JSER

Journal of Science Education Research
Journal homepage: https://journal.uny.ac.id/index.php/jser/index

ISSN: 2597-9701

Development of Low Carbon Education Non-Textbooks to Grow Sustainability Literacy and Sustainability Awareness in First Grade Elementary School Students

Muhamad Sukri[1]*, Anna Permanasari[2], Didit Ardianto[3]
[1,2,3] *Master of Elementary Education Program Universitas Pakuan , Indonesia*
**Corresponding Author, Email: saya28juni@gmail.com*

Abstract

This study aimed to develop and evaluate a Low-Carbon Education non-text book designed to enhance sustainability literacy and sustainability awareness among Grade 1 elementary school students. The study employed research and development using the ADDIE model: analysis, design, development, implementation, and evaluation. The field trial involved 30 Grade 1 students at SDIT Suwarna, Bogor Regency, Indonesia, using a one-group pretest-posttest design. Product feasibility was assessed through expert and practitioner validation, while student outcomes were measured using sustainability literacy and sustainability awareness instruments. The findings showed that the book was feasible for classroom use, with a content and curriculum Content Validity Index (CVI) and Content Validity Ratio (CVR) of 1.00 reported by practitioners. Sustainability literacy increased from a mean of 49.33 to 79.33; the highest gain occurred in sustainability knowledge (N-Gain = 0.77, high), followed by sustainability skills (0.28, medium) and relevant values (0.34, medium). Sustainability awareness increased from 44.67 to 81.67, with N-Gain values of 0.58 for cognitive, 0.53 for affective, 0.47 for behavioral, and 0.50 for risk-awareness domains. Paired-sample t-tests indicated significant pretest-posttest differences ($p < .001$). Students gave a 99% positive response, while teachers reported 98% positive/practical responses. The findings suggest that a contextual, visual, and activity-oriented non-text book can support early sustainability learning, particularly for building foundational knowledge and awareness.

History
Received: July 28, 2025
Revised: October 10, 2026
Accepted: October 29, 2026

Keywords:
Non-text books, Low carbon education, Sustainability Literacy, Sustainability Awareness

How to cite:
Sukri, M., Permanasari, A., Ardianto, D., (2026). Development of Low Carbon Education Non-Textbooks to Grow Sustainability Literacy and Sustainability Awareness in First Grade Elementary School Students. *Journal of Science Education Research*, 10(2), 362-367. doi: https://doi.org/10.21831/j.sc.edu.research.v10i2.88763.

This open access article is distributed under a (CC-BY SA 4.0 License)

1. INTRODUCTION

Environmental degradation, climate change, waste accumulation, and excessive resource consumption have strengthened the need to develop environmental and sustainability competencies from an early age. Education can contribute by connecting environmental knowledge with everyday decisions and actions. Low-Carbon Education (LCE) provides a relevant framework because it links knowledge of carbon emissions and climate change with responsible, low-emission lifestyles (Hudha et al., 2020; Amin & Permanasari, 2020). In Indonesia,

research has also identified the importance of strengthening low-carbon literacy and environmental literacy among elementary students (Amin et al., 2019; Amin et al., 2020).

At the elementary level, sustainability concepts need to be presented through concrete, contextual, and developmentally appropriate learning experiences. Students in the early grades benefit from visual representations, stories, familiar situations, and opportunities to act. Previous studies have shown that visual and narrative learning media, including picture books and educational comics, can support environmental literacy and environmental awareness (Katoppo et al., 2020; Bagus & Sindu, 2023). Recent evidence also indicates that picture-book-based environmental education can improve environmental literacy and ecological sensitivity among lower-grade elementary students (Noh & Bae, 2024).

However, the thesis preliminary study identified a gap at SDIT Suwarna: environmental and low-carbon content was not yet sufficiently integrated into non-text learning resources for Grade 1. The developed solution therefore focused on a contextual book entitled "Ayo Kelola Sampah" (Let's Manage Waste), which introduces waste sorting, waste reduction, recycling, carbon-footprint ideas, and simple environmental actions. The book integrates Indonesian Language and Pancasila learning while embedding sustainability literacy and sustainability awareness.

Sustainability literacy in this study is operationalized through sustainability knowledge, skills, and relevant values, while sustainability awareness covers cognitive, affective, behavioral, and risk-awareness dimensions. This framing is consistent with the need to move sustainability education beyond factual knowledge toward values and action (Chen et al., 2022; Kuehl et al., 2022). The study addressed two practical questions: (1) Is the developed non-text book feasible for Grade 1 learning? and (2) Does its use improve students' sustainability literacy and sustainability awareness?

