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The Effectiveness of Science Storybooks in Improving Students' Scientific Literacy: A Systematic Literature Review

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Abstract

Scientific literacy is essential for enabling students to understand scientific phenomena, evaluate evidence, and apply scientific knowledge in real-life contexts. Yet, Indonesian students continue to face challenges in achieving expected levels of scientific literacy. Science storybooks offer a potentially meaningful and engaging learning medium by integrating scientific concepts with narratives, visual representations, contextual materials, and interactive technology. This study aimed to examine the characteristics of research on science storybooks in science instruction, synthesize evidence of their effectiveness in improving students' scientific literacy, and identify factors influencing their effectiveness. A Systematic Literature Review (SLR) was conducted following the PRISMA 2020 guidelines. Literature published between 2019 and 2026 resulted in 38 eligible empirical articles. The findings showed that research was predominantly conducted at the elementary school level (42.1%) and used descriptive or qualitative approaches (44.7%). Science storybooks demonstrated positive effects on scientific literacy, with an average N-gain of 0.71, while AR-based interactive digital storybooks showed the highest average N-gain (0.80). Six factors influenced effectiveness: visual design, narrative-science integration, contextual relevance, interactivity and technology, student characteristics, and teacher facilitation.

Keywords

Digital Storybook, Science Learning, Science Storybook, Scientific Literacy, Systematic Literature Review.

1. Introduction

Scientific literacy is a fundamental competency that enables individuals to understand natural phenomena, make evidence-based decisions, and participate actively in a society increasingly intertwined with scientific and technological advancements (Pratiwi et al., 2019; OECD, 2023). In formal education, scientific literacy extends beyond mastery of scientific knowledge; it encompasses the ability to identify and formulate scientific problems, explain phenomena using scientific concepts, and use scientific evidence as a basis for decision-making (Yusmar & Fadilah, 2023). The importance of these skills has grown alongside modern challenges such as climate change, energy crises, and technological developments, which require individuals to respond to complex issues rationally and based on evidence (Putra & Wahyuni, 2025).

PISA 2022 data indicate that Indonesian students achieved a science score of 383 points, below the OECD average of 485 points (OECD, 2023). This gap reflects the mismatch between the demands of 21st-century competencies and the current state of science education. Previous studies by Turiman et al. (2012), Robbia and Fuadi (2020), and Tillah and Subekti (2024) have identified rote memorization, limited contextual relevance, and insufficient student engagement as factors associated with low scientific literacy achievement. These challenges highlight the need for learning approaches that make scientific concepts more meaningful, contextual, and engaging for students.

Science storybooks are narrative-based learning media that integrate scientific content with engaging storylines, visual illustrations, and characters that support readers' engagement with learning (Galda & Cullinan, 2002; Kardaş & Şahin, 2020). Unlike conventional textbooks, science storybooks embed scientific knowledge within narrative contexts that can stimulate imagination, empathy, and curiosity. This approach aligns with research on educational storytelling, which indicates that digital storytelling can serve as a flexible pedagogical strategy across educational levels (Wu & Chen, 2020). The narrative approach is also supported by several learning theories. Vygotsky (1978) emphasizes the importance of social interaction and meaningful contexts in knowledge construction, which can be facilitated by stories that situate scientific concepts within familiar situations. Paivio's (1991) dual-coding theory suggests that combining verbal and visual information can support memory and conceptual understanding, while Sweller's (1988) cognitive load theory indicates that well-structured learning materials can help manage learners' cognitive resources.

Advances in educational technology have expanded conventional storybooks into digital and interactive formats. Digital illustrated storybooks have been reported to improve elementary students' scientific literacy skills (Naresti & Suratmi, 2024; Naresti et al., 2024). Recent studies have further explored interactive digital storybooks supported by Augmented Reality (AR), reporting their potential to provide immersive learning experiences and support scientific literacy (Febrianti & Rosidah, 2026; Sembodho & Rosidah, 2026). Storybooks have also incorporated local cultural heritage and ethnoscience, as demonstrated by Alfarisi et al. (2026), indicating opportunities to connect scientific concepts with students' cultural contexts. Such developments suggest that the effectiveness of science storybooks may depend not only on narrative presentation but also on technological features, contextual relevance, visual design, and alignment with learning objectives.

Although empirical studies have demonstrated the potential of storybooks as science learning media, the evidence remains fragmented across educational levels, science topics, technologies, and geographical contexts. Existing studies frequently focus on individual interventions, while broader syntheses examining research characteristics, effectiveness, and factors influencing outcomes remain limited. Rini

et al. (2025) further highlighted the need to explore the integration of ethnoscience within science education, reinforcing the relevance of contextual and culturally grounded learning media. Therefore, a systematic synthesis is needed to consolidate existing evidence and identify patterns across the literature.

A Systematic Literature Review (SLR) provides a structured approach for identifying, evaluating, and synthesizing findings from previous studies (Kitchenham & Charters, 2007). This review follows the PRISMA 2020 guidelines to support transparent and systematic reporting of the review process (Page et al., 2021). Thus, this study aims to systematically examine research on science storybooks in science instruction by identifying the characteristics of existing studies, synthesizing evidence regarding their effectiveness in improving students' scientific literacy, and identifying factors that influence their effectiveness. Through these objectives, the review provides a comprehensive overview of the development, effectiveness, and determinants of science storybook use in developing scientific literacy.

