

Digital Stories as an Effort to Foster Science Literacy on Ecosystem

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ABSTRACT

This study was motivated by the relatively low level of science literacy among Indonesian students, which still needs to be improved. As reflected in the results of the 2022 Program for International Student Assessment (PISA), Indonesia's science literacy scores remain below the OECD average. This situation highlights the need for innovations that support the improvement of students' science literacy. However, research exploring interactive digital picture books that integrate ecosystem content with students' science literacy activities remains limited. Therefore, this study developed a digital picture book aimed at improving students' science literacy. This study employed a Research and Development (R&D) design using the ADDIE model, which consists of analysis, design, development, implementation, and evaluation. The research participants were 17 fifth-grade students at MI Aswaja 1 Tamban. The research results show that: (1) The students' initial science literacy levels were relatively low, with 16 students in the low category and 1 student in the moderate category; (2) The interactive digital picture book met the "highly suitable" criteria according to the validation experts, with a 95% rating from the media expert, a 92.5% rating from the content expert, and an 88% rating from the learning expert; (3) Students' average science literacy scores showed a slight increase from the pre-test to the post-test. These findings indicate that the interactive digital picture books developed are well-suited as supplementary learning materials and have the potential to support science literacy learning. However, the improvement was relatively limited, suggesting that these picture books need further refinement.

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1. INTRODUCTION

The 2022 programme for International Student Assessment (PISA) report, published in late 2023, shows that Indonesia's science literacy score declined to 383 points, which remains below the OECD average of 485 points. In these results, Indonesia ranked 63rd out of 81 countries participating in PISA [1]. The findings imply that the science literacy skills of Indonesian students still require targeted and sustained improvement efforts to meet global competency standards [2].

In light of these circumstances, the Government, through Regulation of the Minister of Education, Culture, Research, and Technology No. 5 of 2022 on Graduate Competency Standards (SKL), explains in Chapter IV, Article 5, that the graduate competencies that elementary school (SD) students must master include the development of students' literacy and numeracy skills for their future education [3].

Science literacy is defined as the scientific knowledge and skills that enable individuals to identify problems, obtain relevant information, understand the nature of science, and examine the relationship between science, technology, and life, thereby encouraging active participation in addressing scientific issues in society [4]. Fananta argued that science literacy can encourage students to develop their frameworks of thought and personalities, as well as shape their character so that they can show empathy and act responsibly toward themselves, members of society, and the natural world—especially amid global challenges marked by rapid technological advancements [5].

Advances in information and communication technology have brought about significant changes in various aspects of life, including the field of education. The shift toward a digital-based learning system has spurred the emergence of various learning innovations that leverage technology [6]. The use of technology in elementary school education has also been extensively developed through various forms of digital media. Previous research has shown that the use of technology-based media can serve as an alternative for creating more engaging learning experiences and increasing student engagement in the learning process [7]. However, the application of technology in learning must be tailored to the characteristics of the subject matter so that learning objectives can be optimally achieved [8]. Subjects that require contextual and interactive media support include natural and social sciences. The primary goal of IPAS instruction in elementary school is not merely to emphasize mastery of the material through memorization, but rather to develop students' ability to apply their knowledge to solve various problems encountered in daily life [9].

IPAS instruction at the elementary school level should be conducted through hands-on activities, such as simple experiments and observations of the surrounding environment [10]. Through these hands-on experiences, students can build their own knowledge based on their observations and learning experiences. Students' active involvement in simple observation activities is essential so that they can discover concepts on their own and make learning more meaningful [11].

However, based on the findings of an observation study conducted by Firda and her colleagues, the implementation of IPAS instruction in elementary schools—particularly regarding the topic of ecosystems—still faces various challenges. The ecosystem curriculum not only addresses the relationship between living organisms and their environment but also covers the abstract concepts of food chains and food webs. These concepts are difficult to observe directly in a single observation of the surrounding environment. As a result, students have difficulty visualizing how food chains function and comprehending the interconnections among the components of an ecosystem as a whole, so their understanding of ecosystem concepts has not yet developed optimally [12].

To address these issues, there is a need for innovative instructional media capable of translating abstract concepts into forms that are easier for students to understand and more engaging. The development of digital-based instructional media is one viable alternative because it can integrate various forms of information presentation, such as text, images, animations, and interactive activities. Research on the development of digital learning media at the elementary school level shows that the use of innovative media can foster student engagement and help students understand abstract learning concepts [13]. In addition, Hurlock stated that using picture books as a teaching tool for elementary school students is an appropriate choice. This is because elementary school children generally show a strong interest in picture books. In line with this view, interactive digital-based approaches can also encourage students to ask questions, answer questions, and express their opinions, which can optimize their ability to think, listen, and observe, as well as hone their writing skills [14] [29] [31].