2. RESEARCH METHOD

This study used a research and development approach with the ADDIE model, consisting of analysis, design, development, implementation, and evaluation. The research was conducted at SDIT Suwarna, Bogor Regency, Indonesia. The field implementation involved 30 Grade 1 students. The effectiveness trial used a one-group pretest-posttest design.

During the analysis stage, curriculum documents, learning resources, student characteristics, and teacher needs were examined. The design stage produced the structure and learning content of the non-text book. The development stage involved expert/practitioner validation and revision. The implementation stage applied the book in classroom learning, followed by measurement of sustainability literacy, sustainability awareness, and user responses. The evaluation stage used the quantitative findings and qualitative suggestions to judge feasibility and identify areas for further improvement.

Product feasibility was assessed using validation instruments covering curriculum alignment, content, language, visual design, learning evaluation, sustainability literacy, sustainability awareness, and usability. The thesis reported CVI and CVR values of 1.00 for the content and curriculum aspects based on practitioner validation. Student and teacher responses were collected after implementation. Sustainability literacy and sustainability awareness were measured through pretest and posttest instruments. Data analysis included descriptive statistics, Shapiro-Wilk normality testing, paired-sample t-tests, and N-Gain analysis. N-Gain was interpreted as high (≥0.70), medium (0.30–0.69), or low (<0.30).

Component	Description
Design	Research and development; ADDIE model
Participants	30 Grade 1 students; SDIT Suwarna, Bogor Regency
Trial design	One-group pretest-posttest
Product	Low-Carbon Education non-text book: "Ayo Kelola Sampah"
Main measures	Sustainability literacy, sustainability awareness, student and teacher responses
Analysis	Descriptive statistics, Shapiro-Wilk, paired-sample t-test, N-Gain, CVI/CVR

3. RESULT AND DISCUSSION

The final product is a visually oriented non-text book designed as a learning supplement rather than a replacement for the main textbook. Its central theme is waste management. The book combines short narratives, illustrations, factual explanations, practical activities, reflection, and simple challenges. The content connects waste practices with carbon footprint and environmental consequences in language accessible to early-grade learners.



Figure 1. Cover of the developed Low-Carbon Education non-text book.

The product design reflects the characteristics of Grade 1 learners by emphasizing concrete experiences and visual cues. The book includes activities such as identifying and sorting waste, reducing single-use materials, creating products from used materials, and reflecting on daily environmental actions. This contextual orientation is consistent with evidence that environmental learning is more meaningful when students can connect concepts to familiar situations and visible actions (Pursitasari et al., 2019; Susilawati et al., 2020).



Figure 2. Representative pages showing the visual and activity-oriented design of the developed book.

The quantitative results indicate improvement in both outcome variables. Sustainability literacy increased from a mean of 49.33 in the pretest to 79.33 in the posttest, while sustainability awareness increased from 44.67 to 81.67. The paired-sample t-test showed significant differences for sustainability literacy ($t = -10.120$, $df = 29$, $p < .001$) and sustainability awareness ($t = -8.493$, $df = 29$, $p < .001$). The normality tests reported in the thesis supported the use of the paired-sample analysis.

Outcome	Pretest Mean	Posttest Mean	Mean Increase	Paired t	p
Sustainability literacy	49.33	79.33	30.00	-10.120	< .001
Sustainability awareness	44.67	81.67	37.00	-8.493	< .001

The N-Gain results show that the strongest improvement in sustainability literacy occurred in sustainability knowledge (0.77; high category). Sustainability skills (0.28) and relevant values (0.34) were in the medium category. This pattern suggests that a short intervention using a visual non-text book can more readily strengthen conceptual understanding than stable skills and values, which normally require repeated practice and reinforcement. Similar arguments are found in sustainability education research emphasizing the importance of combining knowledge with repeated opportunities for action and reflection (Chen et al., 2022; Kuehl et al., 2022).