2. Literature Review

2.1. Science Storybooks in Science Learning

Science storybooks have increasingly been used as learning media because they integrate scientific content with narrative, visual representation, and contextual situations. Storytelling can support science learning by presenting scientific ideas through meaningful narratives, enabling students to encounter concepts through characters, events, and explanations rather than through isolated factual information (Engel et al., 2018; Kardaş & Şahin, 2020). Leech et al. (2020) further emphasized the importance of embedding scientific explanations within narratives to support students' engagement with scientific discourse. In science education, this approach has been applied to topics such as ecosystems, environmental issues, chemistry, and scientific concepts that may be difficult for students to understand directly (Collins et al., 2023; Morais et al., 2026). Scientific picture books and nonfiction storybooks have also demonstrated potential for presenting scientific knowledge through accessible and engaging formats (Koç, 2024; Fujiwara, 2025).

The development of technology has expanded science storybooks from conventional print materials into interactive digital and augmented reality formats. Interactive digital storybooks can incorporate multimedia elements that give students additional opportunities to explore scientific content (Febrianti & Rosidah, 2026). Furthermore, contextualizing science learning through local wisdom and culture can strengthen its relevance of science learning to students' everyday experiences. Science storybooks based on local wisdom have been explored, while Alfarisi et al. (2026) highlighted the potential of local-cultural contexts in science storybook development. Similarly, digital storytelling has been connected with environmental awareness and contextual science learning. These findings indicate that the effectiveness of science storybooks depends not only on narrative presentation but also on the integration of scientific content, visual elements, context, and appropriate technological features.

2.2. Science Storybooks and Scientific Literacy

Scientific literacy requires students to understand scientific concepts, explain scientific phenomena, and apply scientific knowledge in meaningful contexts. Science storybooks can support these abilities by presenting scientific phenomena and concepts within narratives that connect learning materials with students' experiences. Previous studies have reported positive outcomes from the use of storybooks and related narrative approaches in science learning, including improvements in students' understanding, engagement, and interest in science (Engel et al., 2018; Kardaş & Şahin, 2020). Naresti et al. (2024) also reported the

potential of science storybooks to support scientific literacy, while studies involving digital storybooks have demonstrated their capacity to provide more engaging learning experiences. The use of digital formats is particularly relevant because interactive features can allow students to access scientific information through multiple forms of representation and interaction.

The reviewed literature further indicates that the effectiveness of science storybooks is associated with the way narrative, scientific concepts, contextual materials, and student characteristics are integrated. Febrianti and Rosidah (2026) reported high effectiveness of an augmented reality-based digital storybook, while Sembodho and Rosidah (2026) demonstrated the potential of digital storybooks to support science learning. Contextual and culturally relevant content can also strengthen students' connections between scientific knowledge and their surrounding environment (Alfarisi et al., 2026). Recent research on interactive digital learning media at the junior high school level further highlights the importance of digital media in supporting student engagement and practical understanding of learning concepts (Mutaqin et al., 2026). However, the existing literature remains largely concentrated at the elementary level, with fewer experimental studies examining interactive digital storybooks at the junior and senior high school levels. This gap is particularly evident in studies integrating ethnoscience and local wisdom into digital storybooks, indicating the need for further investigation across secondary science education.

3. Methods

This study employed a Systematic Literature Review (SLR) as a secondary research method to identify, evaluate, and synthesize relevant empirical evidence systematically and transparently (Gough et al., 2017). The review protocol followed the PRISMA 2020 guidelines (Page et al., 2021). The literature search was conducted from January to March 2026 using five electronic databases: Google Scholar, ERIC, DOAJ, Scopus, and the Kemendikbudristek Garuda Portal. The search strategy was developed using the PICO approach and Boolean operators with combinations of terms related to science storybooks, science learning, and effectiveness. The primary search string was ("storybook IPA" OR "science storybook" OR "buku cerita sains" OR "media cerita bergambar" OR "digital storybook" OR "interactive storybook") AND ("literasi sains" OR "scientific literacy" OR "pembelajaran IPA" OR "science learning") AND ("efektivitas" OR "effectiveness" OR "peningkatan" OR "improvement"). Additional terms, including "picture book science," "narrative-based science learning," and "story-based inquiry," were used to broaden the search.

Eligibility criteria were established before the search process. Articles were included when they were journal articles indexed in SINTA, Scopus, Google Scholar, ERIC, or DOAJ; published between 2019 and 2026; written in Indonesian or English; examined science storybooks or story-based media in science learning; measured scientific literacy or science competence quantitatively or qualitatively; and involved students at the early childhood (*Pendidikan Anak Usia Dini/PAUD*), elementary, junior high, or senior high school levels. Textbooks, undergraduate theses, master's or doctoral theses, non-journal reports, articles published before 2019, articles in languages other than Indonesian or English, studies unrelated to storybooks or storytelling media in science education, review or opinion articles without empirical data, and studies involving university students or teachers were excluded.

Article selection followed the four PRISMA 2020 stages. The database search identified 248 records, after which 38 duplicates were removed, leaving 210 articles for title and abstract screening. Of these, 142 articles were excluded because they were not relevant to science storybooks or scientific literacy. The remaining 68

articles underwent full-text eligibility assessment, resulting in the exclusion of 30 articles that did not meet the predetermined inclusion criteria. Consequently, 38 articles were included in the final SLR analysis, as illustrated in Figure 1.

