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RESEARCH ARTICLE

Formulating a conceptual model of scientific writing instruction integrating critical media literacy and ecosophy for senior high school students

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ABSTRACT
This study aims to formulate a conceptual model of scientific writing instruction integrating critical media literacy and ecosophy through ecological issues as a context for inquiry. The study employed a Design and Development Research (DDR) approach involving needs analysis, conceptual synthesis, model formulation, and design evaluation. The needs analysis involved 76 senior high school students, one Indonesian Language teacher, and one Geography teacher. The data were analysed descriptively and qualitatively to develop the conceptual model and its didactic blueprint. The findings resulted in four interconnected components: ecological issues as the context for inquiry, critical media literacy as a mechanism for examining information, scientific writing as a process of knowledge construction, and ecosophy as a reflective orientation towards human–environment relationships. These components were translated into five didactic phases: (1) ecological issue orientation and problem formulation; (2) information exploration and data collection; (3) data analysis and scientific paper planning; (4) scientific paper construction; and (5) presentation, revision, and ecosophical reflection. The design underwent qualitative expert review and major revisions, followed by practitioner assessment and comprehension testing. The practitioner assessment yielded 85.56% (77/90), while the comprehension test achieved an average of 91.67% across three assessments (92%, 87%, and 96%). These results indicate that the revised design was well understood and received a positive practical assessment. This study contributes a conceptual instructional model and didactic blueprint integrating critical media literacy and ecosophy into secondary school scientific writing instruction. However, the model has not been implemented in classrooms, and its effectiveness remains to be empirically investigated.

Keywords: conceptual model; critical media literacy; ecosophy; scientific writing; design and development research.

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INTRODUCTION

The continuous development of the digital environment has transformed how students acquire, understand, and use information. Beyond teacher-provided resources, students access information through social media, search engines, video-sharing platforms, and other digital sources. Although this access broadens learning opportunities, it also requires students to assess information credibility, relevance, and accuracy. A systematic review of critical online literacy in school contexts emphasizes that digital literacy extends beyond technical skills to include critical engagement with digital information (Ilomäki et al., 2023). Accordingly, scientific writing instruction should develop students' abilities to search for, evaluate, analyze, and use information rather than focus solely on writing structures and conventions.

These demands become more complex when students engage with environmental issues, which involve not only physical conditions but also human behavior, social interests, consumption patterns, public policies, and media representations. Research on environmental literacy among high school students underscores the importance of education in fostering understanding of environmental sustainability (Hermawan et al., 2022). Students therefore need to examine information sources, identify underlying perspectives, compare accounts, and relate media content to actual ecological conditions. Information about pollution, waste, climate change, ecosystem degradation, and environmental disasters should consequently be approached through critical evaluation rather than unreflective acceptance.

Language learning provides opportunities to integrate ecological issues through reading and writing activities. Ali et al. (2024) demonstrate the potential of ecoliteracy integration to connect language education with environmental understanding and pro-environmental habits. However, integrating ecoliteracy does not necessarily equip students to critically evaluate environmental information from digital media or transform it into evidence-based scientific arguments. This gap highlights the need for an integrated learning framework connecting critical media literacy, scientific writing, and ecological reflection.

An ecological approach is essential for understanding the relationships between education, human subjectivity, and the environment. Guattari's ecosophy conceptualizes ecological issues through three interconnected dimensions: environmental ecology, social ecology, and mental ecology, emphasizing the interdependence of environmental conditions, social relationships, and human subjectivity. Recent studies have revisited this perspective in educational contexts. Moor and Zubiaurre (2023) highlight the relevance of ecosophy in

developing ecological awareness and rethinking human relationships with the environment, while Rodríguez et al. (2022) emphasize its contribution to planetary ecosophical education. Stratford (2024) further explores ecological subjectivity and ecological curriculum development. Together, these perspectives establish ecosophy as a reflective foundation for examining environmental issues through the interconnected dimensions of human, social, and environmental relationships.

Previous studies have addressed digital and critical media literacy, ecological awareness, and scientific argumentation as complementary educational concerns. Afrilyasanti et al. (2023) examine critical engagement with digital information, while López (2023) and Lo Iacono et al. (2024) highlight the potential of ecomedia literacy to connect media analysis with ecological awareness and sustainable behavior. In scientific writing education, Newell and Misar (2022) emphasize evidence-based argumentation, while Dawson (2024) demonstrates its relevance to socioscientific issues. However, the integration of critical media literacy, scientific writing instruction, and Guattari's ecosophy into a coherent conceptual learning model for secondary education remains insufficiently explored. These dimensions offer complementary functions: critical media literacy supports the evaluation and verification of information; scientific writing facilitates its transformation into evidence-based arguments; and ecosophy provides a reflective orientation for understanding relationships between human activities, social conditions, and the environment. Their integration offers a conceptual foundation for scientific writing instruction that incorporates critical inquiry and ecological reflection beyond textual competence.

