JPPIPA 11(6) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

The Development of Multimodal-Based Natural Science Teaching Materials to Improve the Science Literacy of Class IV at MI Masjid Al Akbar Surabaya

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Received: April 08, 2025
Revised: May 17, 2025
Accepted: June 25, 2025
Published: June 30, 2025

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DOI: 10.29303/jppipa.v11i6.11028

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Abstract: The results of field studies showed that the natural science literacy of students in Indonesia was still low. Indonesia's performance in science literacy assessments like PISA has shown the need for improvement due to factors like limited resources, inadequate facilities, and uninspiring teaching materials that are not oriented toward the science literacy component. This study focused on the effectiveness of the use of textbook-oriented provisioning capability in science literacy by using multimodal learning materials. The textbook's development method used a 4D model (define, design, development, and disseminate) to write. Textbook design, which was applied to the topic of "Animal Life Cycle," was implemented among 42 students of the 4th grade at Madrasah Ibtidaiyah (MI) Masjid Al Akbar Surabaya. Effectiveness is determined by consideration of the effect and the normalized percentage gain value, while the hypothesis was tested using the Independent T-test. The results showed that the textbooks that were developed using multimodal-based science can improve the literacy skills of students. Based on the size of the effect size, textbooks developed with a multimodal approach were found effective in improving students' science literacy skills. The improvement occurred in all the competencies and knowledge of scientific literacy. The hypothesis testing showed that there was a significant difference in the ability of science literacy between the class that uses textbooks with multimodal-based and the class that uses the regular textbooks used in schools.

Keywords: Multimodal; Teaching materials; Science literacy

Introduction

Indonesian students face a serious problem in understanding scientific literacy. The *Programme for International Student Assessment* (PISA) survey – an assessment of abilities and knowledge in literacy, mathematics, and natural sciences for 15-year-old students – represents low scientific literacy among Indonesian students. The score in 2000 was 393, placing it 38th out of 41 countries, and in 2018 it was 396, ranking 68 out of 81 countries. In 2022, the score dropped to 383, far below the average PISA score of 485, bringing its position down to 71 of 81 countries surveyed (OECD, 2019b, 2023). The Trends in International Mathematics and Science Study (TIMSS) study in 2011 also showed that only 3% of Indonesian students reached a high level of science proficiency, while 54% were low (Wasis et al., 2020). According to PISA, scientific literacy refers to the ability to draw on scientific knowledge, identify questions, and draw conclusions based on scientific evidence to understand and make decisions about nature and the changes that occur due to human

How to Cite:
Ashari, C., Mariana, N., & Widiasih. (2025). The Development of Multimodal-Based Natural Science Teaching Materials to Improve the Science Literacy of Class IV at MI Masjid Al Akbar Surabaya. *Jurnal Penelitian Pendidikan IPA*, *11*(6), 519-528. https://doi.org/10.29303/jppipa.v11i6.11028

activities. Therefore, the inability to master scientific literacy will lead to difficulty in making decisions related to complex scientific, social, and environmental issues that affect daily life, since it is related to a person's intellectual and cognitive development (OECD, 2019a). The data signifies that the average Indonesian student can only recognize basic facts but cannot yet communicate or relate various science topics, such as applying complex and abstract science concepts to solve real-life problems.

Although the PISA study focused on 15-year-old students in secondary school, the results may illustrate the general condition of students in Indonesia, including at the elementary school level, in scientific literacy. Understandably, students at secondary school are commonly shaped by their education at elementary school, given that elementary school lays the foundation for students' higher education (Bal-Taştan et al., 2018; Kwon, 2005). Therefore, one must be aware of the ineffectiveness or weakness of the education learning process of the science subject at the elementary school. Syahputra et al. (2022) found three main challenges faced by 3rd to 6th-grade elementary school students in the natural science subject: school facilities and infrastructure, the learning media used, and the students' interest in the subject. When those challenges are not taken seriously, students will remain in an ineffective science learning process and have low scientific literacy.

