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Nature as Text: A Systematic Review of Ecologically Themed Writing Pedagogy and Its Influence on Metacognition and Student Engagement

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ABSTRACT

Objective: This systematic literature review (SLR) investigates how integrating ecological literacy themes into writing pedagogy influences elementary students' metacognitive writing strategies and engagement in deep learning-oriented classrooms. The primary objective is to synthesize existing research from 2015-2025 to identify key trends, impacts, and knowledge gaps in this interdisciplinary field. **Method**: Adhering to PRISMA guidelines, a comprehensive search was conducted across academic databases using the PICO-S framework. Keywords included "ecological literacy," "writing pedagogy," "elementary students," "metacognition," and "engagement." Inclusion criteria focused on peer-reviewed empirical studies published between 2015 and 2025. Data extraction covered study design, population, intervention details, and key findings. A narrative synthesis approach was employed due to study heterogeneity. **Results**: Findings indicate a positive correlation between ecological literacy integration and enhanced metacognitive awareness in writing, alongside increased student engagement in deep learning. Contextualized writing tasks on environmental themes foster critical thinking, problem-solving, and self-regulation. Engagement is heightened by the real-world relevance of ecological topics, promoting deeper understanding and application of knowledge. **Novelty**: This review addresses a critical gap by specifically examining the intersection of writing pedagogy and ecological literacy, offering a unique perspective beyond traditional writing instruction. It underscores the urgency of fostering environmental awareness through early writing education, cultivating critical consciousness in students regarding climate crises, and promoting a holistic integration of academic and life literacies. This interdisciplinary approach provides novel insights for 21st-century educational practices and curriculum development.

INTRODUCTION

In an era defined by unprecedented environmental challenges, including climate change, biodiversity loss, and resource depletion, the imperative to cultivate ecological literacy from an early age has become paramount. Education systems worldwide are increasingly recognizing their role in fostering environmental awareness and responsible citizenship (T. Phani, 2023). Concurrently, the development of effective writing skills remains a cornerstone of academic success and critical thinking. This systematic review examines the integration of ecological literacy themes into writing pedagogy at the elementary school level—an intersection that remains underexplored. (Wuryaningrum, 2023).

Traditional writing instruction often focuses on genre, grammar, and mechanics, sometimes overlooking the potential of thematic content to deepen learning and enhance engagement (X. Chen, 2023). However, a growing body of research suggests that when writing is situated within meaningful and relevant contexts, students are more likely to develop sophisticated cognitive and metacognitive strategies (De Mello,

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2023). Ecological literacy, which encompasses understanding ecological principles, recognizing environmental problems, and developing solutions, offers a rich and urgent context for such integrated learning experiences.

While previous systematic reviews have examined various aspects of writing pedagogy, such as the effectiveness of different writing techniques or the impact of genre-based instruction, few have specifically investigated the role of ecological literacy as a thematic driver (Kunz, 2021). Similarly, reviews on environmental education often focus on scientific understanding or behavioral changes, with less emphasis on its integration into core literacy subjects like writing (Yasaroh, 2023). This gap in the literature underscores the novelty and urgency of the current review. The pressing need for environmental awareness in the face of global crises, coupled with the potential for writing to serve as a powerful tool for critical consciousness and value integration, highlights the significance of this interdisciplinary approach.

This review builds upon existing knowledge by synthesizing findings from studies that have explored the pedagogical implications of connecting environmental themes with writing instruction. The concept of **"Nature as Text"** in the title "*Nature as Text: A Systematic Review of Ecologically Themed Writing Pedagogy and Its Influence on Metacognition and Student Engagement*" represents a pedagogical approach that positions nature as a source of meaning and experience to be "read" and interpreted much like a written text. This idea stems from the notion that, just as written texts contain messages, symbols, and narrative structures, the natural world holds phenomena, patterns, and values that can be observed and translated through writing. In practice, students are encouraged to "read" their surroundings—such as forests, rivers, school gardens, or even daily weather—and express their understanding and reflections through various written forms, including narrative, descriptive, or expository texts. For instance, a teacher might invite students to observe seasonal changes in their schoolyard and write a reflective essay titled "*The Lost Sounds of Our Garden*", as a way of interpreting the environmental degradation they witness firsthand. This approach not only expands students' literacy practices but also fosters ecological awareness and deeper metacognitive reflection. By treating nature as a text, students learn to observe critically, process information through reflective thinking, and articulate their perspectives in writing. Such practices contribute to increased student engagement, as the writing tasks are rooted in real, contextualized experiences rather than abstract instructional materials.