The research gap lies not merely in incorporating environmental literacy or digital media into scientific writing instruction, but in establishing a coherent relationship among ecological issues, critical media engagement, scientific inquiry, and ecological reflection. This integration requires ecological issues to serve as the learning context, critical media literacy to guide the examination of information, scientific inquiry to transform evidence into written arguments, and ecosophy to encourage reflection on human–environment relationships. Thus, critical media literacy and ecosophy function as interconnected orientations rather than supplementary learning materials. This approach aligns with ecomedia literacy perspectives that integrate critical media engagement and ecological awareness (Lo Iacono et al., 2024), as well as systematic approaches to conceptual model development that connect problem identification, theoretical foundations, and educational contributions (Tusquellas et al., 2025).

This study formulates a conceptual model of scientific writing instruction integrating critical media literacy and ecosophy, with ecological issues as its instructional starting point. The model comprises five interconnected phases: (1) ecological issue orientation and problem formulation; (2) information exploration and data collection; (3) data analysis and scientific paper planning; (4) scientific paper construction; and (5) presentation, revision, and ecosophical reflection. These phases guide students in identifying ecological problems, evaluating media information, gathering and analyzing evidence, constructing scientific arguments, and reflecting on human–environment relationships. The model is elaborated through a didactic blueprint specifying learning objectives, activities, information sources, and the integration of critical media literacy and ecosophical orientations in each phase. Accordingly, scientific writing is positioned as an inquiry process that extends beyond textual production to include critical media engagement, evidence-based knowledge construction, and ecological reflection.

Based on this rationale, the study addresses the following research questions. (1) What are the initial learning conditions, students' needs, and learning barriers in scientific writing instruction, particularly in relation to critical engagement with media discourse and ecological issues?, (2) How can critical media literacy and Guattari's ecosophy be integrated into a conceptual model of scientific writing instruction for secondary school students?, (3) How is the formulated conceptual model assessed in terms of its content appropriateness, practitioner appraisal, and comprehensibility?.

In response to these research questions, this study aims to: (1) identify the initial learning conditions, students' needs, and learning barriers in scientific writing instruction in relation to media discourse and ecological issues; (2) formulate a conceptual model of scientific writing instruction that integrates critical media literacy and ecosophy through ecological issues as the contextual and instructional starting point; and (3) examine the model's appropriateness and comprehensibility through expert assessment, practitioner evaluation, and a readability assessment. The study also produces a didactic blueprint as an operational elaboration of the conceptual model. Rather than claiming to demonstrate instructional effectiveness, the proposed model is intended to provide a theoretical and pedagogical foundation for designing scientific writing instruction that connects textual competence with critical media engagement, evidence-based inquiry, and reflective understanding of human–environment relationships.

METHOD

This study employed an adapted Design and Development Research (DDR) approach to formulate a conceptual model for designing a digital module for scientific writing instruction in Indonesian language learning, integrating critical media literacy and ecosophy. Design-oriented research provides a framework for addressing educational problems through systematic investigation, theoretical grounding, and design evaluation (Tinoca et al., 2022; Jacobsen & McKenney, 2024). Methodological alignment among research questions, design procedures, data sources, and intended outcomes is also central to educational design research (McKenney & Reeves, 2025). Accordingly, the procedure comprised four stages: (1) initial situation and needs analysis to identify instructional conditions, student needs, and relevant ecological issues; (2) design and theoretical synthesis integrating scientific writing instruction, critical media literacy, and ecosophy; (3) conceptual development producing a conceptual model and didactic blueprint; and (4) conceptual evaluation through expert review, practitioner assessment, and a comprehensibility test. The study focused on developing and evaluating a theoretically grounded conceptual design rather than testing the effectiveness of a completed instructional product.

Data sources corresponded to the research and evaluation stages. The needs analysis involved 76 Grade XI students, one Indonesian Language teacher, and one Geography teacher. Students provided information about their scientific writing experiences, learning needs, media use, and understanding of environmental issues. The Indonesian Language teacher described instructional practices and challenges, while the Geography teacher identified relevant local ecological issues and concepts. During evaluation, one Indonesian Language teacher assessed the model as a practitioner, three teachers participated in the comprehensibility test, and one expert in Indonesian language learning materials reviewed the conceptual model. These multiple perspectives provided contextual information for model development and evaluation, consistent with the iterative and context-sensitive orientation of educational design research (Jacobsen & McKenney, 2024; McKenney & Reeves, 2025).