Hence, evaluation and improvement of natural science learning is a must. All this time, science learning activities draw more on the transfer of knowledge and teacher-oriented, neglecting science process and problem-solving skills that impact students' daily lives (Putri et al., 2025). Some studies show the need for evaluation of inadequate facilities and unattractive learning processes (Akramy, 2022; Atstsaniyah et al., 2024; Kurniawan et al., 2024; Suparya et al., 2022; Uline, 2022; Yangambi, 2023), the unavailability of PISA test materials in the Indonesian curriculum, and the absence of reinforcement of experiments and their applications in real life (Mendikbudristek, 2022). It is necessary for teachers to selectively choose appropriate learning resources since they affect the understanding of concepts, or otherwise, they lead to low levels of scientific literacy among students (Kim et al., 2021; Mamonto et al., 2024; Muslichatun et al., 2021). Therefore, the development of teaching materials that follow the needs of teachers in promoting and improving scientific literacy for elementary school students is important because, so far, natural science books have been less integrated and saturated (Nurhidayati, 2017; Saija et al., 2022).

In this regard, multimodal text-based teaching materials, which integrate various modes or media, such as images, text, audio, and video, in one learning material (Bouchey et al., 2021; Sahidah et al., 2021) to communicate or deliver a comprehensive information or meaning simultanously (Hermawan, 2013), can be an impactful alternative to use in the natural science learning process. Such materials provide an attractive and interactive display and easier access to information and concepts of the subject, making students more interested in learning and understanding more deeply, as well as improving students' visual and digital literacy (Faishol et al., 2021). Working by functioning images, relating visual and verbal materials, presenting explicit explanatory structures, and providing lexico-grammatical resources, multimodal texts effectively boosted science reading comprehension for low-skilled readers among students (Meneses et al., 2018). Klein and Kirkpatrick (2010) viewed multimodal literacies in science as not simply transmitting scientific information, but as integral to reasoning about scientific phenomena. The development of multimodal textbooks allows students to understand the concepts of the subject matter being taught, encourages students to learn to research independently, which leads students to a scientific thinking attitude, and then draws conclusions about the concepts learned in accordance with the goals that have been set in the field of science literacy. Multimodal textbooks that are made attractively will arouse students' interest in reading textbooks, so that the textbooks function to help students learn the knowledge they learn.

A relevant example of the topics students find daily is the animal life cycle. Providing the topic in a multimodal textbook will help students not only receive information about how animals live and reproduce, but also have an imaginary representation to easily identify the phenomena in daily life. Further, students will understand biodiversity with its unique characteristics so that they can respect the lives of creatures and have early environmental awareness. The *Kurikulum Merdeka,* as the national curriculum, allows teachers and students to develop such multimodal-based teaching materials. However, given that multimodal-based textbooks in natural science, in this regard, biology, have not been developed widely, the author then developed it to see how it works in the field. This study carries out the hypothesis that the multimodal-based learning material will be positively impactful for students. However, it will examine to what extent the validity and effectiveness of the multimodal-based teaching material that the authors developed by taking the topic of the animal life cycle from the grade IV elementary school curriculum, and what its impacts are on students' science literacy. Thereby, it aims to engage the utility of multimodal-based textbooks, especially in natural science, as developed in this research, to be adapted in

educational institutions in Indonesia to boost scientific literacy among students.

Method

This paper implies a mixed method and research and development (R&D) approach using the 4-D models that consist of definition, design, development, and dissemination (Thiagarajan, 1974). It has a structured and systematic stage system in which each stage includes evaluation and validation, making the quality and effectiveness of the learning model's results measurable. In addition, this model opens to adaptation of contextual development, such as students' characteristics and needs, making its product relevant to contemporary circumstances. The definition step analyzes five elements: basic problem, students, concepts, curricula, and learning goal specification. This analysis will help determine the design model in which the learning material, lesson plan, learning instruments, and pre-test and post-test will be developed. Next, the design phase is taken in developing the material since selecting and combining any topic resources was undergone and decided here. It is then followed by the development model, where the earlier learning material receives suggestions through student observation sheets, teacher activity sheets, and expert recommendations. Meanwhile, the dissemination model was divided into three activities: validity testing, packaging, and diffusion and adaptation.

This research was conducted at Madrasah Ibtidaiyah (MI) Masjid Al-Akbar Surabaya, a private Islamic elementary school affiliated with Masjid Al-Akbar Surabaya, a provincial national mosque. The research involved 42 fourth-grade students, aged 9 to 10, who are physically and mentally growing, developing the intellectual ability to think abstractly and logically, and mastering the foundational skills of reading, writing, and mathematics. The subjects were selected using probability sampling, typically simple random sampling, carrying the assumption that all students have the same science literacy and ignoring the strata within the population. The research took place from January to March in the odd semester of the 2022/2023 academic year.