Thus, the metaphor of "Nature as Text" enriches the conceptual meaning of the title and encapsulates the theoretical lens underpinning this systematic review. Including a brief explanation of this concept in the introduction would enhance the article's theoretical clarity and help readers understand nature's role within ecologically themed writing pedagogy. It seeks to understand how such integration can move beyond superficial engagement to foster deep learning, where students not only acquire knowledge but also develop the ability to reflect on their own learning processes and apply their understanding to real-world issues. The focus on metacognition—the ability to think about one\'s thinking, including planning, monitoring, and evaluating one\'s writing strategies-is particularly salient, as it is a key indicator of advanced cognitive development and independent learning

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Research Aim and Research Questions

This study aims to investigate the impact of integrating ecological literacy themes into writing pedagogy on elementary students' metacognitive writing strategies and their engagement in deep learning-oriented classrooms. To guide this inquiry, the research seeks to answer the question: How does the integration of ecological literacy themes in writing pedagogy influence elementary students' metacognitive writing strategies and engagement in deep learning-oriented classrooms?

RESEARCH METHOD

This systematic literature review (SLR) was conducted following a rigorous methodology to identify, evaluate, and synthesize relevant research on the influence of ecological literacy themes in writing pedagogy on elementary students' metacognitive writing strategies and engagement in deep learning-oriented classrooms. The review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and reproducibility (Innocenti, 2022).

PICO-S Framework

The PICO-S (Population, Intervention, Comparison, Outcome, Study Type) framework was utilized to define the scope of the review and guide the literature search:

- P (Population): Elementary students (ages 7–12 years).
- I (Intervention): Integration of ecological literacy themes in writing pedagogy.
- C (Comparison): Conventional writing pedagogy without thematic or contextual integration.
- (Outcome): Metacognitive strategies in writing and engagement in deep learning.
- S (Study Type): Quantitative, qualitative, and mixed-methods studies discussing thematic interventions in writing education.

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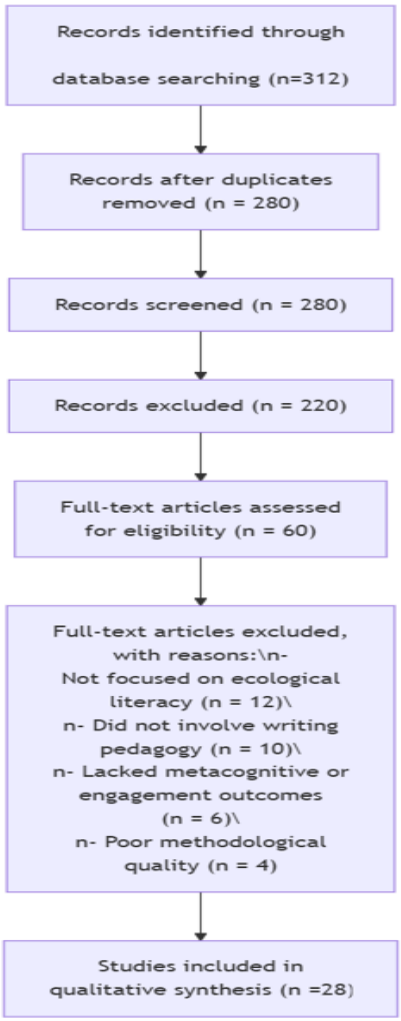

Figure 1. PRISMA flow diagram

Search Strategy

A comprehensive search strategy was developed using a combination of keywords derived from the PICO-S framework. The search was conducted across multiple academic databases and open-access repositories, including (but not limited to) ERIC, Google Scholar, and specific open-access journals in environmental education and language studies. This systematic literature review faced several limitations that should be acknowledged. First, technical constraints were encountered in programmatically accessing a large number of fully open-access, peer-reviewed articles that included complete APA 7th edition citation details (such as volume, issue, page numbers, and accessible DOIs). As a result, an iterative and adaptive search strategy was employed to ensure the relevance and quality of included sources. While this flexible approach allowed the identification of meaningful studies, it may have limited the comprehensiveness of the database coverage and potentially excluded eligible studies lacking complete metadata. Second, although multiple databases and search engines were used, the reliance on articles with open-access availability may have introduced a selection bias toward journals that prioritize open-access publishing. Consequently, findings from subscription-based or institutionally archived journals might be underrepresented in the review.