Various studies have developed teaching materials in the form of picture books and interactive digital storybooks to improve reading skills, language skills, and interest in reading [15]. In addition, the digital comic approach has also been reported to improve science literacy among elementary school students [16]. However, most of these studies still focus on improving reading skills, language skills, and interest in reading, as well as enhancing science literacy, and they still limit the use of learning media to just one or two aspects, such as visual imagery, storytelling, or the limited use of digital technology [17]. Meanwhile, the development of interactive digital picture books as a learning resource to improve elementary school students' science literacy in the IPAS subject—specifically regarding ecosystems—has been relatively little studied [29].

A 2024 study by Nasution and Tambunan, for example, developed instructional materials based on interactive digital storybooks to assess their feasibility, practicality, and effectiveness as a learning medium; however, it did not specifically focus the content on ecosystem concepts nor did it comprehensively evaluate improvements in science literacy [18]. Similarly, Reni's 2025 study placed greater emphasis on the development of digital comic-strip textbooks (on the card.co platform) to improve science literacy, but has not yet developed interactive teaching materials in the form of educational games and picture books for IPAS instruction on the topic of ecosystems [13]. Therefore, there remains a research gap in the form of a lack of learning resources—specifically picture books—that comprehensively integrate science literacy, ecosystem content, and interactive digital elements at the elementary school level.

Based on this gap, this study developed an interactive digital picture book as a learning resource on ecosystems that integrates the presentation of ecosystem concepts through contextual narratives with students' everyday experiences. The products developed also feature visual illustrations that help make abstract concepts—such as food chains and food webs—more concrete, as well as interactive digital features like quizzes and exploratory activities that encourage students' active participation in the learning process. The novelty of this study lies not only in the development of interactive, digital picture-book learning resources, but also in its focus on examining the impact of using the developed product on improving students' science literacy.

Based on the above discussion, this study aims to develop an interactive digital picture book on ecosystems and to determine the impact of its use on the science literacy skills of fifth-grade elementary school students.

2. METHOD (10 PT)

A. Type of Research

The researcher employed a research and development (R&D) approach. The R&D method is a research approach aimed at producing a product and testing the effectiveness of the developed product [19]. This research approach was chosen to produce educational media that is suitable and beneficial for its users.

B. Development Model

The development model applied in this study is the ADDIE model. The educational media development research was conducted based on the stages in the ADDIE model, namely Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because it is a systematic instructional design model oriented toward the development process of educational media or tools [29] [30].

C. Data Collection Methods

- 1) The data collection methods used by the researcher are observation, interviews, documentation, and tests.
- 2) The data collection instruments used by the researcher are an interview instrument for teachers, a questionnaire for validators, and a pre-test instrument for students.

D. Data Analysis Techniques

This study focuses on the development of learning resources and the improvement of students' science literacy through quantitative and qualitative data analysis techniques, depending on the type of data obtained. This analysis process aims to assess the suitability of the developed learning media, determine its impact on improving students' science literacy, and systematically process the data in accordance with the research problem.

1) Analysis of Students' Science Literacy Skills

The analysis of students' science literacy skills is based on assessment results from the pre-test administered before the learning process using the storybook learning resource. Pre-test data is converted into scores expressed as percentages using the formula: [20]

$$\text{Percentage} = \frac{\text{Student's raw score}}{\text{Maximum score}} \times 100\%$$

Next, the science literacy achievement scores were interpreted descriptively using the percentage categories proposed by Suharsimi Arikunto, which were adapted to the needs of this study as follows:[21]

Range (%)	Category
80-100	Very high
66-79	Tall
56-65	Currently
40-55	Low
0-39	Very low

2) Feasibility Analysis of Instructional Media

The feasibility analysis of instructional media is based on the results of an assessment conducted via a questionnaire completed by media experts, subject matter experts, and

instructional experts; the questionnaire uses a Likert scale. Scoring for each category follows the Likert scale guidelines established by Sugiyono: [22]

Category	Score
Very good	5
good	4
Enough	3
Not good	2
Not bad	1

Next, the scores assigned by the validators were analyzed using a formula adapted from (Syafira et al., 2022): [23]

$$x_i = \frac{\sum S}{S_{max}} \times 100\%$$

Description:

x_i : Feasibility percentage

$\sum S$: Total score

S_{max} : Maximum score

The criteria for determining the percentage score of media suitability were adopted and modified from Arikunto: [24]

Percentage Score (%)	Criteria
81-100	Well worth it
61-80	Appropriate
41-60	Quite decent
21-40	Unfit
0-20	Highly inappropriate

3. RESULTS AND DISCUSSION

4.