The study was conducted through two stages. First is the development stage in which the 4D models are applied. This stage was conducted through several steps to determine, design, develop, and disseminate the multimodal-based text materials on the natural sciences subject based on the 2013 national curriculum. Second, the trial stage of the revised product is carried out in a limited manner in the classroom to find out the results of the product application to students. This study was designed using a *Quasi-Experimental Design* with a *Nonequivalent Control Group Design* type, where subjects were divided into two groups, namely the intervention group consisting of 22 students and the control group consisting of 20 students, which were selected selectively. First, both groups faced a pre-test to determine their early understanding before treatment. After that, they were treated differently, where the intervention group was taught using the developed multimodal-based textbook, while the control group was taught using the regular thematic textbook.

The data in this study were collected through several techniques. Observations were made on learning activities between teachers and students. To dig deeper into the information, interviews were conducted, using a structured list of questions, with the students and the teachers who run the class. In the experimental stage, questionnaires are needed to measure the product quality of teaching materials and tests, and both pretest and posttest are needed to determine the material's mastery and the product's effectiveness for improving students' natural science literacy. There are four instruments in the data collection: a validation sheet using the Likert Scale with a score of 1-4 for the design of teaching materials, observation sheets of learning activities, students' response sheets, and the Natural Science Literacy Test Assessment Sheet. With the criteria that $1 \leq P \leq 1.5$ is invalid, $1.6 \leq P \leq 2.5$ is less valid, $2.6 \leq P \leq 3.5$ is valid, and $3.6 \leq P \leq 4$ is very valid, the science literacy assessment sheet has been validated by three validators, a lecturer at Diponegoro University Siti Khabibah and two teachers at MI Masjid Al Akbar Surabaya Ayu Luthfi Permata Rohmat and Suci Ferdiana, as follows:

Table 1. Science Literacy Assessment Sheet

Aspect Assessed	Average	Category
Content (1-4)	3.6	
Language (5-8)	3.68	
	3.6	Very Valid

Considering that the data collected is quantitative and qualitative, quantitative data is analyzed using statistics, while qualitative data will be analyzed descriptively. The quantitative data obtained is data on the validity or feasibility, practicality, and effectiveness of teaching material products, and it is analyzed using SPSS software. Validity analysis aimed to calculate the average score (X) by dividing the total validation score ($\sum X$) by the number of validators (n), using the formula $\bar{X} = \frac{\sum X}{n}$. An average score of at least 2.6 was established as the minimum criterion for product eligibility.

The effectiveness of the product was analyzed based on three aspects. First, students' responses following different group treatments were assessed using a 10 'yes-no' questionnaire. A "yes" response was

scored as 1, while a "no" response was scored as 0. The results were analyzed using the formula A = $\frac{m}{n} \times 100\%$ where A represents the percentage of positive student responses, m is the number of students who responded positively, and n is the total number of students. A minimum threshold of 50% was established to indicate effectiveness. Second, students' cognitive learning outcomes were evaluated using a test with a minimum passing score of 70 out of 100. Class success was defined by at least 75% of students meeting or exceeding this score, with an ideal benchmark of 85% as recommended by Mulyasa (2004). The improvement in learning outcomes was further assessed using N-gain analysis, comparing pretest and posttest scores through SPSS. This calculation compares students' performance before and after the intervention by analyzing their pretest and posttest scores. Specifically, the N-gain is obtained by subtracting the pretest score (S1) from the posttest score (S2), and then dividing the result by the difference between the maximum possible score (Smax) and the pretest score. In other words, the formula is written as $N\text{-}gain = \frac{S2 - S1}{Smax - S1}$. The interpretation of the N-gain score (g) was as follows: $g < 0.3$: Low improvement; $0.3 \leq g < 0.7$: Moderate improvement; and $g \geq 0.7$: High improvement. Third, a difference test was conducted to determine the effect of the developed teaching materials on students' science literacy. A normality test using the Shapiro-Wilk method was applied, as the sample size was under 100. If the Asymp. Sig. (2-tailed) value is > 0.05, the data are normally distributed; otherwise, they are not. A paired t-test was used for normally distributed data; a Wilcoxon test was applied to non-normal data. At a 5% significance level, if the p-value < 0.05, the null hypothesis is rejected, indicating a significant difference between the groups. If the p-value > 0.05, the null hypothesis is accepted, meaning no significant difference was found.