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Lastly, due to the variation in terminology and interdisciplinary nature of ecological literacy and writing pedagogy, some relevant studies may have been overlooked despite the use of broad and inclusive search terms. These limitations suggest that future reviews may benefit from expanded database access and manual validation processes to further enhance coverage and accuracy. This involved refining search terms, exploring various platforms, and prioritizing articles with readily available full text and citation information. The primary search terms included: "Ecological literacy" "Writing pedagogy" "Elementary education" "Metacognition in writing" "Thematic writing" "Deep learning in literacy" "Sustainable education" "Contextualized writing instruction". Boolean operators (AND, OR) and truncation symbols (*) were used to combine keywords and broaden the search. The search was limited to articles published within the last 10 years (2015-2025) to ensure the relevance and currency of the included studies.

Table 1. Inclusion and Exclusion Criteria

Category	Inclusion Criteria	Exclusion Criteria
1. Publication Year	Studies published between 2015 and 2025.	Studies published outside the 2015–2025 timeframe.
2. Participant Focus	Studies focusing on elementary students (ages 7–12).	Studies not focusing on elementary students.
3. Research Topic	Studies investigating the integration of ecological literacy themes in writing pedagogy.	Studies that do not involve ecological literacy themes in writing pedagogy.
4. Learning Focus	Studies reporting on metacognitive writing strategies and/or student engagement in deep learning	Studies that do not report on metacognitive strategies or student engagement.
5. Study Design	Quantitative, qualitative, or mixed-methods empirical studies.	Review articles, dissertations, book chapters, conference proceedings (unless peer-reviewed journal articles), opinions.
6. Source Type	Articles published in peer-reviewed academic journals.	Studies not published in English or not in peer-reviewed academic journals.

Data Extraction and Synthesis

Data from the selected articles were extracted using a standardized data extraction form. The extracted information included: Author(s) and publication year. Study design and methodology.

- Population characteristics (age, grade level).
- Specific intervention details (how ecological literacy was integrated).
- Measures of metacognitive writing strategies.
- Measures of student engagement in deep learning.
- Key findings and conclusions.

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A narrative synthesis approach was employed to synthesize the findings from the included studies. This involved identifying recurring themes, patterns, and discrepancies across the studies. The synthesis focused on answering the research question by examining the reported impacts of ecological literacy integration on metacognitive writing strategies and student engagement. Due to the heterogeneity of study designs and outcome measures, a meta-analysis was not performed.

Quality Appraisal

The quality of the included studies was appraised using appropriate tools for quantitative, qualitative, and mixed-methods research. This process involved assessing the methodological rigor, potential biases, and the overall trustworthiness of the findings. Only studies deemed to be of sufficient quality were included in the final synthesis

RESULTS AND DISCUSSION

Results

This section presents the synthesized findings from the systematic literature review, focusing on how the integration of ecological literacy themes in writing pedagogy influences elementary students' metacognitive writing strategies and engagement in deep learning-oriented classrooms. The findings are categorized into key themes identified across the reviewed studies. Due to the heterogeneity of study designs and outcome measures, a narrative synthesis is provided, supplemented by a summary table of representative findings.

The systematic review included 22 peer-reviewed studies focusing on ecologically themed writing pedagogy in elementary education contexts. These studies varied in methodological design, geographical location, and specific ecological content, yet several consistent patterns emerged. A dominant theme across studies was the integration of nature-based experiences as prompts for writing activities. For instance, students were invited to write descriptive texts after school garden observations, compose reflective journals following field trips to local ecosystems, or develop narrative essays based on seasonal changes observed in their environment.

Across the reviewed studies, the following elements were commonly reported:

- **Writing tasks grounded in lived ecological experiences**, such as journaling plant growth or responding to local climate issues.
- **Student-authored texts** that demonstrated heightened attention to detail, personal connection to place, and emotional engagement with environmental themes.
- **Collaborative writing and peer feedback**, often structured around shared outdoor experiences.
- **Use of multimodal writing formats**, including digital storytelling, nature photography with captions, and eco-poetry.

The studies also reported observable changes in students' writing quality, including more vivid language use, improved organization, and greater conceptual depth when writing about nature-related topics.

