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DEVELOPMENT OF PROBLEM-BASED TEACHING MATERIALS TO IMPROVE SCIENTIFIC LITERACY OF FIFTH-GRADE ELEMENTARY SCHOOL STUDENTS

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Abstract. Science and Social Studies learning in elementary schools currently tends to be conventional and lacks media capable of presenting real-world problems contextually. This research aims to develop valid, practical, and effective problem-based Teaching Materials using local environmental photography to enhance the scientific literacy of fifth-grade students on ecosystem topics. Method: This study employed Research and Development (R&D) using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The resulting product is a printed problem-based book that integrates authentic photographs of local environmental degradation as the primary learning stimulus. Results: Expert validation results showed a high level of feasibility, with scores of 91% from material experts and 94% from media experts. The practicality test conducted by fifth-grade teachers reached a score of 96%. The effectiveness of the Teaching Materials was significantly demonstrated by the increase in students' average scores, from 68 in the pre-test to 86 in the post-test, with a normalized gain (N-Gain) score of 0.56 in the medium category. Furthermore, observation results indicated that 94% of students were actively engaged in analyzing scientific phenomena and formulating environmental solutions. Conclusion: Problem-based Teaching Materials supported by authentic photographs are proven to be valid, practical, and effective learning media solutions for improving ecosystem understanding and scientific literacy, particularly in schools with limited instructional resources.

Keywords: Teaching Materials, Problem-Based Learning, Scientific Literacy, Elementary School

I. INTRODUCTION

Scientific literacy is a crucial 21st-century competency that students must master to transition from being passive recipients of information to active participants in addressing various challenges [1]. At the elementary school level, the urgency of developing scientific literacy is facilitated through Natural and Social Sciences (IPAS) subjects. The primary objective of IPAS learning is not merely to equip students with rote memorization of concepts or theoretical facts, but rather to cultivate critical reasoning and foster their sensitivity toward the dynamics of the surrounding environment [2]. Through proficient scientific literacy, students are guided to observe natural phenomena, identify causal relationships, and engage directly in formulating solutions to environmental problems [3].

However, the ideal implementation of scientific literacy education does not yet fully align with the actual conditions in the field. Based on preliminary observations in elementary schools, it was found that IPAS learning remains predominantly theoretical, making it difficult for students to connect abstract ecosystem concepts with their real-life surroundings. A primary contributing factor is the limited availability of contextual, problem-based teaching materials. Furthermore, infrastructural constraints, specifically limited school internet access, hinder the optimal implementation of interactive digital teaching materials to facilitate science learning.

Scientific literacy is currently viewed as the ability to utilize knowledge in responding to everyday life problems (Busch & Rajwade, 2024). Consequently, low scientific literacy achievement is closely associated with the lack of contextual teaching materials [5]. The successful enhancement of students' scientific literacy heavily depends on the quality of Teaching Materials utilized in the classroom [6]. To address this issue, innovating through the development of problem-based teaching materials becomes an essential solution. These problem-based materials are specifically designed as physical instruments to provide real-world problem stimuli [7], rather than merely applying theoretical learning models. The development of this product focuses on presenting concrete ecosystem issues using photographic media of environmental problems in the vicinity. The utilization of authentic photographs as an alternative to digital video features is designed to enable students to factually visualize phenomena and solve scientific problems, even in environments without internet access.

The development of these problem-based Teaching Materials is expected to shift students' learning paradigms from mere rote memorization to a profound understanding of science through the lens of scientific literacy [8]. Teaching Materials integrating everyday problems with printed visual media have been proven to positively impact the cultivation of independent learning and the connection of academic content to real life [9]. Based on this background and urgency, this study aims to produce problem-based teaching materials utilizing

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photographic media that are valid, practical, and effective in enhancing the scientific literacy of fifth-grade elementary school students, particularly on the topic of ecosystems.