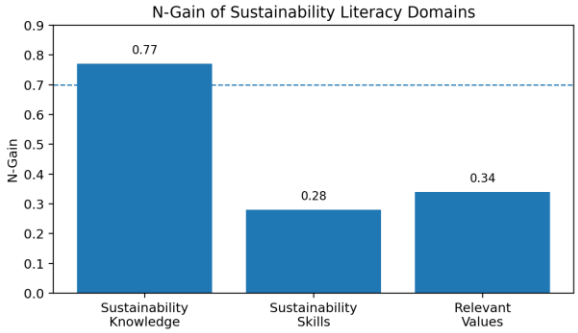


Figure 3. N-Gain across sustainability literacy domains

Sustainability awareness also improved across all measured domains. Cognitive awareness had an N-Gain of 0.58, affective awareness 0.53, behavioral awareness 0.47, and risk awareness 0.50; all were categorized as medium. The relatively broad improvement is important because sustainability awareness is not limited to knowing environmental facts. It includes attitudes, perceived responsibility, behavioral orientation, and recognition of environmental risks. This finding is in line with previous research linking sustainability awareness with the implementation of Education for Sustainable Development (Ekamilasari et al., 2021; Sintiya et al., 2025).

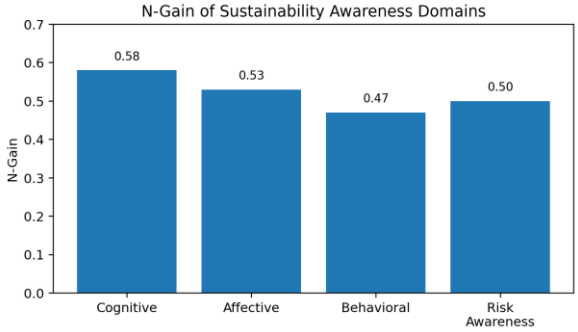


Figure 4. N-Gain across sustainability awareness domains

User responses further supported the practicality and acceptability of the product. The thesis reported a 99% positive response from students and a 98% positive/practical response from teachers. These results are consistent with the product characteristics: the book uses illustrations, short texts, dialogue, interactive prompts, and familiar environmental activities. Similar research on visual environmental media has reported the value of storybooks and comics for making environmental issues accessible to elementary learners (Katoppo et al., 2020; Noh & Bae, 2024).

The findings also clarify the contribution of the present study. Earlier low-carbon education research in Indonesia has established the importance of low-carbon teaching materials and students' low-carbon literacy, while other studies have explored sustainability education, environmental awareness, or digital media. The present product focuses specifically on Grade 1 learners and combines low-carbon concepts with a non-text book, contextual waste activities, sustainability literacy, and sustainability awareness within one integrated learning resource. This provides a practical bridge between the conceptual goals of low-carbon education and the concrete learning needs of early-grade students.

Nevertheless, the interpretation of effectiveness should be made cautiously. The study used a one-group pretest-posttest design without a control group, and the field trial involved 30 students from one school. Therefore, the observed gains demonstrate improvement after implementation but cannot by themselves establish that the book would outperform alternative instructional approaches. Future research should employ a larger sample, comparison groups, and follow-up measurements to examine the durability of changes in sustainability-related behavior.

4. CONCLUSION

The study developed a Low-Carbon Education non-text book for Grade 1 elementary students using the ADDIE model. The product was judged feasible based on validation evidence, including CVI and CVR values of 1.00 for content and curriculum aspects. Its implementation was followed by significant improvements in sustainability literacy and sustainability awareness. The strongest literacy gain occurred in sustainability knowledge (N-Gain = 0.77), while skills and relevant values showed medium gains. All sustainability awareness domains also showed medium gains. High student and teacher response percentages further indicate that the book was acceptable and practical for classroom use. The product is therefore promising as a contextual

supplementary resource for early sustainability education, while further controlled and longitudinal studies are recommended.

ACKNOWLEDGMENTS

The author expresses gratitude to Universitas Pakuan, the supervisors and academic community who supported the completion of the research, and SDIT Suwarna, Bogor Regency, for providing the research setting and facilitating the implementation. Appreciation is also extended to the experts, teachers, and students who contributed data and feedback for the development and evaluation of the book.