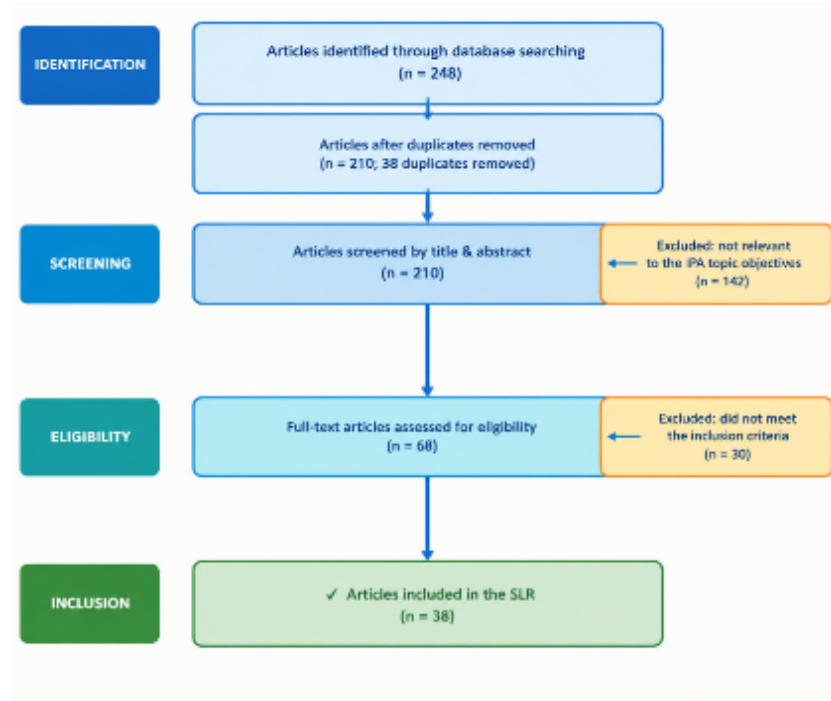


Figure 1. PRISMA 2020 Flow Diagram

Methodological quality was assessed using the 2018 version of the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2019). The assessment process produced an inter-rater agreement of Cohen's Kappa = 0.81, indicating excellent agreement between raters. The eligible studies were subsequently synthesized descriptively to identify study characteristics, evidence of effectiveness, and factors associated with the use of science storybooks for developing students' scientific literacy.

4. Results

4.1. Characteristics of Science Storybook Research

Based on an analysis of the 38 included articles, an overview of the characteristics of science storybook research was obtained, covering publication trends over time, the distribution of educational levels, and the methods and science topics examined.

Table 1. Temporal Distribution of Science Storybook Article Publications (2019-2026)

Years	Number of Articles	Percentage (%)
2019	1	2.6%
2020	9	23.7%
2021	2	5.3%
2022	3	7.9%
2023	3	7.9%
2024	6	15.8%
2025	8	21.1%
2026	6	15.8%
Total	38	100%

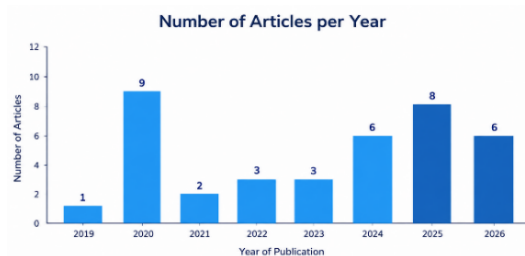


Figure 2. Temporal Distribution of Science Storybook Article Publications (2019–2026)

Table 1 and Figure 2 show that research on science storybooks was published unevenly between 2019 and 2026. The number of publications increased from only one article in 2019 to nine articles in 2020, followed by a decline during 2021–2023 and a subsequent increase in 2024–2026. The 2020–2022 period accounted for 14 of the 38 included articles (36.8%), while another 14 articles (36.8%) were published during 2025–2026. This distribution indicates renewed research activity in recent years, particularly in the development of science storybooks and related learning media. Recent studies have expanded the use of digital and interactive technologies, including augmented reality, as well as contextual and interdisciplinary approaches in science education (Ho et al., 2026; Morais et al., 2026). However, because the 2026 search period covered only January to March, the number of publications for 2026 should not be interpreted as a complete annual publication count. The distribution suggests growing research attention to science storybooks, particularly toward technology-supported and contextually relevant learning media.

Table 2. Distribution of Articles by Educational Level

Educational Levels	Number of Articles	Percentage (%)
Early Childhood Education (PAUD)	4	10.5%
Elementary School (SD)	16	42.1%
Junior High School (SMP)	7	18.4%
Senior High School (SMA)	10	26.3%
Cross-Level	1	2.6%

Table 2 shows that the majority of studies were conducted at the elementary school level, accounting for 42.1% (16 out of 38 articles), followed by senior high school at 26.3% (10 articles), junior high school at 18.4% (7 articles), early childhood education at 10.5% (4 articles), and cross-level at 2.6% (1 article). The prevalence of research at the elementary level is logically associated with the cognitive development of children in this age group, who are still in the concrete operational stage (Piaget, 1970). Consequently, narrative- and image-based media suit their learning needs well (Naresti & Suratmi, 2024; Rusydiana, 2024). Research at the senior high school level was also substantial (26.3%), indicating that the narrative approach is not limited to primary education but can also be applied to teaching more abstract scientific concepts, such as chemistry and biology (Kumala, 2010; Collins et al., 2023; Morais et al., 2026; Presto & Mangia, 2026).