II. RESEARCH METHODS

A. Research Design and Development Procedure

Figure 1 Development Procedure

This study employs the Research and Development (R&D) method adapted from the ADDIE model which comprises Analysis, Design, Development, Implementation, and Evaluation, in Figur 1 Development Procedure. The selection of this model is based on its systematic and structured flow to produce practical and effective teaching materials in facilitating the improvement of fifth-grade elementary school students' scientific literacy on the topic of ecosystems.

The Analysis phase was conducted to validate learning gaps in the field through observations and interviews. This stage identified the needs of fifth-grade students who, psychologically and cognitively, are at the concrete operational stage of development; thus, presenting complex ecosystem materials requires tangible visualization. Furthermore, resource analysis identified constraints regarding limited internet signal access at the school. Consequently, it was decided that the teaching materials would be entirely developed in an offline printed format without relying on digital access.

The Design phase focused on drafting a printed book containing student-centered environmental problems. The main components designed included planning the structure of the printed teaching materials, preparing visual media in the form of photographs of ecosystem problems, formulating scientific literacy performance objectives, and devising product testing strategies. The placement of authentic photographic visualizations was specifically designed to present a concrete problem context on the book's pages, thereby enabling students to directly observe phenomena from the printed media.

The Development phase is the stage of materializing the conceptual design into an actual product, namely problem-based printed teaching materials. In this phase, the ecosystem material content was arranged by integrating problem presentations that guide students to practice solving environmental conservation issues. The prototype of these teaching materials was subsequently validated by experts, consisting of science content experts, educational media experts, and instructional design experts. The validation instrument utilized a Likert scale (score range 1- 4) to examine the aspects of content feasibility, material accuracy, language appropriateness, as well as visual aesthetic quality and photo layout.

The Implementation phase focused on the operational testing of the teaching material prototype in actual learning practices, involving 20 fifth-grade students at SDN Gelaran 1 Jombang. The implementation was carried out through a small-group trial stage to analyze text readability, image attractiveness, and students' initial responses. Subsequently, a field trial on a broader scale within one intact class was conducted to observe the fluency of independent printed book usage and ecosystem problem-solving interactions.

The Evaluation phase employed a mixed-methods approach for data collection and analysis to comprehensively measure the quality and effectiveness of the teaching materials. Data collection techniques included expert validation questionnaires and user response surveys using a 4 point Likert scale to measure validity and practicality. Additionally, cognitive tests (pre-test and post-test) were administered to measure product effectiveness, supported by field observations and interviews to gather qualitative feedback from both the teacher and the students.

Data analysis techniques were conducted both quantitatively and qualitatively. Quantitative data obtained from the validation and practicality questionnaires were analyzed using descriptive percentage formulas to determine the feasibility categories. Meanwhile, the effectiveness data from the cognitive test results were analyzed using the Normalized Gain (N-Gain) equation developed by Hake to measure the actual improvement in students' scientific literacy. Qualitative data sourced from validators' suggestions, field observation notes, and user interviews were analyzed through data reduction to formulate continuous product design improvements.

B. Data Collection and Analysis Techniques

The evaluation phase employed a mixed-methods approach to comprehensively measure the quality and effectiveness of the teaching materials. Data collection techniques included expert validation questionnaires and user response surveys using a 4-point Likert scale to measure validity and practicality. Additionally, cognitive tests (pre-test and post-test) were administered to measure product effectiveness, supported by field observations and interviews to gather qualitative feedback from both the teacher and the students.

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III. RESULT AND DISCUSSION

A. Results

TABLE I.