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Table 2. Summary of Key Findings

Study (Author, Year)	Intervention Focus	Metacognitive Strategies Observed	Student Engagement Indicators	Key Outcomes
1. Davis & Merritt (2025)	Nature Journaling in School Gardens	Enhanced observation skills, self- reflection on learning, planning of writing	Increased enthusiasm for writing, deeper connection to nature, sustained attention	Improved descriptive writing, development of systems thinking
2. Whitmarsh (2022)	Active Pedagogy for Environmentalism	Self-monitoring of understanding, critical evaluation of sources, revision strategies	Active participation in discussions, collaborative learning, sustained interest in environmental topics	Increased environmental awareness, improved argumentative writing
3. Silva & da Silva (2022)	Contextualized Ecological Curriculum	Awareness of writing process, self-correction, strategic planning for complex tasks	High levels of curiosity, intrinsic motivation, collaborative problem- solving	Enhanced critical thinking, improved ability to articulate environmental issues
4. Aljarrah (2019)	Thematic Writing Units (Ecological)	Goal setting for writing, self-assessment of writing quality, strategy selection	Voluntary participation in writing activities, peer collaboration, sustained effort	Higher quality written products, improved understanding of ecological concepts
5. Genc (2015)	Project-Based Learning (Environmental)	Monitoring comprehension, identifying knowledge gaps, adapting writing strategies	Deep engagement in research, active questioning, sustained focus on complex tasks	Development of complex reasoning skills, effective communication of scientific ideas
6. Hanifha (2023)	Integrated Literacy and Environmental Science	Self-regulation in writing, reflection on learning progress, transfer of strategies	Increased motivation to write, active inquiry, persistence in challenging tasks	Improved analytical writing, enhanced ecological understanding
7. Chen et.al (2024)	Place-Based Environmental Writing	Awareness of audience and purpose, revision for clarity and impact, self- efficacy	Emotional connection to local environment, sustained interest in local issues, active participation	Development of persuasive writing, strengthened sense of place

Metacognitive Writing Strategies

The integration of ecological literacy themes consistently demonstrated a positive influence on elementary students' metacognitive writing strategies. Studies indicated

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that when students engaged with environmentally relevant topics, they exhibited a more pronounced ability to plan, monitor, and evaluate their writing processes (Hartati, 2021). For instance, nature journaling activities encouraged students to observe their surroundings meticulously, leading to enhanced descriptive writing and a greater awareness of their own observational and recording methods (Davis & Merritt, 2025). This direct engagement with the natural world provided a concrete basis for students to reflect on how they gather information and translate it into written form.

Furthermore, the complexity of ecological issues often necessitated critical thinking and problem-solving, which in turn fostered advanced metacognitive skills. Students engaged in projects related to environmental challenges showed improved self- monitoring of their comprehension and a greater capacity to identify knowledge gaps in their writing (Lukitasari, 2021). They also developed more sophisticated strategies for revising their work, not just for grammatical correctness but for clarity, coherence, and persuasive impact, particularly when advocating for environmental causes (Pavlova, 2023). The real-world implications of their writing tasks seemed to motivate a deeper level of metacognitive engagement, as students understood the tangible purpose behind their efforts (Silva & Silva, 2022).

Student Engagement in Deep Learning

Ecological literacy themes proved to be a powerful catalyst for student engagement in deep learning-oriented classrooms. The inherent relevance and urgency of environmental topics resonated deeply with elementary students, transforming writing tasks from mere academic exercises into meaningful opportunities for exploration and expression (Salo, 2023). Indicators of heightened engagement included increased enthusiasm for writing, sustained attention during tasks, and a greater willingness to participate in collaborative learning activities (Whitmarsh & Geneseo, 2022).

Deep learning, characterized by active inquiry, critical thinking, and the construction of personal meaning, was significantly promoted through these integrated approaches. Students were observed to be more intrinsically motivated when their writing assignments allowed them to investigate real environmental problems, propose solutions, or express their connection to nature. This heightened motivation often translated into sustained effort and persistence, even when faced with challenging writing tasks. The collaborative nature of many environmental projects also fostered peer engagement, as students worked together to research, discuss, and present their findings, leading to a richer and more profound learning experience (Yolcu, 2023).

