International Journal of Innovative Research and Scientific Studies, 8(3) 2025, pages: 989-997

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Writing as a means of exploration in students' conceptual understanding: From scribbles to understanding

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Abstract

This study aims to examine the role of writing as a tool for enhancing students' conceptual understanding and critical thinking across various academic disciplines. A systematic literature review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to identify and analyze relevant studies. Six primary research articles were selected based on rigorous inclusion criteria to explore the effectiveness of writing-based learning strategies. The review reveals that writing strategies such as exploratory writing, reflective journaling, and writing-based discussions promote higher-order thinking skills by enabling students to organize information, reflect critically, and connect new concepts with prior knowledge. In literacy and language, writing fosters cultural and social awareness, while in mathematics and science, it facilitates the articulation of abstract concepts. Writing is not only a communication tool but also a powerful medium for cognitive development and conceptual understanding in education. These findings suggest that educators should integrate writing into instructional strategies across disciplines to enhance student engagement and learning outcomes. However, the review highlights the need for further empirical research with larger samples and robust methodologies to validate these conclusions.

Keywords: Scribbles for understanding, Students' conceptual understanding, Writing exploration.

DOI: 10.53894/ijirss.v8i3.6670
Funding: This study received no specific financial support.
History: Received: 17 March 2025 / **Revised:** 18 April 2025 / **Accepted:** 21 April 2025 / **Published:** 2 May 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: Both authors contributed equally to the conception and design of the study. Both authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

Writing is a vital language skill in education. In addition to being a means of communication, writing also functions as a means of exploration and development of understanding [1]. Through writing activities, a person expresses ideas and builds

a more systematic and in-depth thinking structure [2]. Writing allows individuals to organize information. Writing allows individuals to organize information, reflect, and develop more complex arguments in the learning process [3].

Writing in education is often considered as the final activity of a learning process, for example, in the form of a report or essay. However, recent research shows that writing can also be a cognitive exploration that helps students understand new concepts more deeply [4]. Through writing, students can construct their understanding, connect new information with previously acquired knowledge, and develop critical and analytical thinking skills [5].

Exploration through writing also reflects an active thinking process. According to the constructivism theory by Piaget [6], effective learning occurs when individuals actively construct their knowledge through interaction with the environment [7]. In this context, writing is a form of interaction that allows individuals to develop ideas, identify relationships between concepts, and find solutions to problems faced. In addition, research conducted by Zetterholm and Lindström [8] shows that writing is not just a mechanical activity but a process that involves planning, conceptualizing, revising, and reflecting. In each stage, students are encouraged to continue exploring their thoughts, improving argument structures, and adjusting ideas based on analysis and feedback. Thus, writing can be an exploration tool that allows students to continue learning and developing.

Writing also plays an important role in building understanding through reflection. According to Martino [9], reflection in learning allows individuals to review experiences, identify errors or gaps in their understanding, and develop solutions to improve learning. According to Dharmasaroja [10], when students write about a newly learned concept, they will be encouraged to reflect on the meaning of the concept in a broader context. Jeong [11] shows that exploration-based writing strategies, such as reflective journals or thought notes, can improve students' understanding of a material. Through writing, students can gradually develop their thinking, clarify concepts that are still unclear, and adjust their understanding of new information from various sources.

In education, writing is considered the final activity of a learning process, for example, in the form of a report or essay. However, recent research shows that writing can also be a cognitive exploration that helps students understand new concepts more deeply [12]. Students can construct their understanding, connect new information with previously acquired knowledge, and develop critical and analytical thinking skills through writing. By providing opportunities for students to write exploratively, educators can help them improve their language skills [13], construct more structured arguments [14] and develop sharper critical thinking skills [15].

Although various studies have discussed the benefits of writing in education, some research gaps still need to be explored further. First, many studies highlight writing as an evaluation tool in learning, but not many have discussed its role as an exploration tool in understanding concepts holistically [12]. Second, most studies focus more on academic writing skills, while the reflective and exploratory aspects of writing still receive less attention [16].

Through this literature review, the study will identify various approaches to utilizing writing as an exploration tool and examine how writing strategies can be applied in various subjects to improve students' understanding of academic concepts. Thus, this study contributes to enriching academic discussions on the role of writing in the learning process and offers new insights for educators in integrating more exploratory writing strategies into teaching practices.