REFERENCES

Abidillah Nugroho, A., Fatonah, A., & Prasetyo, D. E. (2020). Menumbuhkembangkan kepedulian siswa terhadap lingkungan melalui kegiatan penghijauan di MIM Pakang Andong, Boyolali. BAKTI: Jurnal Pengabdian Kepada Masyarakat, 2(2), 69–74. https://doi.org/10.23917/bkkndik.v2i2.11196

Amin, M. S., & Permanasari, A. (2020). Integrasi Low Carbon Education dalam kurikulum pendidikan calon guru IPA di Indonesia sebagai upaya tantangan ekologis di masa depan. Jurnal IPA & Pembelajaran IPA, 4(2), 231–243. https://doi.org/10.24815/jipi.v4i2.17965

Amin, M. S., Permanasari, A., & Setiabudi, A. (2019). Strengthen the student environmental literacy through education with low carbon education teaching materials. Journal of Physics: Conference Series, 1280(3), 032011. https://doi.org/10.1088/1742-6596/1280/3/032011

Amin, M. S., Permanasari, A., Setiabudi, A., & Hamidah, I. (2020). Menakar level literasi low carbon siswa sekolah dasar dalam aktivitas kehidupan sehari-hari. Jurnal Teknologi Informasi dan Pendidikan, 12(2), 49–57. https://doi.org/10.30599/jti.v12i2.653

Azrai, E. P., Heryanti, E., Ramadhani, V., Ilyas, M., & others. (2024). Enhancing students' pro-environmental behavior through project-based learning. Biosfer: Jurnal Pendidikan Biologi, 17(2), 317–325. https://doi.org/10.21009/biosferjpb.28352

Bagus, I., & Sindu, K. (2023). Pengembangan buku Big Book "Miki Si Gajah Kecil" sebagai media pengenalan literasi lingkungan. Generasi Emas, 6(2), 29–40. https://doi.org/10.25299/ge.2023.vol6(2).13631

Boeve-de Pauw, J., & Van Petegem, P. (2018). Eco-school evaluation beyond labels: The impact of environmental policy, didactics and nature at school on student outcomes. Environmental Education Research, 24(9), 1250–1267. https://doi.org/10.1080/13504622.2017.1307327

Brias-Guinart, A., Aivelo, T., Högmander, M., Heriniaina, R., & Cabeza, M. (2023). A better place for whom? Practitioners' perspectives on the purpose of environmental education in Finland and Madagascar. The Journal of Environmental Education, 54(3), 163–180. https://doi.org/10.1080/00958964.2023.2178371

Chen, C., An, Q., Zheng, L., & Guan, C. (2022). Sustainability literacy: Assessment of knowingness, attitude and behavior regarding sustainable development among students in China. Sustainability, 14(9), 4886. https://doi.org/10.3390/su14094886

Ekamilasari, E., Permanasari, A., & Pursitasari, I. D. (2021). Critical thinking skills and sustainability awareness for the implementation of education for sustainable development. Journal of Science Education Research, 5(1). https://doi.org/10.21831/jser.v5i1.41753

Erguvan, I. D. (2024). Assessing the sustainability literacy of undergraduate students in a first-year writing course. Discover Education. https://doi.org/10.1007/s44217-024-00179-7

Fadli, M. F., Subkhan, M., & Masthuro, M. (2023). Media pembelajaran buku saku pembiasaan nilai budaya berbasis pola asuh orang tua. Jurnal Citizenship Virtues, 3(1), 477–491. https://doi.org/10.37640/jcv.v3i1.1735

Hanum, Z., Syahr, A., Syaifullah, D. H., & Sally, N. U. (2024). The review study of environmental education curriculum in climate change mitigation. Jurnal Presipitasi, 21(1), 12–25.

Helmi, H., Nengsih, Y. K., & Suganda, V. A. (2018). Peningkatan kepedulian lingkungan melalui pembinaan penerapan sistem 3R (reduce, reuse, recycle). Jurnal Pendidikan dan Pemberdayaan Masyarakat, 5(1), 1–8.

Hudha, M. H., Hamidah, I., & Permanasari, A. (2020). Low Carbon Education: A review and bibliometric analysis. European Journal of Educational Research, 9(1), 319–329. https://doi.org/10.12973/eu-jer.9.1.319

Karyanto, P. (2019). Non-curricular strategies in the implementation of education for sustainable development in three prominent green schools in Indonesia. Journal of Physics: Conference Series, 1241(1), 012035. https://doi.org/10.1088/1742-6596/1241/1/012035

Katoppo, M. L., Irwandi, E., Ng, A. H., & Lie, S. (2020). Building environmental awareness for future generation through educational comic: The story of 4th-grade students Darussalam elementary school, Panongan, Tangerang. IOP Conference Series: Earth and Environmental Science, 452(1), 012067. https://doi.org/10.1088/1755-1315/452/1/012067

Kuehl, C., Sparks, A. C., Hodges, H., & Smith, E. R. A. N. (2022). Exploring sustainability literacy: Developing and assessing a bottom-up measure of what students know about sustainability.