Table 3. Distribution of Articles by Research Methods

Research Methods	Number of Articles	Percentage
Descriptive / Qualitative	17	44.7%
Research & Development (R&D)	8	21.1%
Experimental / Quasi-experimental	8	21.1%
Literature Review / Theoretical	5	13.2%
Total	38	100%

Table 3 shows that descriptive and qualitative approaches were the most frequently used research methods, accounting for 44.7% of the included studies (17 articles). Research and Development (R&D) and experimental or quasi-experimental methods each accounted for 21.1% (8 articles), indicating that a substantial proportion of studies focused on developing and empirically testing science storybook media. Meanwhile, literature review and theoretical studies represented 13.2% (5 articles). This distribution indicates that research on science storybooks has employed diverse methodological approaches, with descriptive and qualitative studies predominating, while R&D and experimental approaches have also contributed evidence regarding the development and application of storybook-based science learning media.

Table 4. Distribution of Articles based on the Science Topics

Science Topics	Number of Articles	Percentage (%)	Reference Example
Ecosystems and the Environment	8	21.1%	Leech et al. (2020) and Presto and Mangia (2026)
Science Based on Local Wisdom/Ethnoscience	6	15.8%	Alfarisi et al. (2026)
Chemistry & Abstract Concepts	5	13.2%	Reschke et al. (2020), Collins et al. (2023), and Morais et al. (2026)
Water Cycle & Natural Phenomena	4	10.5%	Fitri et al. (2023); Khairunnisa and Sekaringtyas (2025)
Others (Biology, Physics, Thematic)	15	39.4%	
Total	38	100%	

Table 4 shows that the science topics addressed in the reviewed studies were diverse, with ecosystems and the environment representing the most frequently examined topic, accounting for 21.1% (8 articles). This was followed by science based on local wisdom/ethnoscience at 15.8% (6 articles) and chemistry and abstract concepts at 13.2% (5 articles). Water cycle and natural phenomena accounted for 10.5% (4 articles), while other topics, including biology, physics, and thematic science, comprised the remaining 39.4% (15 articles). These findings indicate that science storybooks have been applied across a broad range of scientific topics, particularly those that can be presented through contextual, visual, and narrative-based learning experiences. The examples in the table further illustrate the use of storybooks for environmental, ethnoscientific, chemical, and natural-phenomenon topics (Leech et al., 2020; Reschke et al., 2020; Collins et al., 2023; Alfarisi et al., 2026; Morais et al., 2026).

4.2. The Effectiveness of Science Storybooks on Scientific Literacy

All 38 analyzed articles consistently reported positive effects of using science storybooks on improving students' scientific literacy. The N-gain values reported in the experimental studies ranged from 0.60 to 0.85, with a mean N-gain of 0.71, falling into the high category according to Hake's (1999) criteria.

Table 5. Summary of Science Storybook Effectiveness

Level / Media Type	Average N-Gain	Category	Key References
Early Childhood Education – Printed Storybook	0.62	Medium–High	Fujiwara (2025) and Haber and Kumar (2025)
Elementary School – Printed Storybook	0.65	Medium–High	Leech et al. (2020)
Elementary School – Digital Storybook	0.72	High	Naresti et al. (2024)
Elementary School–Interactive AR Storybook	0.80	High	Febrianti and Rosidah (2026) and Sembodho and Rosidah (2026)
Junior High School (SMP) – Digital Storybook	0.68	Medium–High	Kardaş and Şahin (2020) and Mulbar and Abbas (2025)
Senior High School (SMA) – Narrative-Based Learning	0.70	High	Collins et al. (2023) and Ho et al. (2026)
Overall Average	0.70	High	—

The most significant effects were observed in the area of scientific competence, particularly in explaining phenomena scientifically and utilizing scientific evidence. Table 5 shows that science storybooks were associated with positive gains across educational levels and media types. Printed storybooks at the early childhood and elementary school levels showed average N-gains of 0.62 and 0.65, respectively, while digital storybooks at the elementary and junior high school levels achieved average N-gains of 0.72 and 0.68. Interactive AR storybooks at the elementary school level demonstrated the highest average N-gain (0.80), suggesting strong potential for technology-enhanced narrative learning. These findings are consistent with studies by Leech et al. (2020), Naresti et al. (2024), Febrianti and Rosidah (2026), and Sembodho and Rosidah (2026), which reported positive outcomes from the use of story-based media in science learning.

Cross-study comparisons indicate that science storybooks can support scientific literacy across different media formats. Printed storybooks provide a foundation for narrative and contextual understanding, while digital storybooks offer additional audiovisual features that can support engagement with scientific concepts. Interactive AR storybooks provide more immersive learning experiences by combining narrative, visual representation, and interactive features, which may help students engage with abstract scientific concepts (Febrianti & Rosidah, 2026; Sembodho & Rosidah, 2026). However, the differences in N-gain values across studies should be interpreted cautiously because the studies varied in educational level, learning content, research design, and implementation context.

Beyond the cognitive dimension, several studies have also reported positive effects of science storybooks on students' motivation and interest in learning. In study documented increased learning interest among students using interactive digital science storybooks, while Reschke et al. (2020) found that narrative texts in chemistry education could enhance students' situational interest and support content mastery. These findings suggest that science storybooks may function not only as media for supporting scientific learning outcomes but also as tools for encouraging students' engagement and positive dispositions toward science.