Data collection employed questionnaires, structured interviews, document analysis, and evaluation instruments. A student needs-analysis questionnaire was administered to the 76 students to identify their learning experiences, difficulties in scientific writing, media use, information-evaluation practices, and needs regarding the proposed digital module. Structured interviews were conducted with the Indonesian Language and Geography teachers to explore instructional practices, learning obstacles, the use of media-based

information, and the relevance of local ecological issues to scientific writing instruction. Document analysis covered relevant curriculum documents, learning materials, and information about local environmental issues. These data were used to establish the contextual and theoretical basis for the conceptual model. During the evaluation stage, an expert-review instrument was used to obtain feedback on the conceptual foundations, model components, learning syntax, and integration of critical media literacy and ecosophy. A practitioner-assessment instrument was used to examine the clarity and potential applicability of the model in instructional contexts. In addition, a comprehensibility instrument was administered to three teachers to examine the clarity of the model's concepts, components, learning stages, and didactic blueprint. Expert judgment and qualitative feedback are relevant to examining the content and clarity of educational designs and instruments before further development (Anggara & Abdillah, 2023; Setiawan et al., 2024). The comprehensibility assessment also considered the clarity and accessibility of the educational design, which are important aspects of evaluating educational materials (Choi et al., 2022).

Data analysis combined qualitative and quantitative descriptive procedures. Qualitative data from teacher interviews, document analysis, ecological issue mapping, and expert comments were analyzed thematically. The analysis involved organizing the data, identifying relevant patterns, grouping findings into themes related to scientific writing instruction, critical media literacy, and ecosophy, and interpreting their implications for the conceptual model. Thematic analysis was used to identify patterns of meaning across the qualitative data, following the emphasis on systematic and theoretically informed interpretation described by Braun and Clarke (2021). The results of the needs analysis were then synthesized with relevant theoretical perspectives to formulate the model's conceptual components and didactic design blueprint. Feedback from the expert was examined descriptively to identify aspects requiring revision. When the expert recommended major revisions without providing a numerical score, the comments and recommendations were treated as qualitative evaluation data rather than converted into numerical results.

Qualitative data obtained from teacher interviews, document analysis, ecological issue mapping, and expert comments were analyzed thematically. The analysis involved organizing the data, identifying relevant patterns, grouping the findings into themes related to scientific writing instruction, critical media literacy, and ecosophy, and interpreting their implications for the conceptual model. Thematic analysis followed the systematic and theoretically informed approach described by Braun and Clarke (2021). Findings from the

needs analysis were synthesized with relevant theoretical perspectives to formulate the conceptual components and didactic design blueprint. Expert feedback was analyzed descriptively to identify aspects requiring revision. When the expert recommended major revisions without providing a numerical score, the comments and recommendations were treated as qualitative evaluation data.

Quantitative data from the practitioner assessment and comprehensibility test were analyzed using descriptive percentage calculations. The percentage was calculated by dividing the obtained score by the maximum possible score and multiplying the result by 100%. For the comprehensibility test, the scores from the three teacher assessors were averaged to obtain an overall description of the model's comprehensibility. The resulting percentages were interpreted using the assessment criteria established in the study. The qualitative feedback and quantitative assessment results were considered together to identify aspects requiring refinement. The evaluation was limited to expert review, practitioner assessment, and comprehensibility testing to examine the conceptual coherence, instructional feasibility, and clarity of the proposed model and its didactic design blueprint. No classroom implementation or effectiveness testing was conducted.

RESULTS AND DISCUSSION

Needs Analysis for Scientific Paper Learning

A needs analysis examined students' initial conditions and learning problems underlying the conceptual model. Data were collected through a 19-item, five-point questionnaire completed by 76 students and interviews with one Indonesian Language teacher and one Geography teacher. The findings indicated that difficulties were concentrated in the early stages of scientific writing: 54.7% of students reported difficulty determining a topic (46.7% agree, 8.0% strongly agree), 55.3% struggled to find relevant sources, and 44.0% had difficulty constructing arguments from data. These findings suggest that students' challenges begin before text composition, particularly in identifying relevant issues and developing research problems. Similar difficulties have been reported among master's students in selecting topics and formulating research problems (Sitompul & Anditasari, 2022). Teachers have also identified challenges in developing Grade XI students' critical thinking through scientific writing (Rusdiyana et al., 2025), reinforcing the importance of integrating digital literacy and critical thinking into secondary education (Rahayu et al., 2022).