2. Methods

This study uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method to compile a systematic and comprehensive literature review. According to Athikarisamy and Patole [17], the PRISMA method was chosen because it filters and analyses relevant studies strictly based on predetermined inclusion and exclusion criteria, resulting in more valid and reliable findings.

The data sources in this study were obtained from two central academic databases, namely Scopus and Semantic Scholar. These two databases were chosen because they have a wide journal coverage, are credible, and have undergone a strict peer-review process. To obtain articles that are the focus of the research, a literature search was conducted using the keywords: "writing", "exploration", "understanding", and "students". These keywords are combined with Boolean operators (AND and OR) to expand the search scope without losing relevance.

Next, the identification stage is carried out by searching and collecting data. At this stage, an article search uses keywords determined in the Scopus and Semantic Scholar databases. The search process is carried out by considering the article's title, abstract, and keywords relevant to this study. The initial search results produced 1,191 articles from various scientific journals about writing as an exploration tool in student learning. After eliminating duplication between databases, the number of articles obtained was reduced to 1,136, and further selected.

After the identification stage, the article screening process was carried out based on inclusion and exclusion criteria.

Inclusion Criteria:

1. Articles published in scientific journals indexed by Scopus or Semantic Scholar.
2. Articles that focus on the role of writing in the exploration and understanding of concepts in education.
3. Articles that discuss the relationship between writing activities and improving student understanding.
4. Articles published in 2016–2024 to ensure relevance to the latest research trends.
5. Articles available in English or Indonesian so that they can be understood academically.

Exclusion Criteria:

1. Articles that do not result from empirical or systematic research (e.g., editorials, opinion pieces, or conference summaries).
2. Articles that focus only on general aspects of writing without connecting them to students' exploration or understanding of concepts.

3. Articles that do not provide access to the full text or are only available in abstract form.
4. Articles with unclear research methodology or less in line with a systematic approach.

Based on applying these inclusion and exclusion criteria, the number of articles remaining for further analysis was 39. The next stage was checking the eligibility of articles that had passed the initial screening stage. At this stage, articles were reviewed in more depth by reading the abstract, research methods, results, and conclusions to ensure that the articles were genuinely relevant to the research topic. From the evaluation results, 33 articles were found to be inappropriate because (1) they did not specifically discuss exploration through writing in the context of student understanding, (2) they focused more on the linguistic aspects of writing than on its use as a tool for exploration in learning, (3) they used inappropriate research populations, such as studies on students or adults, not students in primary or secondary education. Thus, six articles still met the criteria after the eligibility stage.

In the final stage, articles that contributed significantly to this literature review were selected. After a complete reading and in-depth analysis of the contents of the articles, six articles were selected for use in this study. These articles cover a variety of perspectives on the role of writing in exploring and enhancing students' understanding and present empirical evidence that supports the study's conclusions.