Kustandi, C., Zianadezdha, Asfara, Fitri, A. K., Farhan, M., & others. (2021). Pemanfaatan media visual dalam tercapainya tujuan pembelajaran. AKADEMIKA: Jurnal Teknologi Pendidikan, 10(2), 291–299.

Noh, J., & Bae, J. (2024). The effect of environmental education using picture books on environmental literacy and ecological sensitivity of elementary lower grade students. Biology Education, 52(4), 551–561. https://doi.org/10.15717/bioedu.2024.52.4.551

Nurramadhani, A., Permanasari, A., & Rahma, I. (2024). How does Low-Carbon Education develop in Indonesia? Bibliometric analysis. Pedagonal: Jurnal Ilmiah Pendidikan, 8(2), 177–187. https://doi.org/10.55215/pedagonal.v8i2.19

Nurramadhani, A., Riandi, R., Permanasari, A., & Suwarma, R. (2022). Low Carbon Education: Students' understanding, applications in daily life, and science learning. Journal of Engineering Science and Technology, 17, 101–109.

Oktarina, P. S., Hari, N. P. L. S., & Ambarwati, N. M. W. (2020). The effectiveness of using picture book to motivate students especially young learners in reading. Yavana Bhasha: Journal of English Language Education, 1(1), 72. https://doi.org/10.25078/yb.v1i1.1379

Paradewari, D. S., Avillanova, A. A., & Lasar, A. B. (2018). Promoting environmental awareness in learning contexts. International Journal of Humanity Studies, 1(2), 243–252. https://doi.org/10.24071/ijhs.v1i2.1322

Permanasari, A., Hamidah, I., & Adriany, V. (2020). Low Carbon Education: How students from lower level education pertain the good environment practices. Advances in Social Science, Education and Humanities Research, 438, 164–166. https://doi.org/10.2991/assehr.k.200513.037

Pursitasari, I. D., Suhardi, E., & Fitriana, I. (2019). Development of context-based teaching book on environmental pollution materials to improve critical thinking skills. Advances in Social Science, Education and Humanities Research, 253, 238–241. https://doi.org/10.2991/aes-18.2019.56

Rachmawati, D., Leksono, S. M., & Nulhakim, L. (2021). Analisis literasi lingkungan dalam buku teks pelajaran IPA SMP Kurikulum 2013. PENDIPA Journal of Science Education, 6(1), 88–97. https://doi.org/10.33369/pendipa.6.1.88-97

Sabanil, S., Sarifah, I., & Imaningtyas, I. (2022). Peran guru dalam pelaksanaan hidden curriculum untuk menumbuhkan karakter kebhinekaan global siswa sekolah dasar. Jurnal Basicedu, 6(4), 6567–6579. https://doi.org/10.31004/basicedu.v6i4.3306

Satrianawati, S., & Fu, W. (2019). Education for Sustainable Development (ESD) in Indonesia: A conceptual framework. International Journal of Education and Learning, 1, 42–49. https://doi.org/10.31763/ijele.v1i1.33

Sintiya, A. M., Luthfi, E., & Ahsani, F. (2025). STEM-based Education for Sustainable Development in elementary schools: Fostering sustainability awareness through a descriptive qualitative approach. Al-Aulad: Journal of Islamic Primary Education, 8(1), 74–85.

Susilawati, W. O., Darniyanti, Y., Prasetyo, D. E., Apreasta, L., & Novitasari, A. (2020). Urgency of Adiwiyata school for education as sustainable development. Journal of Education and Learning (EduLearn), 14(4), 543–549. https://doi.org/10.11591/edulearn.v14i4.15584

Warliyah, H., Permanasari, A., Rachman, I., & Matsumoto, T. (2023). Low Carbon e-Book on climate change with Education for Sustainable Development framework for sustainability literacy of 7th grader. Jurnal IPA & Pembelajaran IPA, 7(4), 317–334. https://doi.org/10.24815/jipi.v7i4.33663

Xiang, C., & Liu, N. (2024). Factors and paths influencing students' low-carbon behavior. Carbon Management, 15(1). https://doi.org/10.1080/17583004.2024.2349173