



Development of a Non-Textbook with SDGs Framework to Enhance Students' Scientific Literacy

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Abstract

This study aims to develop and evaluate the feasibility and effectiveness of the non-textbook *Persahabatan Besi dan Magnet* as an innovative learning material to enhance junior high school students' scientific literacy. The book was created using a Discovery Learning approach integrated with narrative, visual, and experiential elements, and aligned with Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 7 (Affordable and Clean Energy), and SDG 12 (Responsible Consumption and Production). The research followed Borg and Gall's Research and Development (R&D) model, which includes needs analysis, product design, expert validation, limited trials, and effectiveness testing. Participants consisted of 30 students and three science teachers from a junior high school in Sukabumi, Indonesia. Data were collected through questionnaires, expert validation forms, teacher and student response surveys, and a scientific literacy test covering competence, knowledge, context, and attitude. Expert validation showed that the book met the "very good" category, especially in content accuracy and conceptual depth. Teacher and student responses were highly positive, noting clear language, visual appeal, and contextual relevance. Effectiveness testing demonstrated a significant improvement in scientific literacy, supported by medium N-Gain and a very large effect size. These results indicate that the book is a feasible and effective alternative learning resource.

How to Cite

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INTRODUCTION

Scientific literacy is an essential competence that enables students to understand scientific concepts, make informed decisions, and respond to global challenges. However, national assessment data indicate that Indonesian students' literacy achievement, including scientific literacy, remains at a moderate level. The 2023 Education Report revealed that only 62.22% of junior high school students achieved the minimum competency standard, particularly in analyzing and evaluating informational texts (Kemdikbud, 2023). This condition is consistent with international findings from the Programme for International Student Assessment (PISA), which reported that Indonesian students' scientific literacy remains below the international average (OECD, 2018; OECD, 2023).

Previous studies have shown that scientific literacy can be enhanced through learning approaches that emphasize contextuality, inquiry, and relevance to students' daily lives. Discovery-based and problem-based learning models have been reported to significantly improve students' scientific literacy and inquiry skills (Ardianto & Rubini, 2016; Pada et al., 2025). In addition, the use of non-text learning materials, such as scientific storybooks and contextual learning resources, has been found to increase students' motivation and conceptual understanding by presenting scientific concepts in meaningful and accessible contexts (Setiawan & Handayani, 2019; Nugroho et al., 2020). Several studies have reported that inquiry-based and contextual science learning significantly improve students' scientific literacy skills (Ardianto et al., 2021; Restiani et al., 2020).

More recently, science education has increasingly emphasized the integration of socio-scientific issues and sustainability values to prepare students for real-world challenges. Sustainability-oriented learning aligned with the Sustainable Development Goals (SDGs) has been shown to support scientific literacy development while fostering environmental awareness and global citizenship (Rubini, 2019; Rubini, 2022). This approach is in line with SDG 4, which highlights the importance of quality education that equips learners with relevant competencies for sustainable development (United Nations, 2015).

However, despite the growing body of research on contextual and sustainability-oriented science learning, studies that specifically develop SDG-based non-textbooks integrated with scientific literacy frameworks for junior high school science learning remain limited. A preliminary

survey conducted with science teachers in Sukabumi City revealed that 94% of teachers still rely primarily on textbooks, while both teachers and students expressed the need for more engaging, contextual, and literacy-oriented supplementary learning materials.

Based on these conditions, this study aims to develop and evaluate the feasibility and effectiveness of an SDG-based non-textbook entitled *Persahabatan Besi dan Magnet* to enhance junior high school students' scientific literacy. The developed material integrates narrative learning, experimental activities, and sustainability values to support meaningful and contextual science learning.

METHOD

This study employed a Research and Development (R&D) approach using the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). This model was selected because it is systematic, flexible, and suitable for developing learning products that are valid, practical, and effective. The product developed in this study was a science non-textbook entitled *Persahabatan Besi dan Magnet*, designed to improve junior high school students' scientific literacy through a narrative, contextual, and SDG-integrated approach. The research was conducted at SMP Negeri 12 Sukabumi City during the second semester of the 2024/2025 academic year. The research subjects included 30 ninth-grade students as trial participants and three science teachers as evaluators, selected through purposive sampling based on their active involvement in science learning and availability to participate in all research stages.

The analysis stage identified learning needs, student characteristics, and discrepancies between actual and ideal learning conditions through questionnaires, interviews, and curriculum reviews. The design stage focused on developing the structure and content of the non-textbook based on Discovery Learning principles and holistic scientific literacy. The book was conceptualized to integrate scientific narratives, simple investigations, reflective questions, and character-related SDG values, supported by a storyboard, illustrations, and QR codes linked to experimental videos. During the development stage, a prototype was produced, validated by content, media, and language experts, revised accordingly, and tested for readability with ten students.

The implementation stage involved a limited trial with the selected students over two

learning sessions on magnetism. Students completed pretests and posttests to measure scientific literacy improvement, while teachers and students provided feedback on readability, attractiveness, practicality, and relevance. All research instruments were validated by three experts, and the scientific literacy test demonstrated high reliability (Cronbach's Alpha ≥ 0.7). Summative evaluation was conducted using paired sample t-tests, N-Gain calculations, and Cohen's d to determine the effectiveness and effect size of the developed product. Learning improvement was analyzed using the normalized gain (N-Gain) score (Hake, 1998).