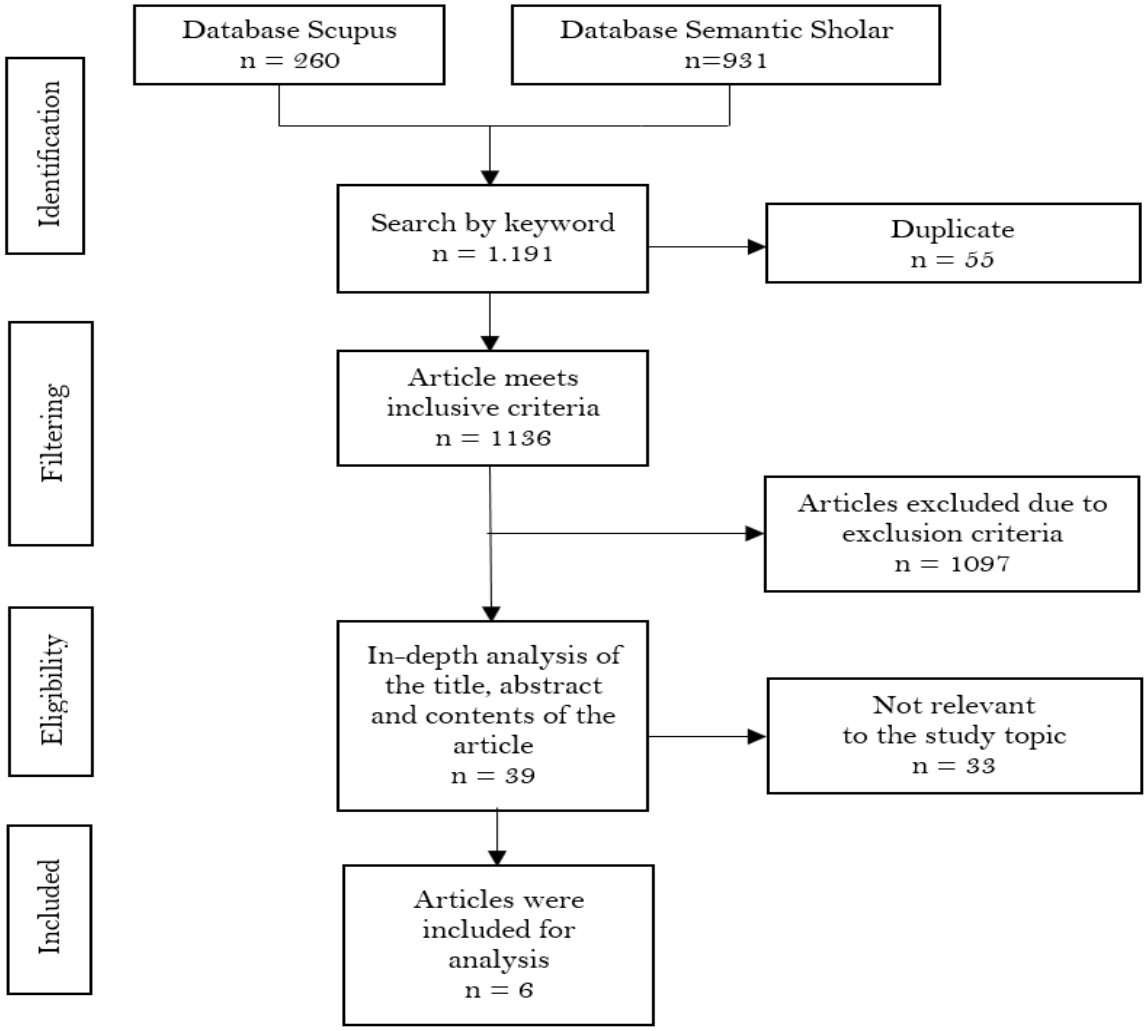

Figure 1.
Prism Stages.

3. Results

The research analyzed in this document reveals interesting findings about exploratory approaches to learning, mainly related to literacy and understanding of academic concepts across various subjects. The studies used qualitative and quantitative methods to evaluate the effectiveness of learning strategies based on exploration, reflection, and interaction in group discussions and journal writing.

Table 1.
Included Research.

No.	Name (year)	Title	Country	Method	Conclusion	Implications	Limitations
1.	Lee, et al. [18]	Exploratory writing in student learning	United States of America	Qualitative research is done by developing exploratory writing learning activities for students. Analyzing reflective essays using constant comparative analysis.	The exploratory writing activity was developed to enhance students' understanding of dress's social, psychological, and cultural aspects. It facilitates deeper engagement and reflection and ultimately assists students in conceptual renewal as they prepare their final group presentations.	This study develops specific learning activities incorporating exploratory writing, which can be used in similar courses. This approach can help educators design more engaging and reflective assignments that encourage a deeper understanding of complex subjects such as the social, psychological, and cultural aspects of clothing.	This study was conducted at a single university in the southern United States, which may limit the generalizability of the findings. A larger, more diverse sample across multiple institutions could provide a broader understanding of the impact of exploratory writing on student learning. Additionally, the exploratory writing activity was conducted over two weeks. This short time frame may not be sufficient to fully assess the long-term effects of exploratory writing on student learning and knowledge retention.
2.	Nurhadi, et al. [19]	"Online group discussion was challenging but we enjoyed it!" an exploratory practice in extensive reading	Indonesian	Student reading logs and semi-structured interviews were used in a qualitative study, and data were analyzed using thematic analysis.	Exploratory practice (EP) enhances students' understanding of extensive online reading by encouraging engagement through group discussions and reading logs, enabling them to recognize their potential and the importance of active participation in learning activities.	This study shows that EP-driven online group work encourages all students to participate actively in learning activities. This engagement is essential for fostering a collaborative learning environment, which can lead to improved language skills and a deeper understanding of the material.	One of the significant limitations noted in this study was the small sample size of participants. This limitation may affect the reliability and validity of the findings, as a larger sample would provide more data and insights. Due to the small sample size, the study's results may not be generalizable to other educational settings or populations. The specific context of the study, involving English language education students, may limit the applicability of the findings to other groups or disciplines.
3.	Colonnese [20]	Exploratory Writing to Support	United States of America	Qualitative research, with personal prose to support mathematical sense-	Exploratory writing enhances students' understanding by allowing them to articulate their	Teachers can significantly improve students' understanding of fractions by implementing personal prose	This paper may not address how to mitigate these risks or provide strategies for teachers to effectively guide students through the writing