4.3. Factors Influencing the Effectiveness of Science Storybooks

A cross-article analysis identified six key factors that consistently influence the effectiveness of science storybooks. Table 6 summarizes these six factors along with the supporting empirical evidence.

Table 6. Factors Influencing the Effectiveness of Science Storybooks

Factor	Description	Key References
Visual Design Quality	Scientifically accurate illustrations, clear typography, harmonious colors, and layouts that minimize unnecessary cognitive load	Koç (2024) and Saripudin et al. (2025)
Integration of Narrative and Scientific Content	Scientific concepts integrated naturally into a coherent storyline with a clear narrative structure	Engel et al. (2018), Leech et al. (2020) and Soares et al. (2023)
Contextual Approach	Integration of local contexts, local wisdom, and environmental issues that are relevant to students' experiences	Widiarini et al. (2025) and Alfarisi et al. (2026)
Interactivity and Technology	Use of multimedia features, such as animation, augmented reality, and simulations, to support engagement and understanding of scientific concepts	Wu and Chen (2020), Jiménez-Valverde (2025), Sembodho and Rosidah (2026)
Student Characteristics	Effectiveness may vary according to students' developmental levels, learning characteristics, and familiarity with visual and narrative-based learning	Fujiwara (2025) and Ho et al. (2026)
Teacher Role and Learning Strategies	Structured guidance, post-reading discussions, and reflective questions that support students' interpretation and application of scientific concepts	Collins et al. (2023) and Carlos et al. (2025)

Table 6 shows that visual design that is engaging, consistent, and appropriate for students' developmental stages is an important factor in the effectiveness of science storybooks. Scientifically accurate yet aesthetically pleasing illustrations can help students construct accurate mental representations. Koç (2024) highlights visual quality as an important aspect of children's reading engagement, while Sweller (1988) cautions that poor design can increase unnecessary cognitive load. The effectiveness of science storybooks also depends on how naturally scientific concepts are embedded in the storyline. Leech et al. (2020) emphasize that organically integrated scientific explanations can support children's scientific discourse and learning more effectively than isolated factual presentation. Engel et al. (2018) and Soares et al. (2023) further highlight the role of narrative as a cognitive tool for supporting science learning. Storybooks integrating local wisdom can support students' understanding of scientific concepts.

Science storybooks that incorporate local contexts or experiences familiar to students can provide more meaningful learning experiences (Mulbar & Abbas, 2025). Alfarisi et al. (2026) demonstrate that cultural contexts can be used to integrate scientific literacy with Indonesian language learning. Presto and Mangia (2026) emphasize that climate change-themed storybooks can support both scientific literacy and students' environmental awareness. These findings are consistent with the ethnoscience approach discussed by Widiarini et al. (2025) and Sihombing et al. (2025), which emphasizes the integration of scientific learning with local knowledge and cultural contexts.

Science storybooks in interactive digital formats, including animations, narrated audio, and simulations, provide additional opportunities for student engagement and conceptual understanding. Sembodho and Rosidah (2026) found that AR integrated into interactive storybooks can provide multisensory learning experiences that support spatial and conceptual understanding, particularly for abstract topics such as the water cycle and the solar system. However, the effectiveness of technology depends on its pedagogical suitability and alignment with learning objectives rather than on technical sophistication alone (Jiménez-Valverde, 2025).

The effectiveness of science storybooks may also vary according to students' educational levels, developmental characteristics, and learning needs. At the elementary school level, particularly among students in grades 4–6, illustrated and narrative-based media can suit students' developmental characteristics. Visual characteristics of storybooks can support students' engagement with science learning. At the early childhood education level, Fujiwara (2025) and Haber and Kumar (2025) report that storybooks can support the introduction of natural phenomena through concrete and accessible representations. At the high school level, Ho et al. (2026) demonstrate that storytelling can contribute to STEM identity by supporting students' sense of belonging, self-efficacy, and perceptions of classroom climate.

The role of teachers and learning strategies is another important factor influencing the effectiveness of science storybooks. Structured teacher guidance, planned post-reading discussions, and reflective questions can strengthen students' interpretation and application of scientific concepts (Khairunnisa & Sekaringtyas, 2025). Carlos et al. (2025) highlight the importance of narratives that stimulate scientific curiosity and student engagement, while Collins et al. (2023) emphasize that storytelling as a pedagogical approach requires teachers to effectively deliver narratives and connect them meaningfully with scientific concepts.

5. Discussion

The findings of this systematic literature review indicate that research on science storybooks has developed across diverse educational levels, methods, topics, and media formats. Regarding RQ1, the 38 included studies were most frequently conducted at the elementary school level, followed by senior high school, junior high school, and early childhood education. Descriptive and qualitative approaches were the most common (44.7%), followed by research and development and experimental or quasi-experimental designs (21.1% each). The science topics also varied, including ecosystems and environmental issues, ethnoscience and local wisdom, chemistry, water cycles, biology, physics, and thematic science. These findings indicate that science storybooks have been adapted to different educational contexts rather than being restricted to a particular level or topic. The increasing use of digital and interactive formats further reflects the development of storybooks from conventional print media toward technology-supported learning. This trend aligns with Wu and Chen (2020), who identified digital storytelling as a flexible educational approach, and with recent studies applying augmented reality to science storybooks (Febrianti & Rosidah, 2026; Sembodho & Rosidah, 2026).