RESULT AND DISCUSSION

This study produced a non-textbook entitled *Persahabatan Besi dan Magnet* developed to address the limited availability of contextual learning resources for magnetism topics in junior high schools (Kemdikbud, 2023). Needs analysis indicated that most students relied on conventional textbooks that were less engaging and weakly connected to real-life contexts. Therefore, the developed non-textbook integrates narrative, experimental activities, reflection, and sustainability values aligned with the Sustainable Development Goals (SDGs), particularly SDG 4, SDG 7, and SDG 12.

Expert validation involving content, language, and media specialists demonstrated that the developed book met the very good category with an overall mean score of 3.58, consistent with feasibility criteria for instructional material development (Prastowo, 2015). High scores were obtained in content depth and language–presentation aspects, indicating strong conceptual accuracy and suitability for students' cognitive levels. These results confirm that the book is feasible for classroom implementation and supports literacy-oriented science learning (Okryanida, 2020).

Table 1. Recapitulation of Expert Validation Results

No	Assessment Aspect	Mean Score	Category
1	Relevance to SDGs	3.50	Very Good
2	Content Depth	4.00	Very Good
3	Language and Presentation	4.00	Very Good
4	Attractiveness and Visuals	3.00	Good
5	Interactivity	3.67	Very Good
6	Evaluation Component	3.33	Good

The effectiveness test conducted with 30 ninth-grade students showed a significant improvement in scientific literacy after using the non-textbook. Students' average scores increased from pretest to posttest with an N-Gain of 0.48 (moderate category), indicating a meaningful learning improvement.

Table 2. Descriptive Statistics of Pretest–Posttest Results

Statistic	Pretest	Posttest	N-Gain
Standard Deviation	8.04	15.39	0.18
Minimum	6.88	12.12	0.35
Maximum	42	88	0.83
25%	21	54	0.35
50%	29	63	0.47
75%	33	88	0.53

Statistical analysis confirmed a significant difference between pretest and posttest results ($p < 0.05$) with a very large effect size (Cohen's $d = 2.89$), demonstrating the strong effectiveness of the developed learning material.

Table 3. Paired Sample t-Test Results

Test Type	p-value	Decision Criteria	Interpretation
Paired t-test	< 0.001	$p < 0.05 \rightarrow$ significant	Significant difference between pretest and posttest
Cohen's d	2.89	$> 0.8 =$ very large	Very strong effect

Analysis based on the PISA 2025 scientific literacy framework revealed improvement across all dimensions (OECD, 2020). The competence dimension showed the highest gain, particularly in evaluating and designing scientific investigations, reflecting the effectiveness of inquiry-based and experimental activities embedded in the book (Beichumila et al., 2022). The knowledge dimension improved notably in content and procedural knowledge, indicating that narrative-based explanations supported students' conceptual understanding (Santika et al., 2020; Satar et al., 2025; Savitri et al., 2025). The context dimension showed higher gains in personal and global contexts, suggesting that the integration of everyday phenomena and sustainability issues successfully strengthened students' ability to relate science to real-life situations. Although the attitude di-

mension showed a lower gain compared to other dimensions, positive growth was observed in students' curiosity, responsibility, and awareness toward science and sustainability.

Table 4. N-Gain of Scientific Literacy Dimensions (PISA 2025 Framework)

Dimension	N-Gain	Category
Competence	0.64	Medium
Knowledge	0.69	Medium
Context	0.60	Medium
Attitude	0.27	Low–Medium

Students' responses indicated that the narrative structure, illustrations, and hands-on experiments increased learning motivation and made abstract magnetism concepts easier to understand, as also reported in previous studies on narrative and contextual science learning (Nugroho et al., 2020; Rubini, 2019). Teachers also reported that the non-textbook was practical, engaging, and aligned with the Merdeka Curriculum, particularly in supporting contextual learning and higher-order thinking skills. These findings are consistent with previous studies highlighting the effectiveness of contextual, narrative, and sustainability-oriented science learning in enhancing students' scientific literacy (Baptisa et al., 2019; Baydere et al., 2020; Bazerman & Prior, 2003).

Overall, the results demonstrate that the SDG-based non-textbook *Persahabatan Besi dan Magnet* is valid, practical, and effective as an alternative learning resource, supporting earlier findings on sustainability-oriented science education (Bybee, 2013; Rubini, 2022). The integration of storytelling, experimentation, and sustainability values contributes not only to improved scientific literacy but also to students' awareness of the relevance of science in addressing global and environmental issues (Nugraha & Rachmawati, 2023; Artun et al., 2020).

CONCLUSION

This study developed an SDG-based non-textbook entitled *Persahabatan Besi dan Magnet* to enhance junior high school students' scientific literacy. The development process followed the ADDIE model and resulted in a learning material that integrates narrative, experimental activities, and sustainability values to support contextual science learning. Expert validation confirmed that the developed non-textbook met the very good category in terms of content ac-

curacy, language, and media quality, indicating that it is feasible for classroom use. The implementation results demonstrated that the use of the non-textbook significantly improved students' scientific literacy, as indicated by a moderate N-Gain score and a very large effect size. Improvement was observed across all scientific literacy dimensions, particularly in scientific competence, knowledge, and contextual understanding. These findings indicate that narrative-based and sustainability-oriented learning materials can serve as effective alternative resources for science learning by connecting scientific concepts with real-life and global issues. Therefore, the non-textbook *Persahabatan Besi dan Magnet* is considered valid, practical, and effective for supporting scientific literacy development in junior high school students. Future studies are recommended to implement the developed material on a larger scale and across different science topics to further strengthen sustainability-oriented science education.

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