A. Results

1) Students' Science Literacy Levels Before Using Storybooks as Learning Resources

Students' science literacy levels were measured through a test designed to assess their initial abilities. This activity was conducted by administering a pre-test to fifth-grade students at MI Aswaja 1 Tamban. The data obtained from the pre-test was then used as a basis for identifying students' initial science literacy levels prior to the use of the developed learning resources, as shown below:

Name	Total Value	Percentage (%)	Description
Naila	17	42,5	Low
Rafa	22	55	Low
Aflam	22	55	Low
Haikal	22	55	Low
Niko	20	50	Low
Faza	18	45	Low
Kiki	17	42,5	Low
Aurel	18	45	Low
Farah	16	40	Low
Citra	18	45	Low
Amicho	17	42,5	Low
Faris	20	50	Low
Sauki	19	47,5	Low
Akbar	19	47,5	Low

Rafik	21	52,5	Low
Mail	18	45	Low
Dhani	24	60	Currently

The science literacy levels of the 17 fifth-grade students remain relatively low. This is indicated by the percentage of students whose scores fall within the range of 40% to 60%, meaning that the majority of students have not yet met the proficiency criteria ($\geq 70\%$). Based on the assessment categories presented in the bar chart above, nearly all students fell into the low category, and only one student reached the moderate category. Meanwhile, no students fell into the very low, high, or very high categories. These results indicate that the initial science literacy skills of students at MI Aswaja 1 Tamban have not yet developed optimally. The predominance of students in the low category indicates that most students still struggle to understand scientific concepts, connect those concepts to daily life, and interpret scientific information.

2) Procedures for Developing Storybook Learning Resources to Improve Students' Science Literacy

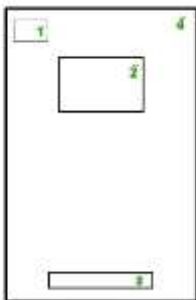
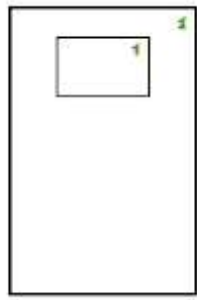
a) Analysis

This analysis phase was conducted by the researcher through classroom observations in fifth grade and interviews with the homeroom teacher. The objective was to identify the methods, teaching materials, classroom conditions, and obstacles that arose during classroom instruction. The results of the observations indicate that the learning process in fifth-grade classrooms is still dominated by the lecture method, with the primary learning resources being printed workbooks and the use of a blackboard. At the beginning of the lesson, students appear to pay attention to the teacher's explanations; however, as time goes on, they tend to become bored because the learning materials used lack variety. The findings of the observation above are consistent with the results of the researcher's interview with Ms. Nurul Wirda, M.Ed., the fifth-grade homeroom teacher. Ms. Wirda stated: "The lecture method is more frequently used in learning activities, with workbooks serving as the primary learning resource.

Additionally, PowerPoint (PPT) presentations or interactive quizzes such as Kahoot, tailored to the learning material, are occasionally utilized. The lecture method is chosen because it can serve as a catalyst to help students' understanding become more focused. However, there is a challenge in the learning process: students tend to easily forget the material they have learned. To address this, brief reviews are typically provided or short-answer quizzes are administered. The use of learning resources is still limited to printed workbooks and does not yet utilize other, more varied learning resources." [25] The researcher then proposed the idea of developing digital storybook learning resources, which was well-received by the homeroom teachers; the hope is that these resources will help students understand the material more easily.

b) Design

The design developed in this study is a digital storybook framework created using the Canva application. The framework was designed to serve as a guide for organizing the storybook's content so that it is presented in a logical sequence and aligns with the learning objectives, as shown below:

Front Cover	Book Contents
	

Descriptions: 1. Name of the institution 2. Story title 3. Autor's name 4. Illustration	Descriptions: 1. plot 2. Illustration
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c) Development

The development phase involves bringing the product design to fruition through a process of creating and refining learning resources until they are deemed suitable for use. Product development is carried out using the Canva application, while the refinement of illustrations is aided by the use of ChatGPT AI. The purpose of this phase is to ensure that the designed product is developed to its full potential in helping students achieve their learning objectives.

