulmin Pada Materi Perubahan Lingkungan Di SMA/MA," *Al-Alam Islam. Nat. Sci. Educ. J.*, vol. 4, no. 2, pp. 46–55, July 2025, doi: 10.33477/al-alam.v4i2.10287.
[42] F. H. Hidayati and E. W. Evy Wisudariani, "Pengaruh Pembelajaran Berbasis Kasus (Case Based Learning) dalam Meningkatkan Kreativitas dan Kemampuan Berpikir Mahasiswa: (The Effect Of Case-Based Learning In Increasing Students' Creativity And Thinking Ability In Vector Control And Rodent Courses)," *BIODIK*, vol. 9, no. 2, pp. 180–190, Aug. 2023, doi: 10.22437/biodik.v9i2.20821.