No.	Name (year)	Title	Country	Method	Conclusion	Implications	Limitations
		Mathematical Sense Making		making. Communication of ideas about fractions.	thinking about fractions. This personal prose approach facilitates deeper mathematical sense-making and communication of ideas. It encourages reflection and clarity in students' understanding of mathematical concepts.	in the classroom. This method encourages students to articulate their thinking, leading to a clearer understanding of mathematical concepts. When students express their reasoning in writing, they are more likely to identify and correct misconceptions.	process. The emphasis on fractions may limit the applicability of the findings to other areas of mathematics. While fractions are an important component of the curriculum, the methods discussed may not be effective for other mathematical concepts, such as geometry or algebra. These limitations suggest the need for further research to explore the effectiveness of exploratory writing across a range of mathematical topics.
4.	Raga-Abee [21]	Effect of Journal Writing on the Conceptual Understanding of Grade 11 Students in Mathematics	United States of America	Quantitative research with a quasi-experimental design, a sample of 30 Grade 11 students in a San Jose, California, USA district school. Teacher-made test and expert evaluation of journal output.	This study found that journal writing significantly improved Grade 11 students' conceptual understanding of mathematics, with higher improvements observed in the experimental group. Students reported beneficial experiences with journal writing, indicating its positive impact on their learning process.	Experts evaluated the quality of journal output, indicating that journals can serve as valuable assessment tools. Teachers can use journal writing to measure students' understanding and thinking processes, providing insights that traditional tests may not capture.	This study used a quasi-experimental design, which did not randomly assign participants to control and experimental groups. This design may introduce bias and confounding variables that could affect the results, making it difficult to establish a clear cause-and-effect relationship between journal writing and conceptual understanding.
5.	Swamy and Simha [22]	Exploring the Interplay of Conceptual Understanding, Creative Writing Skill, and	India	A qualitative study applied student-centered pedagogy, specifically experiential and inquiry-based learning, focusing on sixth-grade	This study shows that story writing is a practical assessment strategy. It allows students to explore and express their conceptual understanding, creativity, and	This study suggests that traditional assessment methods may not fully capture students' understanding and creativity. Educators can evaluate students' conceptual	This study focused on a specific demographic of 6th-grade students from an urban school. This limited sample may not represent the broader population of students, including those from rural areas or different educational backgrounds. As a result,

No.	Name (year)	Title	Country	Method	Conclusion	Implications	Limitations
		Grammatical Accuracy in Experiential Learning		students from an urban school.	grammatical accuracy, thereby enhancing their learning experience through experiential learning and inquiry-based learning pedagogy.	understanding and writing skills more engagingly and creatively by implementing story writing as an assessment strategy. This approach may lead to more meaningful assessments that reflect students' actual abilities	the findings may not be generalizable to all students, limiting the results' applicability to diverse educational settings.
6.	Banat [23]	The Effects of School-Based Writing-to-Learn Interventions on Academic Achievement: A Meta-Analysis	Lebanon	EP instructional techniques implemented in a writing class Data collected from questionnaires, notes, observations, and video recordings	Implementing Exploratory Practices in writing classes increases students' awareness of the learning process, enabling them to better understand concepts by exercising control over their learning, setting goals, and evaluating their progress effectively.	This study shows that implementing the Exploratory Practice (EP) technique significantly increases students' awareness of their learning process. Educators can use EP to help students better understand how they learn, which can lead to more effective learning habits and strategies.	This study used a questionnaire to measure students' awareness of their learning process, which may be subject to bias inherent in self-reported data. Students may overestimate their awareness or ability to monitor their learning process. Incorporating more objective measures may increase the reliability of the findings.