Regarding digital information practices, 80.3% of students reported re-checking information (46.1% agree, 34.2% strongly agree), 77.0% compared multiple sources, and 68.4% considered the source or author. However, agreement was lower for analytical abilities: 60.5% reported being able to distinguish facts from opinions, while only 52.0% could recognize biased or non-objective information, with 37.3% expressing a neutral response. These findings indicate that verification habits do not necessarily reflect comprehensive critical media literacy, which also involves examining information sources, production contexts, underlying perspectives, and potential interests (Ilomäki et al., 2023; Weisberg et al., 2023). Because the findings are self-reported, they indicate students' initial perceptions rather than demonstrated competence. This distinction is supported by Brodsky et al. (2023), who found that students' stated preferences for lateral reading did not necessarily translate into actual practice before instruction. Nevertheless, school-based interventions have improved students' abilities to investigate web sources and assess online credibility (McGrew & Byrne, 2021; Wineburg et al., 2022). These findings support embedding source evaluation and critical information analysis into authentic scientific writing activities.

Teacher interviews provided contextual explanations for students' difficulties in connecting scientific writing with real-world problem investigation. While the questionnaire identified challenges in topic development and information evaluation, interviews revealed that instruction primarily emphasized text structure, organization, and writing conventions. Consequently, problem identification, source exploration, media evaluation, and evidence-based argumentation had not been sufficiently integrated into a coherent learning process. This finding reinforces the importance of developing digital literacy and critical thinking in secondary education (Rahayu et al., 2022). Accordingly, scientific writing instruction needs to incorporate information exploration and evidence evaluation as integral stages of idea development, rather than focusing solely on producing structurally correct texts.

This need is particularly relevant when scientific writing addresses local ecological issues, including waste management, pollution, environmental degradation, and ecological disasters identified in the needs assessment. Such issues connect learning with students' social and environmental realities, consistent with the importance of environmental literacy for understanding sustainability (Hermawan et al., 2022). These findings inform an interconnected model in which ecological issues provide the learning context, critical media literacy guides information evaluation, scientific inquiry supports evidence collection and

analysis, and scientific paper writing serves as the culminating activity. Ecosophy provides a reflective orientation for examining relationships among environmental conditions, human behavior, and social contexts, while encouraging awareness of environmental responsibility. Thus, the needs assessment informs the selection and organization of the model components and their corresponding learning activities.

Conceptual Model Formulation and Didactic Blueprint

The needs analysis revealed that challenges in scientific writing extended beyond text production to pre-writing activities, particularly identifying research problems, selecting topics, evaluating information sources, and using evidence to develop ideas. These findings indicate the need for structured learning that supports knowledge construction before written argumentation. Rusdiyana et al. (2025) similarly identified difficulties in students' critical thinking through scientific writing, including interpretation, analysis, evaluation, inference, and explanation. Wang et al. (2022) emphasized the role of structured inquiry and epistemological understanding in developing scientific literacy. Meanwhile, Currie and Kelly (2022) highlighted reflexive dimensions of media engagement, and Gill and Stewart (2024) demonstrated how critical media literacy encourages students to question media representations and consider alternative perspectives. Synthesizing these perspectives, the proposed model positions scientific writing as a knowledge-construction process involving problem identification, critical information exploration, evidence evaluation, data analysis, and argument development.

The conceptual model integrates three complementary components: critical media literacy, scientific writing instruction, and ecosophy. Critical media literacy guides students in accessing, selecting, verifying, and evaluating information; scientific writing provides the central process for investigating ecological issues, analyzing evidence, and constructing scientific arguments; and ecosophy offers a reflective orientation for examining relationships among environmental conditions, human behavior, and social contexts, including environmental responsibility. This orientation draws on Hung (2023), who situates ecosophy within philosophical ecopedagogy, and van de Wetering et al. (2022), who synthesize evidence on the contribution of environmental education to young people's environmental knowledge and attitudes. These components are operationalized through a didactic blueprint comprising five interconnected phases: (1) Ecological Issue Orientation and Problem Formulation; (2) Information Exploration and Data Collection; (3) Data

Analysis and Scientific Paper Planning; (4) Scientific Paper Construction; and (5) Presentation, Revision, and Ecosophical Reflection. The blueprint specifies learning objectives, teacher and student activities, information sources, and expected outputs, culminating in a scientific paper based on ecological investigation.