PRODUCT SPECIFICATIONS

Feature	Description
Product Name	Misi Detektif Lingkungan
Product Type	Printed Problem-Based Instructional Material
Main Stimulus	Authentic photographs of local environmental issues forest waste, water pollution, illegal hunting
Target Users	5th-grade students Elementary School
Learning Approach	Problem based stimulus for Science and Social Studies (IPAS)
Core Components	Case narratives, guided observation questions, and activity based scientific literacy tasks

The needs analysis phase conducted at SDN Gelaran 1 Jombang revealed a gap between the ongoing Natural and Social Sciences (IPAS) learning practices and the target for students' scientific literacy achievement. Based on the observation and interview results, the availability of teaching materials connecting ecosystem topics with real environmental problems remains in the "fairly good" category (average score of 3.3 out of 5), causing the learning process to be predominantly theoretical and suboptimal in stimulating problem-solving activities. The limited supporting facilities and the absence of internet access at the school reinforce the urgency for an intervention through the development of contextual and offline problem-based printed teaching materials.

In the design and development phases, the structure of the teaching materials was synchronized with the Learning Outcomes (CP) for Phase C of the Emancipated Curriculum (Kurikulum Merdeka). These problem-based teaching materials were developed into three main Learning Activities (Kegiatan Belajar/KB) addressing local environmental issues: waste accumulation in the forest, groundwater pollution, and the threat of wildlife poaching. As a solution to the lack of digital access, these teaching materials rely on stimuli in the form of authentic photographs from actual documentation in the surrounding environment to replace animation or video features. The learning flow is packaged through an Environmental Detective Mission scenario, equipped with interactive features such as image observation, fact-finding, cause analysis, and the formulation of concrete action plans to hone the scientific literacy skills of fifth-grade students.

The implementation phase was conducted through small-group and large-group trials at SDN Gelaran 1 Jombang. The practicality of the problem-based materials was evaluated from both the teacher's and the students' perspectives. The practicality test conducted by the fifth-grade teacher achieved an excellent score of 96%. Furthermore, the large-group field trial involving the 20 students recorded a practicality validity rate of 87% with an average score of 3.5. This high level of practicality indicates that students were highly enthusiastic about formulating solutions to waste and clean water problems after observing the authentic photographs within the book.

The effectiveness of these teaching materials was measured by the gradual improvement in students' cognitive learning outcomes and scientific literacy. Based on the comparative results, there was a highly significant surge in the average score from the pre-test stage of 68 to the final post-test of 86. The N-Gain analysis resulted in a score of 0.56, which falls into the medium category. This 18-point increase, supported by the positive N-Gain result, proves that the consistent use of original visual documentation assists in empirically strengthening students' comprehension of ecosystem concepts.

B. Product Implementation

The implementation was conducted in the classroom as an integrated part of the IPAS learning process. The learning activities followed systematic steps, beginning with a Stimulus Phase where students observed authentic photographs of environmental degradation provided in the book to spark their curiosity. This was followed by a Problem Analysis phase, in which students, guided by case narratives, worked in small groups to identify environmental issues and their causes. Subsequently, in the Inquiry and Solution phase, students applied their scientific literacy skills to discuss potential solutions based on the provided materials. Finally, the process concluded with an Assessment phase, utilizing cognitive testing to measure the improvement of students' scientific literacy after the implementation of the problem-based stimulus.

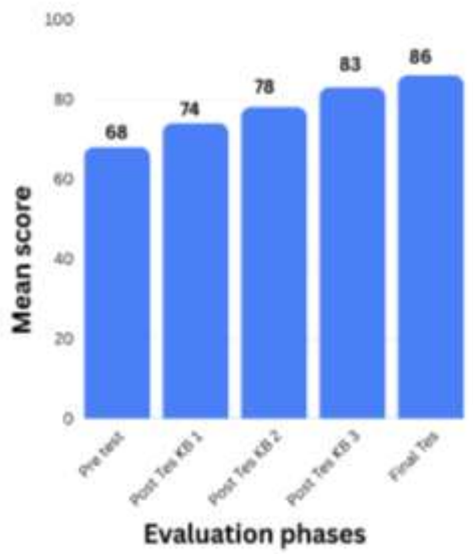

Figure 2 Improvement in Learning Outcomes

C. Discussion

The initial state of IPAS instruction at SDN Gelaran 1 Jombang was dominated by a conventional, teacher-centered approach, where students tended to absorb material passively. This gap highlights the necessity for teacher creativity in implementing innovations that address student learning needs, as examined by [10]. Reliance on traditional lecture methods without supporting media is often ineffective for complex material and tends to diminish enthusiasm [11], while also overburdening students' working memory due to overly abstract concepts [12]. Therefore, the implementation of teaching materials focusing on local environmental issues is essential to enhance student engagement [13] and trigger motivation to optimize problem-solving skills [14].