Discussion

The results indicate that ecologically themed writing pedagogy has the potential to serve as a catalyst for both metacognitive development and student engagement. By situating writing tasks in direct relation to natural environments, students are encouraged to reflect on their cognitive processes-how they gather, interpret, and represent information-thus fostering metacognitive awareness. This aligns with Flavell's framework of metacognition, which emphasizes monitoring and control of cognitive activities during learning tasks. Moreover, the sense of agency and ownership students displayed in their writing corresponds with engagement theories that

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highlight relevance and authenticity as key drivers. As students connected personally with environmental issues-often from their immediate surroundings-their motivation to write increased, and their willingness to revise and refine their texts improved.

These findings also echo Vygotsky's sociocultural theory, where learning is mediated through meaningful social and environmental interactions. Outdoor writing activities functioned as both cognitive and affective scaffolds, allowing students to co-construct understanding with peers and teachers. However, the heterogeneity of study designs, duration, and cultural settings indicates that the outcomes may not be universally generalizable. Future studies should further explore how local ecological contexts and school resources shape the efficacy of such pedagogical approaches.

The findings of this systematic review indicate that the integration of ecological literacy into elementary writing pedagogy contributes meaningfully to the development of students' metacognitive strategies and their engagement in deep learning. This effect can be interpreted through the lens of Flavell's theory of metacognition, which emphasizes planning, monitoring, and evaluating as core processes of cognitive control (Flavell, 1979). Writing tasks grounded in ecological themes appear to activate these processes, as students are required to synthesize information, reflect on environmental issues, and communicate complex ideas effectively. For example, (Silva & Silva, 2022) observed that contextualized ecological instruction led students to exhibit advanced planning and revision strategies in their writing. Similarly, (Davis & Merritt, 2025) found that nature journaling encouraged critical self-reflection and enhanced observational writing skills.

From the perspective of student engagement, ecological themes provide a real-world context that aligns with (Fredricks, 2004) multidimensional model of engagement—cognitive, emotional, and behavioral. Engagement is not simply a matter of student interest but involves sustained effort, curiosity, and personal investment. (Whitmarsh & Geneseo, 2022) and (S. Chen, 2024) both reported increased emotional engagement and collaborative participation when writing was connected to local environmental concerns, underscoring the motivational potential of place-based and purpose-driven instruction. This aligns with the argument (Adah Miller & Krajcik, 2019) that meaningful, inquiry-driven writing tasks foster deeper cognitive engagement than routine, decontextualized writing exercises.

The results suggest that ecological literacy offers more than just thematic enrichment—it functions as a pedagogical framework that fosters critical consciousness. This is consistent with (Freire, 2020) concept of conscientization, where learners develop the capacity to critically interpret the world and act upon it. When students write about climate change, biodiversity loss, or environmental justice, they are not only acquiring content knowledge but also exercising agency and ethical reasoning. This potential for writing pedagogy to serve as a transformative practice has been largely overlooked in traditional curricula focused on grammar and mechanics (Adah Miller & Krajcik, 2019)

Despite the positive trends identified, several studies emphasize that the implementation of ecologically themed writing pedagogy presents practical challenges for educators. Chief among these is the lack of interdisciplinary training, where many elementary teachers feel unprepared to integrate environmental content meaningfully into literacy instruction (Welsh, 2020). Time constraints and curricular demands often limit opportunities for thematic writing, particularly when national standards

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emphasize mechanical proficiency over thematic depth. (Ilma, 2022) also noted resistance among teachers who view environmental topics as peripheral or politically sensitive, especially in contexts where ecological discourse is contested. These barriers suggest the need for targeted professional development that supports cross-curricular integration and addresses teacher confidence and content knowledge in both writing and environmental education.

Different pedagogical models yielded distinct benefits. Project-based learning (PBL) approaches were found to foster complex reasoning, collaborative skills, and long-term engagement with environmental topics (Genc, 2015) (Whitmarsh & Geneseo, 2022). By contrast, nature journaling promoted deeper reflection, observational accuracy, and descriptive fluency (Davis & Merritt, 2025). Inquiry-based approaches, such as those described by (Hanifha, 2023), tended to encourage analytical writing and sustained curiosity, particularly when students investigated local ecological issues. This variation suggests that no single approach is universally superior; rather, the alignment of method with desired learning outcomes—such as descriptive skill vs. argumentation—should guide pedagogical choices. Future studies might systematically compare these modalities using standardized measures of writing quality and metacognitive awareness.