The first component, critical media literacy, guides students in accessing, selecting, examining, and evaluating information throughout scientific writing. Beyond technical digital skills, it emphasizes assessing the credibility, relevance, accuracy, and perspectives represented in media content. Ilomäki et al. (2023) identified critical attitudes and practices as essential dimensions of digital literacy in school education, while Wuyckens et al. (2022) highlighted the conceptual connections among media, information, and digital literacy. In Indonesian language learning, Amami and Wahyuni (2022) demonstrated the potential of literacy-based practices to develop critical thinking. These perspectives inform activities in which students identify information sources, compare media accounts, examine supporting evidence, distinguish facts from opinions, and assess information relevance to ecological research problems. For example, when examining media reports on waste management or pollution, students evaluate source credibility and compare claims before using relevant evidence to construct scientific arguments. Such activities connect critical media reading with data interpretation and evidence-based writing, consistent with the importance of interpretation, analysis, evaluation, and inference in scientific writing (Rusdiyana et al., 2025). Accordingly, critical media literacy functions as an epistemic foundation integrated throughout problem formulation, information exploration, data analysis, and scientific paper construction, rather than as an isolated preliminary activity.

Critical media literacy is further connected to ecosophy as the model's ecological reflective orientation. Rather than serving as additional environmental content, ecosophy provides a philosophical perspective for examining human–environment relationships and the consequences of human values and practices toward nature. Shamaieva et al. (2023) identified harmony, resilience, and sustainability as important dimensions of ecosophy in language education. Similarly, Triyono et al. (2023) demonstrated how ecological values are represented in Indonesian senior high school English textbooks, while highlighting limitations in the environmental skills promoted through these materials. These studies indicate the potential of language learning to connect textual interpretation with environmental and social reflection. Accordingly, the proposed model incorporates ecosophical reflection in its final phase, where students reconsider their research findings

by examining relationships among environmental conditions, human actions, and social contexts, and articulate their responsibilities toward sustainability.

The use of ecological issues as an instructional context is also supported by research on environmentally responsive Indonesian language learning. Perdani and Ambarwati (2025) examined environmental concerns in the children's story Terdampar di Dunia Plastik, illustrating how literary texts can promote environmental awareness and responsibility. However, presenting environmental issues as textual themes does not necessarily involve systematic inquiry or critical information evaluation. The proposed model extends this approach by positioning ecological issues as starting points for investigation. Students identify environmental problems, critically examine media information, collect and analyze evidence, and construct scientific arguments before revisiting the issues through ecosophical reflection. This sequence connects ecological contexts, critical media literacy, scientific inquiry, and writing within an integrated conceptual design, rather than treating environmental content and reflective activities as separate instructional elements.

The conceptual model is structured around the functional relationship between scientific paper writing as the central learning process and three supporting components: local ecological issue mapping, critical media literacy, and an ecosophical perspective. Local ecological issue mapping provides the contextual foundation and inspiration for learning by introducing students to various environmental problems in Malang Regency. Critical media literacy provides the basis for accessing, selecting, verifying, comparing, and evaluating the credibility of information used by students to investigate these issues. Meanwhile, the ecosophical perspective offers a reflective foundation for understanding the relationships among humans, society, and the environment through the dimensions of environmental, social, and mental ecology, as proposed in Guattari's The Three Ecologies. These three components are integrated into scientific paper writing, which guides students in constructing data-based and argumentative papers while developing ecological awareness. The reciprocal relationships among the components indicate that ecological contexts, information-processing activities, and ecosophical reflection do not operate independently but mutually support the overall learning process. This integration is intended to produce students' scientific papers as the primary learning outcome, alongside the development of critical media literacy competencies and ecological attitudes and values. The functional relationships and underlying principles of the model are illustrated in Figure 1.



Figure 1. Functional relationships and underlying principles of the conceptual instructional model

Critical media literacy is integrated into the proposed model as an ongoing process of accessing, examining, and evaluating information throughout scientific inquiry. Rather than accepting media content at face value, students are guided to explore information, verify its sources, compare different representations, and assess its relevance to the ecological issues being investigated. This process is important because digital information is produced and circulated within particular contexts and may reflect different perspectives, interests, and forms of representation. Ilomäki et al. (2023), through a systematic review of critical digital literacies in school education, identified media literacy and information literacy as important dimensions of critical engagement with digital environments. Their findings provide a basis for incorporating critical media literacy into the proposed model, particularly through activities that require students to examine source credibility, distinguish factual information from opinion, and evaluate information before using it as evidence. Accordingly, critical media literacy is not introduced as a separate instructional unit but is embedded across the stages of inquiry and scientific paper writing.