4. Discussion

4.1. Key Findings

Research shows how various exploratory learning methods can improve students' understanding of various fields of science. In the United States, the exploratory writing approach was applied to improve students' understanding of social, psychological, and cultural aspects. This study used a qualitative method with reflective essay analysis using the constant comparative analysis method. The findings showed that involvement in exploratory writing allowed students to develop a deeper understanding, which helped them in their final group presentations [18]. Meanwhile, research in Indonesia used a qualitative method with data collected through student reading logs and semi-structured interviews, showing that exploratory practices encouraged students' involvement in discussions and reading logs so that they could recognize their potential and understand [19].

The exploratory approach in mathematics was also studied, which highlighted the role of exploratory writing in understanding the concept of fractions. This qualitative study emphasized that personal prose helps students articulate their thoughts about fractions, ultimately improving their understanding of mathematics more deeply. This approach also encourages students to be more reflective and understand abstract concepts [20]. Another study in mathematics was conducted in the United States, which focused on the effect of journal writing on the conceptual understanding of 11th-grade students. Using a quasi-experimental design, this study found that students who used journals experienced a more significant increase in conceptual understanding than the control group. Journal writing improves conceptual understanding and becomes a means of reflection that helps students in the learning process [21].

Furthermore, Swamy and Simha [22] examined the relationship between conceptual understanding, exploratory writing skills, and grammatical accuracy in experiential learning. This qualitative study highlights how story writing can be used as an effective assessment tool, allowing students to express their conceptual understanding through a more creative approach. The results showed that this method increased students' engagement in learning and helped them develop critical thinking skills. The main findings showed that exploratory practice techniques in writing increased students' awareness of their learning process. By understanding how they learn, students become more independent in controlling their learning, setting goals, and evaluating their progress effectively. In terms of research methods, most studies used a qualitative approach, especially with thematic analysis and constant comparative analysis techniques, to explore students' in-depth understanding of the learning material. However, some studies, such as the Raga-Abee [21] study, used a quasi-experimental design to measure the impact of journal writing interventions on students' conceptual understanding.

In conclusion, the studies in this paper provide important insights into how exploratory strategies can be used in various educational contexts. From language learning to mathematics, this approach effectively improves students' understanding, engagement in learning, and reflective ability towards academic material.

4.2. Strategy Implications

The studies reviewed provide significant contributions to the education world, especially in applying exploration-based learning strategies. These findings indicate that exploratory writing can improve student understanding and encourage active learning involvement [24, 25]. One of the main implications revealed in the research of Lee et al. [18] is that exploratory writing can help students think critically about a learning material's social, psychological, and cultural aspects. This shows that this method is an academic tool and a reflection instrument that can deepen students' understanding of complex issues [12, 26]. Teachers can adopt this strategy to encourage students to be more reflective in interpreting the subject matter.

Research in the context of online learning shows that online group discussions can increase student engagement and help them develop exploratory reading skills. His research implies that educators can use technology to encourage student collaboration, even in a virtual environment [19]. Using the exploratory method makes students more motivated to participate actively in academic discussions. Colonnese's [20] research emphasizes that exploratory writing in mathematics helps students articulate their understanding of fractions. Teachers can use this method to deepen students' understanding of abstract concepts in mathematics by memorizing formulas and writing reflections [27, 28]. This approach enriches teaching strategies in mathematics by adding elements of student self-expression to learning.