The findings show that science storybooks generally have strong potential to improve students' scientific literacy. The overall average N-gain was 0.70, categorized as high according to the classification applied in this review. Printed storybooks showed average N-gains of 0.62 at the early childhood level and 0.65 at the elementary level, while digital storybooks achieved 0.72 at the elementary level and 0.68 at the junior high level. Interactive AR storybooks recorded the highest average N-gain (0.80) at the elementary level, while narrative-based learning at the senior high school level achieved 0.70. These findings are supported by Naresti et al. (2024), who reported improvements in elementary students' science literacy through digital picture storybooks, and Leech et al. (2020), who found that embedding scientific explanations within storybooks supported children's scientific discourse and learning.

The higher N-gain observed for interactive AR storybooks suggests that interactivity may give students more opportunities to visualize and engage with scientific concepts. However, this finding should not be interpreted as evidence that AR or digital media are universally superior to printed storybooks because the reviewed studies differed in research design, educational level, science topics, participants, and implementation contexts. Instead, different formats may provide different learning affordances. Printed storybooks can provide accessible narrative and visual representations, whereas digital and interactive formats offer additional audiovisual and interactive features. This interpretation aligns with Fitri et al. (2023), who developed digital picture storybooks for science learning, and Sembodho and Rosidah (2026), who examined AR-based interactive storybooks to improve students' science literacy.

The synthesis identifies six factors influencing effectiveness: visual design quality, integration of narrative and scientific content, contextual relevance, interactivity and technology, student characteristics, and teacher roles and learning strategies. Scientifically accurate illustrations, appropriate typography, and coherent layouts can support students' mental representations, whereas poor design may increase unnecessary cognitive load (Sweller, 1988). The integration of scientific concepts into coherent narratives is also important because meaningful explanations embedded within stories can support scientific discourse and conceptual learning (Leech et al., 2020; Soares et al., 2023). Contextual relevance further strengthens learning by connecting scientific concepts with students' experiences, local wisdom, and environmental issues. Alfarisi et al. (2026) demonstrate the integration of cultural heritage into science and Indonesian language learning, while Widiarini et al. (2025) emphasize the relevance of local wisdom in science education.

Effectiveness also depends on appropriate technology, student characteristics, and teacher facilitation. Interactive features can support engagement when aligned with learning objectives rather than used merely for technical sophistication. The developmental characteristics and learning needs of students should likewise guide the selection of narrative, visual, and technological features. Fujiwara (2025) and Haber and Kumar (2025) highlight the potential of storybooks for early childhood science learning, while Ho et al. (2026) demonstrate the broader role of storytelling in supporting STEM identity among older students. Teacher facilitation is similarly important because structured guidance, discussion, and reflective activities can help students connect narrative content with scientific concepts. Carlos et al. (2025) emphasize strategies for stimulating scientific curiosity, while Collins et al. (2023) highlight storytelling as a pedagogical approach for classroom engagement. Science storybooks are most effective when scientifically accurate content, appropriate narrative and visual design, contextual relevance, suitable interactivity, student characteristics, and teacher facilitation are integrated into the learning process.

6. Conclusion

Based on a systematic literature review of 38 articles meeting the PRISMA 2020 inclusion criteria, the use of science storybooks grew rapidly during 2020–2026, with a significant surge in 2025–2026, accounting for 36.9% of all articles. Research was predominantly conducted at the elementary school level (42.1%) using descriptive or qualitative approaches, while the most frequently studied topics included ecosystems, the environment, ethnoscience, and abstract scientific concepts. Science storybooks consistently proved effective in enhancing students' scientific literacy, with an average N-gain of 0.71 (high category), while the highest effectiveness was observed in AR-based interactive digital storybooks (N-gain = 0.80). These media also improved students' ability to understand and explain scientific phenomena, learning motivation, interest in science, and environmental awareness. Successful implementation was influenced by six interacting factors: visual design quality, integration of narrative with scientific concepts, contextual material presentation based on local wisdom, interactivity and technology, alignment with student characteristics, and the teacher's active role in facilitating learning.

The identified research gaps indicate a scarcity of experimental studies examining the effectiveness of interactive digital storybooks at the junior and senior high school levels and a limited number of studies integrating ethnoscience approaches into digital storybooks for secondary education. Therefore, future research should develop interactive digital science storybooks based on local wisdom that adapt to the individual needs of junior and senior high school students, conduct longitudinal studies to measure long-term impacts on scientific literacy and scientific dispositions, and perform meta-analysis to more accurately estimate effect sizes from available experimental studies. Further studies should also test effectiveness at the secondary education level using true experimental designs and more representative samples, while developing standardized scientific literacy assessment instruments tailored to science storybooks in Indonesia.