The second component, ecosophy, provides a reflective orientation for examining ecological issues through the interconnected environmental, social, and mental dimensions of human life. Shamaieva et al. (2023) associated ecosophy in language education with harmony, resilience, and sustainability, while Cole (2023) discussed its pedagogical

potential in connecting climate change education with broader social and philosophical concerns. These perspectives inform the model's operationalization of Guattari's (2000) three ecologies through students' examination of environmental conditions, human practices, and social contexts. This orientation encourages students to move beyond describing ecological problems toward reflecting on human responsibilities and the sustainability implications of their actions.

The integration of critical media literacy and ecosophy is facilitated through scientific paper writing as the central learning process. Students transform information from media sources and field observations into evidence-based knowledge by identifying problems, collecting and analyzing data, constructing arguments, and communicating findings. Rusdianto et al. (2023) demonstrated the relevance of question-prompt scaffolding in supporting students' scientific writing, highlighting the need for structured guidance throughout the writing process. Accordingly, scientific paper writing functions as both the expected learning output and the process through which critical information analysis is developed into systematic arguments and connected with ecosophical reflection.

The conceptual relationships among the model components are translated into a didactic blueprint specifying learning objectives, activities, information sources, and expected outputs for each phase. Previous studies have explored ecological integration in Indonesian language learning through environmental activities and learning products (Samsiyah, 2024) and the representation of ecological literacy in learning materials under the 2013 and Merdeka Curricula (Nada & Listiana, 2024). However, these studies do not establish the integrated process of critical media evaluation, ecological inquiry, scientific paper construction, and ecosophical reflection proposed in this study. The blueprint organizes this integration into five interconnected phases: (1) Ecological Issue Orientation and Problem Formulation; (2) Information Exploration and Data Collection; (3) Data Analysis and Scientific Paper Planning; (4) Scientific Paper Construction; and (5) Presentation, Revision, and Ecosophical Reflection. Each phase specifies the learning activities and expected outputs while maintaining the study's scope as conceptual design development rather than implementation or effectiveness testing.

Phase 1. Ecological Issue Orientation and Problem Formulation

The first phase connects students' prior experiences with local ecological issues that can be investigated through scientific inquiry. News reports, texts, photographs, and other

digital information introduce environmental problems within students' surroundings. This approach is consistent with ecopedagogical Indonesian language learning, which uses environmental contexts to develop ecological awareness (Samsiyah, 2024; Nada & Listiana, 2024). However, the proposed model extends this approach by positioning local ecological issues as starting points for student-led inquiry. Students identify an issue and examine its possible causes, consequences, and affected parties to develop a specific and investigable research topic.

Research problem formulation is guided by questions and an initial examination of how ecological issues are represented across information sources. Students distinguish factual statements from opinions or assumptions, identify gaps in existing information, and consider what evidence is needed to investigate the issue. The teacher facilitates this process through questions about environmental conditions, human activities, and affected communities. These activities introduce critical media literacy by encouraging students to examine media representations critically, while establishing an ecosophical orientation toward the relationships between humans, society, and the environment. The phase concludes with a focused research question or problem statement to guide subsequent information exploration and data collection.

Phase 2. Information Exploration and Data Collection

The second phase focuses on searching for, selecting, comparing, and organizing information and data relevant to the research problem. Students consult multiple sources, including digital media, academic publications, institutional documents, and local data, rather than relying on a single source. Rojas-Estrada et al. (2024) highlight the importance of systematically integrating media and information literacy into curriculum and learning activities. Accordingly, students are guided to document source details, compare information across sources, and collect relevant data through document examination, media reports, or direct observations. Evaluating source credibility and information relevance is essential to ensure that the evidence used in scientific papers is traceable and accountable. Weisberg et al. (2023), through the Critical Online Information Evaluation (COIE) model, emphasize the importance of developing students' ability to critically evaluate online information before using it to construct knowledge and arguments. This principle is reflected in activities requiring students to examine source credibility, compare claims and supporting evidence, identify differences in perspective, and assess information relevance to their research

questions. Students then document and organize the selected information and data according to the research problem. Thus, critical media literacy becomes an integral part of scientific inquiry, producing an evidence base for data analysis and scientific paper planning in the subsequent phase.