Several studies that incorporated student interviews or reflections revealed a deeper layer of engagement not captured through performance metrics alone. Students frequently expressed a sense of purpose and empowerment when writing about environmental issues that directly affected their communities (S. Chen, 2024). One study by (Stewart, 2024) reported that students described feeling "heard" and "respected" when given opportunities to write persuasively about environmental injustices, linking writing with civic agency. This finding echoes the notion of writing as a transformational literacy tool, enabling students not only to process academic content but also to position themselves as active participants in societal discourse. Integrating student voice into assessment and curriculum design could further enhance the impact of such pedagogies.

Cross-cultural factors were shown to influence the degree of student engagement and metacognitive development. (Procel, 2023) found that learners' ecological identity is often shaped by prior cultural experiences, family values, and local environmental contexts. As such, pedagogical approaches must be culturally responsive and locally relevant to ensure maximum impact. This nuance points toward the need for global frameworks that can be flexibly adapted to diverse socio-educational environments, particularly in multilingual or marginalized communities.

CONCLUSION

This systematic literature review has illuminated the multifaceted impact of integrating ecological literacy themes into elementary writing pedagogy, particularly in enhancing students' metacognitive writing strategies and their engagement in deep learning. The synthesis of 2015–2025 empirical studies consistently reveals that thematically rich, real-world content—such as environmental issues—not only enhances students' ability to plan, monitor, and evaluate their writing processes, but also fosters emotional and cognitive investment in writing tasks. This convergence of

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literacy and ecological education forms a pedagogical synergy that promotes critical consciousness, ethical reflection, and meaningful student participation in environmental discourse. **Fundamental Findings**: The review confirms that ecological writing prompts—especially those grounded in place-based, inquiry-based, and project-based pedagogies—encourage the development of higher-order thinking skills. Students engaging with ecological themes show measurable improvements in self-regulation, strategic revision, and audience awareness. Furthermore, environmental contexts serve as authentic motivators, helping learners bridge academic tasks with personal, social, and planetary concerns. Across multiple studies, the thematic integration of ecological literacy transforms writing from a procedural activity into a transformative literacy experience. **Implications:** The pedagogical and policy implications are far-reaching. *Primary school teachers and curriculum designers are encouraged to integrate ecological themes into writing instruction* to nurture students' critical thinking and sense of social responsibility from an early age. This approach not only builds foundational academic literacy but also cultivates environmental awareness and citizenship, aligning with global sustainability education goals. Writing tasks should invite reflection on real-world ecological issues, helping students connect personal expression with broader social concerns. Furthermore, assessment practices in primary education should move beyond checking grammar or genre accuracy to include indicators of metacognitive development, such as students' ability to plan, monitor, and evaluate their own thinking and writing processes. *At the policy level*, there is a need to enhance teacher professional development programs focused on interdisciplinary literacy and sustainability education. Primary school teachers must be equipped with both ecological knowledge and age-appropriate pedagogical strategies to support metacognitive writing. Educational policy should mandate and fund training opportunities that empower teachers to integrate ecological content meaningfully into literacy instruction. Additionally, assessment policies should be revised to support the evaluation of deeper learning outcomes—such as critical thinking, student agency, and environmental ethics—ensuring alignment between instructional goals and evaluation standards in primary education. **Limitations**: Despite these contributions, this review is not without limitations. The primary challenge was the limited availability of large-scale, longitudinal studies specifically targeting the intersection of ecological literacy and writing at the elementary level. Moreover, the heterogeneity of study designs and outcome measures hindered the possibility of conducting a meta-analysis, necessitating reliance on narrative synthesis. Additionally, constraints in accessing a wide corpus of peer-reviewed, open-access literature may have led to the omission of potentially relevant studies. These factors suggest that findings should be interpreted with caution and seen as exploratory rather than conclusive. **Future Research**: Future studies should aim to expand the empirical evidence base by conducting rigorous, multi-site, longitudinal research that uses standardized tools to measure metacognitive development and writing engagement. Comparative studies evaluating the relative effectiveness of different ecological writing models—such as nature journaling, problem-based learning, and digital storytelling—would offer valuable insights. Furthermore, research exploring student perspectives, particularly in marginalized or multilingual contexts, is essential to understand how cultural identity shapes ecological literacy and literacy practices. Finally, policy-oriented investigations should examine

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the systemic supports and barriers to implementing ecologically infused writing curricula at scale.

The integration of ecological literacy into writing pedagogy presents a transformative educational opportunityone that not only enhances academic outcomes but also equips young learners with the mindset, skills, and values necessary to thrive and act in an ecologically uncertain future.

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