(a) Product Description

Images are designed in the Canva application; the designs created in Canva are then refined with the help of AI ChatGPT, and subsequently edited again in the Canva application to add the following elements:

(1) Home Page



Gambar 4. 1 Sampul Depan Buku Cerita di Aplikasi Canva



Gambar 4. 2 Sampul Depan Penyempurnaan AI

The design created using Canva, which was still incomplete, was then refined with the help of ChatGPT AI, including the addition of characters and improvements to several elements to make it look polished.

(2) Storybook Pages

The story background created in Canva was then enhanced with character illustrations tailored to the narrative crafted by the author, and the story's narrative was edited.



Gambar 4. 3 Buku Cerita di Aplikasi Canva



Gambar 4. 4 Buku Cerita Penyempurnaan AI

(3) Game Pages

Web-based games, such as Boombazle and Zipquiz, take the form of mazes and are presented as barcodes, as shown in the image.



Gambar 4. 6 Barcode Permainan

(b) Validation of the Storybook Media

Media validation was conducted by distributing a questionnaire to the validators. The results of the content validation and instructional validation conducted by Nurul Widayati, M.Ed., yielded a score of 92.5% for content and 88% for instruction. Meanwhile, the expert media validation yielded a score of 95%.

d) Implementation

During the implementation phase, the activity was conducted through classroom instruction using interactive digital picture books as learning resources for the ecosystem unit. Based on observations during the learning activities, students appeared focused on the screen and listened attentively to each page of the story read aloud by their classmates. Most students demonstrated enthusiasm and active participation throughout the lesson. Although a few students occasionally chatted with their neighbors, the overall classroom atmosphere remained conducive throughout the pilot implementation.

The presence of game and quiz features in the digital storybook also captured the students' attention. Students appeared enthusiastic when participating in group quizzes such as Boombazzle and individual quizzes like the Zep Quiz Labyrinth. The game elements incorporated into the learning process made the students more enthusiastic and less prone to boredom during the learning activities.

e) Evaluation

Evaluation Results: During the pilot test, students generally participated in the activities in a fairly orderly and conducive manner from the beginning to the end of the lesson. However, several challenges were still encountered during the implementation process. First, some students easily lost focus because the pilot test was conducted close to recess time, causing their concentration to wane toward the end of the lesson. Second, during the reading activity, some students paid insufficient attention to punctuation marks while reading the text. This situation is believed to be caused by the students not yet being accustomed to reading carefully or the text size on the materials being too small, which affected the students' comfort while reading. Third, there were still some students who talked with their classmates during the lesson, so their attention to the material was not optimal. Although there were some challenges, overall the pilot activity was carried out successfully.

3) The Impact of Using Interactive Illustrated Digital Storybooks as a Learning Resource on Students' Science Literacy Skills

In this study, the impact of using interactive illustrated digital storybooks on students' science literacy skills was measured by comparing the results of pre-tests and post-tests administered to 17 fifth-grade students at MI Aswaja 1 Tamban. The data from the students' pre-tests and post-tests are presented in the table below.

Name	Pre-test	Post-test
Naila	17	19
Rafa	22	21
Aflam	22	18
Haikal	22	22
Niko	20	21
Faza	18	19
Kiki	17	16

Aurel	18	17
Farah	16	21
Citra	18	20
Amicho	17	15
Faris	20	21
Sauki	19	20
Akbar	19	22
Rafik	21	26
Mail	18	26
Dhani	24	30
On Average	19,29	20,82

The results of the pre-test and post-test showed a slight increase in the average score, from 19.29 (48%) to 20.82 (52%). Although some students still saw a decline in their scores, the use of interactive digital picture books has the potential to help students better understand ecosystem concepts. Thus, this learning resource has a fairly positive impact on improving science literacy in fifth grade.

B. Discussion

1) Students' Science Literacy Levels Before Using Storybooks as Learning Resources

Science literacy is an individual's ability to use scientific knowledge to explain phenomena, analyze data, and draw conclusions based on evidence [26]. In this study, the science literacy skills of fifth-grade students at MI Aswaja 1 Tamban were assessed through a pre-test that covered the aspects of analyzing scientific phenomena, explaining concepts, analyzing data, and drawing conclusions. The pre-test results showed that the students' science literacy skills were still low. Of the 17 students, 16 were in the low category and 1 was in the moderate category. No students were in the very low, high, or very high categories.