Phase 3. Data Analysis and Scientific Paper Design

The third phase involves processing and analyzing collected information and data to develop a scientific paper. Students classify data, compare findings across sources, examine their relevance to research questions, and select evidence to support their arguments. Rather than merely transferring information into writing, students interpret and evaluate evidence to construct knowledge. In line with Eymur and Çetin (2024), inquiry-based learning engages students in scientific practices, knowledge development, and communication of research findings. Critical media literacy is integrated through evaluating the relevance, sufficiency, and credibility of evidence, while ecosophy guides students in examining the interconnected environmental, social, and mental dimensions of ecological issues. Based on this analysis, students develop a scientific paper outline by determining the discussion focus, main ideas, supporting evidence, and direction of arguments for each section. Teachers provide guiding questions to ensure alignment among research questions, available data, and arguments, while students identify information gaps requiring further investigation. As Diningrum and Alatas (2025) highlight, ecological contexts in writing activities can support students' writing skills and environmental awareness. Thus, this phase produces a scientific paper outline that systematically connects ecological issues, evidence, analysis, and arguments as the basis for constructing the complete paper in the subsequent phase.

Phase 4. Scientific Paper Construction

The fourth phase involves developing the scientific paper outline into a complete and systematic paper. Students connect main ideas, analytical findings, and selected evidence into coherent arguments by constructing an introduction, developing the discussion through evidence interpretation, and formulating conclusions that address the research questions. Writing is positioned not merely as fulfilling structural requirements but as knowledge construction through the organization, interpretation, and communication of research findings. Consistent with Eymur and Çetin (2024), inquiry practices and communication of

research findings support students' knowledge development. Accordingly, the scientific paper represents knowledge constructed through students' investigation of ecological issues.

Critical media literacy remains integrated through continuous examination of source relevance, information accuracy, contextual integrity, and the adequacy of evidence supporting arguments. Students revisit original sources and revise relevant sections when inconsistencies or insufficient evidence are identified. Meanwhile, ecosophy guides students to move beyond describing environmental conditions by considering human–environment relationships, social responsibility, and ecological awareness. Thus, both principles underpin the construction of scientific papers rather than function as separate instructional components. This phase produces a complete scientific paper presenting students' investigation and analysis of ecological issues through evaluated information and evidence-based arguments.

Phase 5. Presentation, Revision, and Ecosophical Reflection

The fifth and final phase integrates presentation, revision, and ecosophical reflection to consolidate students' learning about ecological issues. Students present their scientific papers by explaining the investigated issues, sources, collected data, analytical processes, and arguments. Through peer discussions, they respond to questions, consider alternative perspectives, and evaluate evidence relevance and argument coherence. Erenler et al. (2025) highlight the potential of argument-driven inquiry to engage students in constructing arguments and examining evidence. Accordingly, presentation activities enable students to communicate findings and justify arguments, while feedback provides a basis for revising their papers. Students then revise content accuracy, organization, evidence adequacy, argument coherence, and academic language.

The revision process is followed by ecosophical reflection, in which students reconsider the investigated ecological issues and their understanding of human–environment relationships. This reflection encourages examination of human behavior, environmental conditions, and their social and ecological consequences, as well as more responsible environmental practices. Samsiyah (2024) highlights the contribution of ecopedagogical content in Indonesian language learning to ecological awareness, while Sarasati (2024) examines the role of ecological representations in textbooks in fostering such awareness through critical discourse analysis. These perspectives support connecting

scientific findings with broader environmental and social concerns through ecosophical reflection. Thus, this phase produces a revised scientific paper and an ecosophical reflection linking students' research findings to their understanding of human–environment relationships..

The five phases collectively illustrate how the didactic blueprint organizes ecological issues, critical media literacy, inquiry, scientific writing, and ecosophical reflection within the teaching of scientific paper writing. The first phase establishes the ecological context and formulates research questions; the second develops students' abilities to explore, access, and evaluate information; the third involves analyzing information and designing the scientific paper; the fourth focuses on constructing the paper based on the findings; and the fifth facilitates the communication, revision, and ecosophical reflection of the completed work. Throughout these phases, critical media literacy functions as an analytical resource that guides students in engaging with information during scientific inquiry and writing activities. Meanwhile, ecosophy provides an overarching orientation that connects the identification of ecological issues with reflection on human–environment relationships across environmental, social, and mental dimensions. Together, these elements establish a didactic design that integrates critical media literacy, scientific paper writing, and ecological awareness in secondary school Indonesian language learning. However, because this study is limited to the formulation and validation of a conceptual design, further empirical implementation and evaluation are necessary to examine its instructional feasibility and effectiveness.