References

- Alfarisi, M., Maulana, R. A., Gunawan, A., & Editya, D. B. (2026). Development of science storybook based on Metro City cultural heritage as integrated literacy media for science and Indonesian language in elementary school. *IJECA (International Journal of Education and Curriculum Application)*, 9(1), 38–49. <https://doi.org/10.31764/ijeca.v9i1.38355>.
- Carlos, J. L., Linaugo, J., & Sulaeman, N. F. (2025). Teachers' narratives on strategies for enhancing scientific curiosity in a public secondary school. *Jurnal Pendidikan IPA Indonesia*, 14(4), 667–677. <https://doi.org/10.15294/jpii.v14i4.31829>.
- Collins, S., Steele, T., & Nelson, M. (2023). Storytelling as pedagogy: The power of chemistry stories as a tool for classroom engagement. *Journal of Chemical Education*, 100(7), 2664–2672. <https://doi.org/10.1021/acs.jchemed.3c00008>.
- Engel, A., Lucido, K., & Cook, K. (2018). Rethinking narrative: Leveraging storytelling for science learning. *Childhood Education*, 94(6), 4–12. <https://doi.org/10.1080/00094056.2018.1540189>.
- Febrianti, T., & Rosidah, C. T. (2026). Peningkatan literasi sains siswa SD melalui implementasi deep learning berbantuan interactive digital storybook berbasis AR. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 11(02), 218–235. <https://doi.org/10.23969/jp.v11i02.46860>.
- Fitri, A. N., Auliaty, Y., & Imaningtyas. (2023). Pengembangan buku cerita bergambar digital berbasis literasi sains pada pembelajaran IPA materi siklus air kelas V SD. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 8(1), 364–374. <https://doi.org/10.23969/jp.v8i1.7157>.
- Fujiwara, M. (2025). The use of scientific picture books in early childhood education. *Koshien Junior College Bulletin*, 43(1), 1–30. https://doi.org/10.24699/koshient.43.0_3.
- Galda, L., & Cullinan, B. E. (2002). *Literature and the child* (5th ed.). White Plains: Wadsworth/Thomson Learning.

- Gough, D., Oliver, S., & Thomas, J. (2017). *An introduction to systematic reviews* (2nd ed.). London: SAGE Publications.
- Haber, A. S., & Kumar, S. C. (2025). Reimagining science learning in early childhood through storybook reading. *Education Sciences*, 15(10), 1361-1371. <https://doi.org/10.3390/educsci15101361>.
- Hake, R. R. (1999). *Analyzing change/gain scores*. Bloomington: Indiana University.
- Ho, K., Chen, A., & Clark, D. B. (2026). Fostering STEM identity through storytelling: links to belonging, self-efficacy, classroom climate, and lab performance. *Chemistry Education Research and Practice*, 27(1), 291-303. <https://doi.org/10.1039/D5RP00230C>.
- Hong, Q. N., Pluye, P., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., ... & Vedel, I. (2019). Improving the content validity of the mixed methods appraisal tool: a modified e-Delphi study. *Journal of Clinical Epidemiology*, 111(1), 49-59. <https://doi.org/10.1016/j.jclinepi.2019.03.008>.
- Jiménez-Valverde, G. (2025). Narrative approaches in science education: From conceptual understanding to applications in chemistry and gamification. *Encyclopedia*, 5(3), 116-126. <https://doi.org/10.3390/encyclopedia5030116>.
- Kardaş, S., & Şahin, F. (2020). Investigation of the effect of scientific stories on 6th grade students' academic achievements and understanding the nature of science. *IBAD Journal of Social Sciences*, 7(2), 222-234. <https://doi.org/10.21733/ibad.686456>.
- Khairunnisa, S. Z., & Sekaringtyas, T. (2025). Pengembangan buku cerita bergambar digital berbasis problem-based learning untuk melatih kemampuan literasi sains siswa kelas IV SD. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 10(3), 237-248. <https://doi.org/10.23969/jp.v10i03.29629>.
- Kitchenham, B., & Charters, S. (2007). *Guidelines for performing systematic literature reviews in software engineering* (EBSE Technical Report EBSE-2007-01). Keele: Keele University.
- Koç, E. D. (2024). Review of non-fiction science picture books for pre-school children. *Journal of Education and Future*, 26(1), 1-12. <https://doi.org/10.30786/jef.1246919>.
- Kumala, M. (2010). The neverending story-Using the narrative as a fundamental approach to teaching biology and beyond. *Evolution: Education and Outreach*, 3(4), 526-531. <https://doi.org/10.1007/s12052-010-0277-2>.
- Leech, K. A., Haber, A. S., Jalkh, Y., & Corriveau, K. H. (2020). Embedding scientific explanations into storybooks impacts children's scientific discourse and learning. *Frontiers in Psychology*, 11(10), 1016-1026. <https://doi.org/10.3389/fpsyg.2020.01016>.
- Morais, C., Ferreira, A., Araújo, J. L., & Moreira, L. (2026). Chemistry in early childhood: Storytelling and hands-on water-based activities. *Chemistry Education Research and Practice*, 27(1), 607-621. <https://doi.org/10.1039/D5RP00271K>.
- Mulbar, U., & Abbas, N. F. (2025). Scientific-based digital storytelling to enhance science literacy and environmental awareness in junior high school students. *Jurnal Ilmiah Pendidikan MIPA*, 15(2), 47-58.
- Mutaqin, F., Taufiqulloh, T., & Nafiati, D. A. (2026). A needs analysis for scratch-based digital media in junior high coding and artificial intelligence education. *Research Horizon*, 6(1), 621-632. <https://doi.org/10.54518/rh.6.1.2026.970>.
- Naresti, D. A., & Suratmi. (2024). Developing digital storybooks to enhance primary school students' scientific literacy: A needs analysis. *Jurnal Komunikasi Pendidikan*, 8(2), 215-224. <https://doi.org/10.32585/jurnalkomdik.v8i2.5081>.
- Naresti, D. A., Suratmi, & Hartono. (2024). Improving elementary school students' science literacy skills through digital picture storybooks. *Jurnal Ilmiah Sekolah Dasar*, 8(4), 634-643. <https://doi.org/10.23887/jisd.v8i4.86894>.
- OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. Paris: OECD Publishing. <https://doi.org/10.1787/53f23881-en>.
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *The BMJ*, 372(1), 71-81. <https://doi.org/10.1136/bmj.n71>.
- Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology*, 45(3), 255-287. <https://doi.org/10.1037/h0084295>.
- Piaget, J. (1970). *Science of education and the psychology of the child*. New York: Orion Press.
- Pratiwi, S. N., Cari, C., & Aminah, N. S. (2019). Pembelajaran IPA abad 21 dengan literasi sains siswa. *Jurnal Materi dan Pembelajaran Fisika*, 9(1), 34-42. <https://doi.org/10.20961/jmpf.v9i1.31612>.