Result and Discussion

Definition Phase

The definition phase is the starting phase of the research to identify problems and alternatives. Here, the phase starts with a front-end analysis to identify problems occurring in the natural science subject learning activities in the 4th grade at MI Masjid Al Akbar Surabaya and finds an effective learning medium needed to boost the students' science literacy. Later, the authors analysed students and found less interest and understanding among the students in studying due to uninteresting textbooks. Therefore, the authors conducted a conceptual analysis to formulate the textbook on animal life cycles and a task analysis to decide the materials and exercises given to the students. The phase ends with specifying the instructional objective in which students can improve their understanding of and creativity in the topic of animal life cycle, develop their ability to be critical of the materials, and increase their awareness of the topic subject.

Design Phase

After the definition phase, the authors designed the textbook from various resources. The textbook combines texts, images, QR codes for information, experiments, science stories, practice questions, enrichment questions, and summary material that covers themes of the definition of animal life cycles, their types, perfect and imperfect metamorphosis, and examples of animals that do not metamorphose. It also includes a syllabus, learning implementation plans, and student worksheets. It is designed to be visually interesting, colourful, and proportional.

Development Phase

This phase has two steps: the expert appraisal and the development testing. The expert appraisal involves assessing the textbook developed by the content expert and the learning media expert. They make several suggestions regarding the content and the design. The textbook is later revised according to these suggestions and is ready to be implemented in the dissemination phase.

Dissemination Phase

After being developed, the product is implemented in the intervention class to see if there is a difference in how it is used compared to the regular thematic textbook. To measure it, validation is important to ensure it meets the set standards. Three validators, namely a lecturer at Diponegoro University Siti Khabibah and two teachers at MI Masjid Al Akbar Surabaya Ayu Luthfi Permata Rohmat and Suci Ferdiana, contributed to this process to assess teaching materials, syllabus, learning implementation plans, student worksheets, and natural science literacy assessment sheets, using a Likert scale with a score range of 1 to 4. Teaching materials are assessed by those three validators from four aspects, namely content feasibility, presentation feasibility, language feasibility, and display. Table 2 shows the average score of each aspect which is categorized as very valid.

After the textbook had been validated, its effectiveness in improving students' science literacy was examined. After implementing different treatments, the assessment was carried out by holding a pretest and posttest in the control and intervention group. The data were then analysed using the N-gain formula. Tables 3 and 4 show the data for each group.

Table 2. Teaching Materials' Validation

Content Feasibility	Average Score	Presentation Feasibility	Average Score	Language Feasibility	Average Score	Graphic Feasibility	Average Score
Content Compatibility with Basic Competencies (1-3)	3.8	Presentation Technique (1)	3.7	Straight-forwardness (1)	3.7	The orientation of the book size (1-3)	3.7
Content Accuracy (4-8)	3.74	Presentation Support (2-6)	3.76	Communicative (2-4)	3.8	Cover Design (4-7)	3.78
Content Relevancy (9-10)	3.8	Learning Presentation (7)	3.7	Dialogic and interactive (5)	3.3	Content Design (8-14)	3.55
Curiosity Encouragement (11-12)	3.7	Coherence and Sequence of Thought (8-9)	4	Compliance with Student Development (6-7)	3.5		
		Science Literacy Aspect (10-12)	3.43	Compliance with Language Rules (8-9)	3.7		
				Multimodality Aspect (10-11)	3.5		
Average Score	3.76		3.72		3.6		3.68

Table 3. The Control Group's Treatment Progress

Name	Score S1 (Pre-test)	Score S2 (Post-test)	S2-S1	Max Score	N-Gain= $\frac{S2-S1}{Smax-S1}$	Category
A1	51	65	14	100	0.29	Low
A2	67	77	10	100	0.30	Medium
A3	62	78	16	100	0.42	Medium
A4	70	87	17	100	0.57	Medium
A5	66	92	26	100	0.76	High
A6	72	90	18	100	0.64	Medium
A7	71	92	21	100	0.72	High
A8	75	95	20	100	0.80	High
A9	71	78	7	100	0.24	Low
A10	55	65	10	100	0.22	Low
A11	64	70	6	100	0.17	Low
A12	62	76	14	100	0.37	Medium
A13	63	74	11	100	0.30	Medium
A14	71	71	0	100	0.00	Low
A15	74	92	18	100	0.69	Medium
A16	65	66	1	100	0.03	Low
A17	73	84	11	100	0.41	Medium
A18	61	90	29	100	0.74	High
A19	80	95	15	100	0.75	High
A20	66	74	8	100	0.24	Low
				Average	0.43	Medium