These problem-based teaching materials were systematically designed as physical tools integrating theory with problem-solving practice (rather than merely applying the learning model), enabling teachers to provide structured guidance despite limited educational resources [15]. By presenting real-world cases within the materials, students become accustomed to discovering answers independently through observation and critical thinking aligned with actual occurrences in their surroundings [8]. Grounded in the social constructivism theory of Vygotsky et al. (1978), the "Environmental Detective Mission" structure serves as instructional scaffolding that bridges the initial abilities of fifth-grade students toward the target of scientific literacy achievement. Authentic learning experiences that directly intersect with the environment have been significantly proven to enhance students' cognitive and affective engagement [16].

Based on triangulation evaluation, these teaching materials holistically fulfill the aspects of validity, practicality, and effectiveness. The high validity aspect indicates that a comprehensive product evaluation yields strong pedagogical support [17] relevant to improving academic achievement [18]. Regarding practicality, the textbook equipped with clear instructions is proven to help students become more independent in regulating their learning [19], while simultaneously increasing classroom management efficiency for teachers [20]. In terms of effectiveness, the significant improvement based on the N-Gain test proves that real-case scenarios are highly effective in stimulating mid to high level cognition and supporting the mastery of nature conservation concepts. The integration of step-by-step formative assessments, such as reflection features and cause-and-effect analysis, further provides a boost in measurable learning outcomes and enhances learning independence.

Overall, the development of these problem-based teaching materials reforms the learning ecosystem from conventional to adaptive, interactive, and collaborative without being hindered by school technological infrastructure limitations [21], [22]. The theoretical implications of this study reinforce that successful scientific literacy stimulation does not absolutely depend on digital multimedia but is instead highly determined by the depth of the case narrative and the relevance of photographs to the students' surrounding environment. Practically, well-structured materials accelerate concept understanding in the classroom, provide space for teachers to make instructional decisions based on student performance data, and support broad, adaptive curriculum integration at the elementary school level [23].

III. CONCLUSIONS

This research and development study yielded a problem-based teaching material in the form of a printed book focusing on ecosystems for fifth-grade elementary school students. The development of this product successfully addressed the practical gap regarding conventional teaching methods and the limited availability of media capable of presenting contextual problems without relying on internet access. The teaching materials were systematically structured using an Environmental Detective Mission scenario, which guided students' scientific investigations while integrating authentic photographs of local environmental degradation as the primary stimulus.

The feasibility test results indicated that this teaching material is highly feasible and practical for instructional use. Its validity was evidenced by the percentage scores from material experts 91% and media experts 94%, while the practicality test conducted by fifth-grade teachers achieved a score of 96%. These figures confirm that the product meets the pedagogical and instructional design standards for student-centered learning in the fifth grade, particularly concerning content accuracy, language readability, and problem presentation.

Both quantitatively and qualitatively, the utilization of this teaching material proved to be effective and significant in enhancing students' scientific literacy. This effectiveness was demonstrated by a substantial increase in learning outcomes, with the students' average scores rising from 68 in the pre-test to 86 in the post-test, yielding an N-Gain of 0.56 in the medium category. Furthermore, field observations corroborated these findings, noting that 94% of the students actively engaged in analyzing scientific phenomena and formulating environmental solutions. Therefore, it can be concluded that this problem-based teaching material, utilizing authentic photographs, serves as a valid, practical, and effective solution to improve students' understanding of ecosystems and scientific literacy, particularly in schools with limited digital facilities.