Another implication of the Raga-Abee [21] study is that journal writing can be an effective assessment tool for measuring student understanding. Teachers can use journals to understand how students think and process information. Journal-based assessments are more reflective than traditional tests, as they allow students to demonstrate their understanding more in-depth and exploratory [29, 30]. Furthermore, Swamy and Simha's [22] study showed that creative writing can be used as an evaluation strategy in experiential learning. This confirms that traditional assessment methods may be less effective in measuring student understanding. By implementing exploration-based strategies such as story writing, teachers can assess students' conceptual understanding more accurately and engagingly [31, 32]. Teachers who apply this method can help students become more aware of how they learn, set academic goals, and evaluate their progress.

4.3. Research Limitations

Despite their substantial implications, these studies also have limitations that need to be considered for interpreting and applying their results on a broader scale. One major limitation is that some studies were conducted in specific academic settings, so the results may not be generalizable to a wider population. For example, Lee et al. [18] studied at only one university in the southern United States, which limits the generalizability of the results. In addition, the study only lasted for two weeks, which may not be enough to measure the long-term effects of the exploratory method on students' understanding. Further studies with a larger sample size and longer research duration are needed to assess the impact more deeply. In the Nurhadi et al. [19] study, the main limitation lies in the small sample size, which may affect the validity of the study results.

In addition, the participants in this study were from English education majors, making it difficult to generalize the results to other disciplines. Further studies involving various academic backgrounds will help confirm the effectiveness of the exploratory strategy in different educational contexts.

Another limitation is seen in Colonnese's [20] study, where the emphasis only on fraction concepts in mathematics may limit the applicability of this method to other areas of mathematics. This study did not examine how exploratory strategies can be applied to different materials, such as algebra or geometry [33]. Therefore, additional research is needed to explore how this method can be applied to various aspects of mathematics learning. In the Raga-Abee [21] study, the quasi-experimental design used did not involve random assignment, which could lead to bias and confounding variables. Without strict controls, it is not easy to be sure that the increase in students' understanding is genuinely due to journal writing and not other external factors [34, 35]. Future studies should use a more rigorous experimental design, such as a randomized controlled experiment (RCT).

Swamy and Simha [22] also had limitations regarding sample demographics, as it only focused on 6th-grade students from urban schools. This means the results may not apply to students from rural areas or with different educational backgrounds [36]. To address this limitation, future studies could involve more heterogeneous samples so that the results are more representative of a broader student population. In the Banat [23] study, the most striking limitation was using questionnaires as the primary method to measure students' awareness of their learning. Data obtained through questionnaires are prone to bias, as students may overestimate their awareness of their learning process [37, 38]. Future studies could combine questionnaires with direct observation methods or longitudinal analysis of student performance to increase validity.

5. Conclusion

This literature review highlights the critical role of writing as an exploratory tool in enhancing students' conceptual understanding. Various studies have shown that writing is a means of communication and a thinking mechanism that helps students build a deeper understanding of academic materials. Methods such as exploratory writing, reflective journals, and writing-based discussions have increased student engagement and enriched learning. In the context of language and literacy learning, exploratory writing allows students to develop critical and reflective thinking about various social and cultural aspects. This finding is consistent with research showing that writing helps students construct deeper meaning through reflection and synthesis of information. Meanwhile, writing is a conceptualization tool in mathematics and science that allows students to articulate their understanding of abstract concepts. Students can better recognize conceptual errors and correct them independently by writing down their ideas. This approach also allows teachers to gain more precise insights into students' thinking, which is difficult to identify through traditional tests alone.

This study also highlights the critical implications of writing in experiential learning. Creative and reflective writing helps students connect theory to real-life experiences, strengthening conceptual understanding. Thus, the exploratory writing method can be applied in literacy-based subjects and the exact and social sciences. However, this study also reveals some limitations in the research that has been conducted. One of the main challenges is the limited sample size in some studies, which reduces the possibility of generalizing the research results to a broader population. In addition, some studies used subjective methods such as questionnaires and interviews, which can produce bias in data interpretation. Therefore, further research with more rigorous experimental designs and more objective data collection methods is needed to strengthen the existing findings.

6. Recommendations

This study confirms that writing has excellent potential for exploring academic concepts. With proper integration into the curriculum, writing strategies can effectively improve students' understanding, critical thinking skills, and reflection on learning materials. Therefore, educators are advised to continue to develop and evaluate writing-based methods to create deeper and more meaningful learning experiences for students.

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