Table 4. The Intervention Group's Treatment Progress

Name	Score S1 (Pre-test)	Score S2 (Post-test)	U2-U1	Max Score	N-Gain= $\frac{S2-S1}{Smax-S1}$	Category
B1	67	92	25	100	0.76	High
B2	74	96	22	100	0.85	High
B3	76	89	13	100	0.54	Medium
B4	65	80	15	100	0.43	Medium
B5	76	76	0	100	0.00	Low
B6	73	100	27	100	1.00	High
B7	76	95	19	100	0.79	High
B8	66	88	22	100	0.65	Medium
B9	64	95	31	100	0.86	High
B10	75	92	17	100	0.68	Medium
B11	65	90	25	100	0.71	High
B12	54	70	16	100	0.35	Medium
B13	76	100	24	100	1.00	High
B14	72	90	18	100	0.64	Medium

Name	Score S1 (Pre-test)	Score S2 (Post-test)	U2-U1	Max Score	N-Gain= $\frac{S2-S1}{Smax-S1}$	Category
B15	57	75	18	100	0.42	Medium
B16	62	79	17	100	0.45	Medium
B17	50	80	30	100	0.60	Medium
B18	67	85	18	100	0.55	Medium
B19	84	100	16	100	1.00	High
B20	67	85	18	100	0.55	Medium
B21	73	95	22	100	0.81	High
B22	71	95	24	100	0.83	High
				Average	0.70	High

Furthermore, a differential test was carried out to determine whether there was a significant difference between students' science literacy abilities using multimodal-based and thematic teaching materials. Two prerequisite tests are carried out, namely the normality test and the homogeneity test, to determine whether to use a parametric or non-parametric statistical test. The normality prerequisite test was carried out to assess the data distribution in the data group (variable) sample and whether it was normally distributed. In this study, the normality test was carried out using the Shapiro-Wilk test (N < 50).

Table 5. Normality Test Result

		Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Control Class	Pretest	.120	20	.200*	.972	20	.796
	Postest	.167	20	.145*	.911	20	.068
Intervension Class	Pretest	.136	22	.200*	.950	22	.322
	Posttest	.136	22	.200*	.938	22	.179

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Field data showed that the scores of students in the control class before and after using the thematic natural science teaching materials had significance values respectively of 0.796 > 0.05 and 0.068 > 0.05 so that the data was declared to be distributed normally. Similarly, the score data of students in the intervention class was also distributed normally between before and after using multimodal natural science teaching materials with significance values of 0.322 > 0.05 and 0.179 > 0.05. The next prerequisite test is the homogeneity test to see whether the data group being tested has a similar data dispersion rate. The data shows a homogeneity value of 0.154 > 0.05, meaning that the data has a similar or homogeneous distribution.

Since the data in this study is normal and homogeneous, the measurement of the parametric test is continued using a different test. The following are the results of the different tests using the t-test:

Table 6. T-Test Difference Result

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Natural Science Literacy	Equal variances assumed	2.111	.154	-2.688	40	.010	-7.950	2.957	-13.927	-1.973
	Equal variances not assumed			-2.665	37.164	.011	-7.950	2.983	-13.994	-1.906

Based on the results of the t-test in Table 4.12, it can be found that the significance value (2-tailed) is 0.010 < 0.05, so it can be stated that there is a significant difference in the posttest average score of students' science literacy between the control class and the experimental class. This means that the use of teaching materials based on multimodal texts affects science literacy. Through the use of multimodal text-based teaching materials, students' science literacy skills can be significantly improved.

In addition, the effectiveness of teaching materials can be assessed from students' responses to their use and the learning process. Five structured 'yes or no' questions were asked of the students regarding the

product application process. In the opinion question related to learning activities by applying products, 38 students, or 91 percent, were happy and interested in following the developed learning concept. In comparison, 4 students, or 9 percent, were the opposite. 40 students (95 percent) admitted they were interested in the teaching materials and student worksheets developed, the learning process, and the atmosphere, while the remaining 2 (5 percent) were not interested. The exact number also admitted that the learning component was new. From the questionnaire data, a very positive assessment of 92.75 percent was obtained based on criteria where 75% of ≤ P < 100% can be considered very positive (Akdon, 2012).