REFERENCES

[1] J. D. Cebrero, "21st century skills and science achievement among Secondary School Students: A Systematic Review," *Journal Of Turkish Science Education*, Vol. 22, No. 2, Pp. 248–268, Jun. 2025, Doi: 10.36681/Tused.2025.013.
[2] M. Isro, N. Wayan Asri Udayani, M. Isra, R. Ayu Rachmawati, And A. Sukarso, "Implementasi Pembelajaran Ipas Di Sekolah Dasar: Studi Kasus Di Sd Negeri 1 Giri Tembesi, Lombok Barat," *Journal Of Classroom Action Research*, Vol. 7, No. Special Issue, 2025, Doi: 10.29303/Jcar.V7 Special Issue.10914.
[3] Z. Arifin, Sukarmin, And S. Saputro, "Feasibility And Effectiveness Of Culturally Sustaining Inquiry-Based Learning Integrated With Socio-Scientific Issues For Enhancing Critical Thinking On Climate Change," *Journal Of Baltic Science Education*, Vol. 24, No. 4, Pp. 624–636, 2025, Doi: 10.33225/Jbse/25.24.624.
[4] K. C. Busch And A. Rajwade, "Conceptualizing Community Scientific Literacy: Results From A Systematic Literature Review And A Delphi Method Survey Of Experts," *Sci. Educ.*, Vol. 108, No. 5, Pp. 1231–1268, Sep. 2024, Doi: 10.1002/Sce.21871.
[5] S. Nur Faizah, "Pengembangan E-Modul Berbasis Socio-Scientific Issues (Ssi) Pada Materi Kesetimbangan Benda

Tegar Untuk Meningkatkan Literasi Sains," 2025. [Online]. Available: Https://Journal.Unnes.Ac.Id/Journals/Upej

[6] G. Roy, S. Sikder, And L. Danaia, "Adopting Scientific Literacy In Early Years From Empirical Studies On Formal Education: A Systematic Review Of The Literature," Dec. 01, 2025, *Springer Science And Business Media Deutschland Gmbh*. Doi: 10.1186/S40594-025-00547-1.

[7] L. Cong And C. S. Ironsi, "Integrating Mobile Learning And Problem-Based Learning In Improving Students' Action Competence In Problem-Solving And Critical Thinking Skills," *Humanit. Soc. Sci. Commun.*, Vol. 12, No. 1, Dec. 2025, Doi: 10.1057/S41599-025-05397-4.

[8] E. Adah Miller, T. Li, I. C. Chen, J. Krajcik, And S. Codere Kelly, "Designing For And Investigating Elementary Students' Cognitive Flexibility, Science, And Literacy Achievement In Project-Based Science Learning," *Disciplinary And Interdisciplinary Science Education Research*, Vol. 7, No. 1, Dec. 2025, Doi: 10.1186/S43031-025-00131-1.

[9] H. Syofyan, M. R. Fadli, And P. Pappachan, "Determinant Factors Of Scientific Literacy In Elementary School Science Learning," *International Electronic Journal Of Elementary Education* , Vol. 17, No. 4, Pp. 567–578, Jun. 2025, Doi: 10.26822/Iejee.2025.400.

[10] J. Levin, M. Ş. Bellibaş, F. Ryskulueva, And M. Pietsch, "Inspiring Teacher Creativity Through Leader-Teacher Exchange (Lmx): A Job Demands-Resources Perspective," *Social Psychology Of Education*, Vol. 29, No. 1, Dec. 2026, Doi: 10.1007/S11218-026-10180-7.

[11] T. Zhou, H. Wang, And X. Jiang, "Integrating Case-Based Learning (Cbl) And Concept Mapping (Cm) Enhances Learning Outcomes In Medical Biochemistry," *Bmc Med. Educ.*, Vol. 26, No. 1, Dec. 2026, Doi: 10.1186/S12909-026-08906-4.