- Presto, S., & Mangia, C. (2026). Storytelling and hands-on science to engage children in climate and gender-aware education. *Sustainability*, 18(3), 1332–1342. <https://doi.org/10.3390/su18031333>.
- Putra, B. P., & Wahyuni, S. (2025). Integrasi kearifan lokal dalam pembelajaran IPA untuk meningkatkan literasi sains siswa: Kajian literatur. *Jurnal Kajian Kebudayaan*, 13(2), 200–211. <https://doi.org/10.20961/jkc.v13i2.103518>.
- Reschke, T., Koenen, J., & Sumfleth, E. (2020). Situational interest and its influence on students' content knowledge: The use of narrative texts in chemistry lessons. *Zeitschrift für Didaktik der Naturwissenschaften*, 26(1), 191–206. <https://doi.org/10.1007/s40573-020-00120-z>.
- Rini, E. F. S., Rahardjo, S. B., & Bramastia, B. (2025). Bibliometric analysis from 2014–2024: Integration of ethnoscience in science learning. *Journal Evaluation in Education*, 6(1), 185–199. <https://doi.org/10.37251/jee.v6i1.1262>.
- Robbia, A. Z., & Fuadi, H. (2020). Pengembangan keterampilan multimedia interaktif pembelajaran IPA untuk meningkatkan literasi sains peserta didik di abad 21. *Jurnal Ilmiah Profesi Pendidikan*, 5(2), 117–123. <https://doi.org/10.29303/jipp.v5i2.125>.
- Rusydiana, U. (2024). Pengembangan buku cerita bergambar untuk meningkatkan kemampuan literasi sains peserta didik kelas 4 sekolah dasar. *Jurnal Didaktika Pendidikan Dasar*, 8(3), 905–940. <https://doi.org/10.26811/didaktika.v8i3.1692>.
- Saripudin, A. S., Aulia, R. E., Mulyana, A., & Magasida, D. (2025). Exploring natural phenomena with pop-up books: A tool for early science literacy. *Golden Age: Jurnal Ilmiah Tumbuh Kembang Anak Usia Dini*, 10(4), 841–851.
- Sembodho, A., & Rosidah, C. T. (2026). Evaluasi dampak penggunaan teknologi augmented reality dalam storybook interaktif terhadap literasi sains siswa SD. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 11(02), 279–289. <https://doi.org/10.23969/jp.v11i02.45824>.
- Sihombing, R. A., Anwar, S., Liu, S. Y., Muslim, M., Winarno, N., & Sihombing, P. J. (2025). Integrating local wisdom into environmental education: A systematic review of ethnoscience research in Indonesia. *Journal of Natural Science and Integration*, 8(1), 57–74. <https://doi.org/10.24014/jnsi.v8i1.35762>.
- Soares, S., Gonçalves, M., Jerónimo, R., & Kolinsky, R. (2023). Narrating science: Can it benefit science learning, and how? A theoretical review. *Journal of Research in Science Teaching*, 60(9), 2042–2075. <https://doi.org/10.1002/tea.21851>.
- Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285. [https://doi.org/10.1016/0364-0213\(88\)90023-7](https://doi.org/10.1016/0364-0213(88)90023-7).
- Tillah, N., & Subekti, H. (2024). Analisis kemampuan literasi sains siswa SMP berdasarkan indikator dan level literasi sains. *EDUSAINTEK*, 12(1), 137–154. <https://doi.org/10.47668/edusaintek.v12i1.1271>.
- Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st century skills through scientific literacy and science process skills. *Procedia - Social and Behavioral Sciences*, 59, 110–116. <https://doi.org/10.1016/j.sbspro.2012.09.253>.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.
- Widiarini, P., Suastra, I. W., & Arnyana, I. B. P. (2025). Integrasi kearifan lokal Bali dalam pembelajaran IPA masa kini. *EDUCATIONAL: Jurnal Inovasi Pendidikan & Pengajaran*, 5(1), 48–60. <https://doi.org/10.51878/educational.v5i1.4431>.
- Wu, J., & Chen, D. T. (2020). A systematic review of educational digital storytelling. *Computers & Education*, 147, 103786. <https://doi.org/10.1016/j.compedu.2019.103786>.
- Yusmar, F., & Fadilah, R. E. (2023). Analisis rendahnya literasi sains peserta didik Indonesia: Hasil PISA dan faktor penyebab. *LENSA (Lentera Sains)*, 13(1), 11–19. <https://doi.org/10.24929/lensa.v13i1.283>.

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Data Disclosure Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.



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