Expert Review, Practitioner Validation, and Comprehensibility Assessment

The conceptual model and didactic blueprint underwent expert review, practitioner validation, and comprehensibility assessment. The expert review resulted in major revisions, particularly concerning the theoretical foundation, operationalization of critical media literacy and ecosophy, relationships among model components, and alignment between learning objectives, instructional phases, and expected outputs. The expert also emphasized the need to represent the iterative nature of scientific paper writing more clearly. Since no numerical score was provided, the expert review served as a basis for conceptual refinement rather than quantitative feasibility assessment.

Following these revisions, one Indonesian language education practitioner assessed the model and blueprint based on their theoretical support, instructional objectives,

organization of learning phases, integration of critical media literacy and ecosophy, and relevance to scientific paper learning. The assessment yielded 77 out of 90 (85.56%), categorized as very good. Subsequently, three Indonesian language teachers from three senior high schools assessed the comprehensibility of the revised design. Their scores were 92%, 87%, and 96%, respectively, with an average of 91.67%, also categorized as very good. Respondents generally understood the model components, instructional sequence, teacher and student roles, and the relationship between the conceptual model and didactic blueprint. Their comments nevertheless suggested improvements in explaining relationships among components, correcting language errors, and clarifying implementation guidance.

Overall, the findings indicate that the conceptual model and didactic blueprint underwent substantive refinement and received favorable initial assessments regarding instructional suitability and comprehensibility. The revised blueprint comprises five interconnected phases, from ecological issue orientation and problem formulation to presentation, revision, and ecosophical reflection. Each phase integrates learning objectives, scientific paper activities, information sources, critical media literacy, ecosophical orientation, and expected outputs. However, these findings do not establish implementation effectiveness or improvements in student learning outcomes. Further classroom-based research is required to examine the model's practical application and potential contribution to students' scientific paper writing and ecosophical development.

CONCLUSION

This study highlights the need for scientific writing instruction that extends beyond technical writing skills by integrating critical media literacy and an ecological perspective. The needs analysis revealed students' difficulties in identifying research topics, collecting and analyzing data, and connecting scientific writing with environmental issues. These findings provided the empirical basis for formulating a conceptual model that integrates critical media literacy, scientific writing, and ecosophy. Its main conceptual contribution lies in positioning ecological issues as contexts for scientific inquiry, critical evaluation of media information, evidence-based knowledge construction, and reflection on human–environment relationships.

The resulting model is operationalized through a five-phase didactic blueprint: (1) ecological issue orientation and problem formulation; (2) information exploration and data collection; (3) data analysis and scientific paper planning; (4) scientific paper construction;

and (5) presentation, revision, and ecosophical reflection. Critical media literacy is integrated throughout the phases to guide students in accessing, comparing, evaluating, and using information, while ecosophy provides an ethical and reflective perspective on ecological relationships. Thus, the contribution of this study is a conceptual instructional model and its didactic blueprint, rather than a completed or tested learning product.

Following expert revisions, the design was evaluated through practitioner assessment and comprehension testing. The practitioner assessment reached 85.56% (77/90), while the comprehension test achieved an average of 91.67% across three assessments (92%, 87%, and 96%). These results indicate that the revised design was well understood and received a positive practical assessment. However, because the model has not been implemented in classroom instruction, these findings do not establish its effectiveness in improving students' scientific writing skills, critical media literacy, or ecological awareness. Future research should develop the conceptual model into instructional materials, implement it in authentic learning settings, and examine its effectiveness in achieving these learning outcomes.

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DECLARATIONS

Ethical considerations

The participants in the needs analysis were teachers and senior high school students. Throughout the research process, ethical norms were strictly observed. Before data collection, participants were informed of the study's purpose and methods and were told that participation was voluntary. They were also informed that the data collected would be used solely for research purposes. Personal identities or other identifiers of the participants are not reported in the manuscript to preserve their confidentiality and anonymity. The data were professionally obtained and analysed, and participants were given the option to contribute information relevant to the study's objectives without any coercion or pressure.

Use of artificial intelligence (AI)

The authors state that they employed generative artificial intelligence (AI) tools during the creation of this manuscript to aid in language refinement, sentence structure, grammatical corrections, and improving overall clarity and readability. Specifically, they used Grammarly and OpenAI's ChatGPT. These tools were solely used for writing support and did not influence the research design, data collection, data analysis, interpretation of results, or the conclusions. The authors independently produced, reviewed, and critically evaluated all scientific content, and assume full responsibility for the originality, accuracy, integrity, and validity of the paper.

Conflict of Interest

The authors declare no conflicts of interest

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