The research argues that using multimodal text-based teaching materials positively and significantly affects science literacy skills among the 4th-grade students of MI Masjid Al Akbar Surabaya. Based on the posttest data of students' natural science literacy, the results show a significance value (2-tailed) of 0.010 < 0.05, where the intervention group, which was taught with multimodal-based teaching materials, performed better than the control group taught with the regular thematic textbook. This learning tool has the potential to be widely adopted to increase the PISA scores of Indonesian students. These results are aligned with various research results that developing feasible (valid, practical, effective) teaching multimodal-based materials (Sahidah et al., 2021), media (Syaifa et al., 2023), *e-book* (Munawwarah et al., 2022), e-module (Bachrudin et al., 2023) can improve the science literacy of elementary school students. In addition, this is also in line with the research of Murcia (2014), which proves that learning supported by multimodal technology can improve students' high-level thinking skills and conceptual engagement during learning, Meneses et. al. (Meneses et al., 2018), in which high multimodal texts significantly improve science reading comprehension for students with low reading comprehension ability.

Besides having a very positive result in its validity and effectivity test as the main criteria (Akker et al., 2006), the development of this teaching material also refers to the fulfillment of four elements according to the National Education Standards Agency (Badan Standar Nasional Pendidikan, BSNP), namely content feasibility, language feasibility, presentation feasibility, and graphics. Thus, the teaching materials developed are not only displayed attractively, but also pay attention to the feasibility of the substance that is the core of the science being conveyed. The developed multimodal teaching material examined in this research is designed to engage students in an interesting learning process. The situation can stimulate students to get a more comprehensive and deeper understanding of the topic and apply it to their daily lives. The topic of animal life cycles is chosen since it is easily found in their daily lives and as an introduction to multimodal-based materials in natural science subjects in the school.

The Department of National Education (Depdiknas, 2008) noted that students are more interested in diverse teaching materials that encourage them to be active in learning, and multimodal-based teaching materials, as examined in this research, can be highly recommended alternatives. Multimodal-based teaching materials enable the integration of science and attractive and easily understood language which, according to Fazio et al. (2019), affects the understanding of science and a complete understanding when processing information and is positively correlated with the learning achievement of students in both fields. Text is not only understood in words, images, movements, graphics, and others but also influences the act of communication, especially in learning. With a multimodal approach, students can choose for themselves the learning object or representation that best suits their learning preferences based on their dominant learning style (Al Fajri, 2018). The collaboration between literacy and multimodal gives students a complete and comprehensive understanding. Adding pictures or illustrations in teaching materials also helps clarify the intent of the material presented instead of just using text (Kersten, 2017). Through this integration, children can use attention, memory, and strategies to process information, and children aged 7-11 years can perform logical reasoning and concrete operations (Piaget, 1972).

Several factors enable multimodal learning materials to increase students' science literacy. First, students are active in learning instead of being passive. Visual images guide the students in doing observational tasks, which allow students to learn outside the class and experience reality beyond the text. Visual images enable students to interpret the text in various ways and foster innovative interpretations of the text (Poyas et al., 2012). Second, the multimodal approach helps students apply concepts and trains them to make decisions based on analysis and solutions (Firmansyah, 2021). Third, the textbook contains various learning resources, allowing students to have different learning methods and media personalized for them. Thus, the development of multimodal-based teaching materials helps to meet diversity (Abidin, 2022), ensuring inclusivity that encourages intellectual quality and allows students to experience a broad learning experience while allowing teachers to meet the needs of different learners in a learning environment.

Conclusion

This study proves that the multimodal text-based science teaching materials developed are valid and effective in improving the science literacy of 4th grade students of MI Masjid Al Akbar Surabaya. With an average score of 3.6 in the highly valid category and a reliability score of 95%, these teaching materials are in accordance with learning objectives, easy to apply in the classroom, and encourage active student participation. The posttest results showed a significant value (2-tailed) of 0.010 < 0.05, which indicated a significant influence of teaching materials on improving science literacy, with an N-Gain score of 0.70 (high category) in the experimental class compared to 0.43 (medium category) in the control class. These results are in line with other studies that confirm that multimodal texts support science comprehension, especially for students with low reading ability. Therefore, these teaching materials deserve to be widely adopted to improve the science literacy of Indonesian students and prepare them for the challenges of 21st-century learning. For future research, the study recommends that this teaching material be practically adopted for other grades and subjects by adapting its materials and topics.

Acknowledgments
Praise be to Allah, the Almighty God, who has given us the opportunity to do this research. We also thank our families for their support during this study, which takes time from them.

Author Contributions
All authors contribute significantly to this paper: C.A. created the learning material, dug the data from the fieldwork, validated it, made a formal analysis, and drafted the article; N.M. helped in preparing the methodology and ensured the analysis aligned with it; and W. ensured the data curation, supervised the research, and helped in project administration. All authors have read and agreed to the published version of the manuscript.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest since the article is made for research output in a scientific journal as evidence of required performance.

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