Students' low science literacy skills are believed to be influenced by several factors. First, instruction is still dominated by conventional methods and worksheets as the primary learning resources, resulting in students being less active in developing an understanding of scientific concepts. Second, students' suboptimal reading skills also affect their comprehension of science material. Third, the use of innovative learning media remains limited, making the learning process less varied and engaging. Fourth, students tend to have difficulty remembering the material due to a lack of variety in learning resources. This condition aligns with previous research stating that a lack of variety in learning resources and media can lead to low science literacy among students [2].

Based on these results, students' science literacy skills prior to using interactive illustrated digital storybooks were in the low category. Therefore, more engaging, interactive, and contextual learning resources are needed to support the improvement of students' science literacy skills.

2) Procedures for Developing Storybook Learning Resources to Improve Students' Science Literacy

The development of an interactive illustrated digital storybook was carried out using the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. During the analysis phase, it was found that IPAS learning in Grade 5 at MI Aswaja 1 Tamban was still dominated by lecture methods and the use of worksheets, resulting in students being less active and easily bored. These conditions indicate the need for learning resources that are more engaging, interactive, and suited to the characteristics of elementary school students [29] [30].

Based on the results of a needs analysis, an interactive illustrated digital storybook on ecosystems was developed, combining text, images, stories, quizzes, and interactive games. The product was designed in a digital format to enhance its appeal and ease of access for students. The product's development was guided by multimedia learning principles that emphasize the integration of visual and verbal elements to support conceptual understanding. The product's suitability was tested through validation by media experts, content experts, and instructional experts. The validation results showed approval rates of 95% from media experts, 92.5% from content experts, and 88% from instructional experts. All of these results fell into the "highly

suitable” category, meaning the product was deemed to meet the criteria for visual presentation, content, and instructional appropriateness. After revisions were made based on the validators’ suggestions, the product was implemented with 17 fifth-grade students.

The results of the implementation show that students were more active and enthusiastic during the learning process. Presenting the material through a narrative, illustrations, and interactive features helped students understand ecosystem concepts in a more contextual way and increased their engagement in the learning process. These findings are consistent with previous research showing that digital storybooks can be an effective learning resource and are well-suited to the characteristics of elementary school students [27] [30].

Overall, the interactive illustrated digital storybook developed meets the criteria for suitability as a learning resource on ecosystem material and has the potential to support the improvement of elementary school science literacy skills.

3) The Impact of Using Interactive Illustrated Digital Storybooks as a Learning Resource on Students’ Science Literacy Skills

The use of interactive digital picture storybooks on ecosystem topics had a positive impact on the science literacy skills of fifth-grade students at MI Aswaja 1 Tamban. The research results showed an improvement in science literacy skills following the use of this learning resource. Students’ average scores increased from 19.29 on the pre-test to 20.82 on the post-test, while the percentage of science literacy skills rose from 48% to 52%. This improvement is supported by the presentation of the material in the form of illustrated stories, which helps students understand scientific concepts in a more contextual manner and in a way that is closer to their daily lives [28]. Additionally, the illustrations made it easier for students to grasp the abstract concept of ecosystems, while interactive features such as quizzes and educational games boosted student engagement, motivation, and focus during the learning process. These findings suggest that a combination of visual, narrative, and interactive elements can create a more engaging and meaningful learning experience [29].

Although the improvement observed was not particularly significant, the research findings indicate that interactive digital picture storybooks have the potential to serve as a learning resource to support the development of science literacy among elementary school students. Several factors, such as suboptimal testing conditions and varying levels of student concentration, are believed to have influenced the results. Nevertheless, the use of innovative, interactive, and contextual learning resources continues to demonstrate a positive contribution to improving students’ science literacy skills.

5. CONCLUSION

This study aimed to develop an interactive illustrated digital picture book for IPAS learning on ecosystem topics and to examine its potential to support the science literacy skills of fifth-grade elementary school students. Using the ADDIE model, the developed media integrated illustrated narratives, ecosystem concepts, quizzes, and interactive games, and was validated as highly suitable by media, content, and instructional experts. The implementation showed an increase in students’ average science literacy scores from 19.29 (48%) in the pre-test to 20.82 (52%) in the post-test, indicating that the digital picture book has potential as a supplementary learning resource to support science literacy. However, this study was limited by the small sample of 17 students from a single school, the relatively short implementation period, and the limited improvement in science literacy, while technical aspects such as text readability and the need for teacher guidance also remained challenges. Therefore, future research should involve larger and more diverse samples, longer implementation periods, and more rigorous experimental designs, while further developing the media through improved readability and additional interactive features such as simulations, educational videos, and virtual experiments to optimize its contribution to students’ science literacy and other learning outcomes.

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