[12] D. Cairns, "Balancing Teacher-Led And Student-Led Learning In Science: The Importance Of Cognitive Load," *Large. Scale. Assess. Educ.*, Vol. 13, No. 1, Dec. 2025, Doi: 10.1186/S40536-025-00263-W.

[13] X. S. Apedoe, K. Nielsen, R. Smith, J. Allen, S. P. S. Arriaga, And J. Kaelin, "The Cellular Construction Workshop: An Integrated Stem Teacher–Student Co-Learning Experience," *Discover Education*, Vol. 5, No. 1, Dec. 2026, Doi: 10.1007/S44217-026-01197-3.

[14] Y. Ying And R. Tiemann, "Investigating The Factors Influencing Collaborative Problem-Solving In Chemistry Education: A Cross-National Study Of German And Chinese Students," *Int. J. Sci. Math. Educ.*, Vol. 24, No. 2, Feb. 2026, Doi: 10.1007/S10763-025-10629-9.

[15] X. Zhao *Et Al.*, "Impact Of Scientific Inquiry-Based Reading Activities On Language Development In Chinese Economically Disadvantaged Preschoolers," *Early Child. Educ. J.*, Apr. 2025, Doi: 10.1007/S10643-025-02045-Z.

[16] S. J. Carrier *Et Al.*, "Incorporating Participatory Science In Elementary Schools: Teacher And Student Experiences With Outdoor Learning," 2026.

[17] L. S. Muchlis, A. Hamid, A. Mardika, And F. Himmah, "Development Of Project Based-Flipped Classroom Textbooks In Ict-Based Learning Media Courses," Vol. 33, No. 1, P. 33, 2026, Doi: 10.15548/Jt.V32i3.1016.

[18] S. Khamkaew And A. Trussat, "The Impact Of Authentic English Teaching Materials On Grade 10-12 Students' Learning Experience And Academic Performance," *International Journal Of English Language Teaching*, Vol. 14, No. 1, Pp. 1–13, Jan. 2026, Doi: 10.37745/Ijelt.13/Vol14n1113.

[19] S. A. Mostafa, K. Smith, K. Nelson, T. Elbayoumi, And C. Nzekwe, "A Learning Strategy Intervention To Promote Self-Regulation, Growth Mindset, And Performance In Introductory Mathematics Courses," *Eur. J. Investig. Health Psychol. Educ.*, Vol. 15, No. 10, Oct. 2025, Doi: 10.3390/Ejihpe15100198.

[20] X. Mao, Y. Dai, Y. Liu, Y. Jiang, And Y. Zhang, "Optimizing Cognitive Load In Digital Mathematics Textbooks: A Mixed-Methods Study On Content Organization And Application Models," *Journal Of Educational Technology And Innovation*, Vol. 7, No. 3, Sep. 2025, Doi: 10.61414/Pxn87q66.

[21] O. Coşkunserçe, "The Use Of 3d-Printed Teaching Materials In Active Learning Activities Within Science Lessons," *Journal Of Educational Technology And Online Learning*, Vol. 8, No. 3, Pp. 351–367, Sep. 2025, Doi: 10.31681/Jetol.1751802.

[22] R. Rusman, W. Setiawardani, N. Nandi, A. Hadiapurwa, B. Robandi, And A. Apriyanto, "Enhancing Science Literacy Through Curriculum Design With The Rama Sinta Application," 2025.

[23] F. Chen, Y. Zhang, And G. Chen, "Exploring The Effects Of Technology-Supported Collaborative Inquiry And Students' Ict Competency On Scientific Literacy And Subject Knowledge In Rural Science Classrooms," *Educ. Inf. Technol. (Dordr).*, Vol. 30, No. 13, Pp. 18705–18732, Aug. 2025, Doi: 10.1007/S10639-025-13512-W.