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Development of an Ethnoscience-Based Science Encyclopedia Integrated with Role-Play Methods to Improve Elementary School Students' Science Literacy

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ABSTRACT

The rapid development of information and communication technology has influenced the field of education, which can be utilized in the learning process. This study aims to test the feasibility and effectiveness of developing an ethnoscience-based science encyclopedia integrated with role-playing methods to improve scientific literacy. This study is a research and development (R&D) study. The subjects of this study consisted of 67 fifth-grade elementary school students in Klaten Regency, Central Java, selected using purposive sampling techniques. Data collection techniques were through questionnaires, tests, and observations. Data were analyzed quantitatively and qualitatively, then analyzed inferentially with a paired sample t-test. The results of the study indicate that the development of an ethnoscience-based science encyclopedia integrated with role-playing methods is proven valid and effective in improving scientific literacy. The results of the study showed: (1) the validation of the science encyclopedia product obtained an average value of 97.22% from teaching material experts and 90.21% from material experts, and obtained a value of 95.5% from practitioners, and (2) the results of the analysis showed a probability value of 0.032 < 0.05, meaning that there was a difference between the results of the pretest of scientific literacy skills that had not been treated and the posttest that had implemented the science encyclopedia based on ethnoscience integrated with the role play method. Thus, the developed science encyclopedia was declared valid and effective in improving the science literacy skills of elementary school students.

Keywords: Ethnoscience-Based Science Encyclopedia, Students' Science Literacy, Role-Play Methods

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PENDAHULUAN

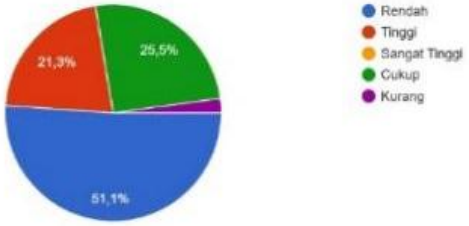
Natural and Social Sciences (IPAS) learning in elementary schools emphasizes not only memorization of concepts or theories but also higher-order thinking skills, including critical thinking, problem-solving, and evidence-based decision-making (Rahmawati et al., 2025). Ideally, IPAS learning should be active, contextual, and link students' learning experiences to their surrounding social and cultural environment. IPAS learning provides hands-on experience in developing mastery of scientific products, processes, and attitudes, or more broadly, mastery of scientific literacy (Fortus et al., 2022).

Scientific literacy in the context of basic education in Indonesia is implemented through the Natural and Social Sciences (IPAS) subject in the Independent Curriculum. According to Maulidiawati et al., (2023), scientific literacy is an individual's ability to apply their knowledge

by identifying problems, constructing new knowledge, communicating scientific explanations, drawing conclusions based on scientific facts, and developing reflective thinking. Scientific literacy is the knowledge and understanding of scientific concepts and processes needed to make new decisions, contribute to cultural and social activities, and economic productivity (Marjanah et al., 2021).

Scientific literacy encompasses several aspects, including skills, values, attitudes, understanding, competencies, and scientific knowledge that individuals need to investigate and explain scientific phenomena, interpret data, and draw conclusions (Rosidin et al., 2023).Scientific literacy is also understood as a way to effectively engage and motivate students in science learning and scientific work (María et al., 2024).

The actual situation at Sawit 2 Public Elementary School shows that the implementation of science and science learning still faces various fundamental problems. Based on the results of distributing questionnaires to 47 elementary school teachers in Gantiwarno District in August 2025, data obtained showed a low level of student literacy in science and science material reaching 51.5%, as shown in the following diagram. This figure indicates a still limited understanding in integrating science concepts with real-life contexts around students.



Gambar 1. Rata-rata tingkat literasi sains siswa

One approach considered effective in addressing these issues is developing ethnoscience-based teaching materials, namely learning that integrates traditional practices and cultural values of the community into a scientific context (Lestari & Zulirfan, 2024). The ethnoscience approach is believed to bridge the gap between abstract scientific concepts and the realities of students' daily lives, allowing them to more easily understand and internalize scientific concepts. Furthermore, ethnoscience can increase the relevance of learning, foster curiosity, and strengthen students' cultural identity (Wirama et al., 2023).

Ethnoscience-based learning provides knowledge that goes beyond understanding science as global knowledge, but also as part of their own local culture and experiences. In line with the opinion of (Wati et al., 2021), ethnoscience learning provides students with better knowledge of science process skills. This statement aligns with the opinion of Dewi et al., (2021) that science learning with cultural content can be one way to create quality education. The science learning process is expected to implement a student-centered approach, so that students can develop their individual potential (Nuraini & Muliawan, 2020). Science learning designed with a student-centered learning approach will activate learning activities through role-playing methods.

Role-playing is an active learning strategy that engages students in simulated situations based on their roles (Aflah & Rahmani, 2022). According to Biynazarova et al., (2024), role-playing can improve learning motivation, communication skills, and understanding of scientific concepts because students learn through direct experience. Role-playing activities can also train students' cooperation, empathy, and social skills (Komisaryk et al., 2023). Role-playing activities can be applied in learning about the water cycle. Students can act as water molecules undergoing evaporation, condensation, and precipitation.

Student success in role-playing is supported by a scientific database that explains the scientific concepts behind a phenomenon with the realities of students' lives, specifically called an encyclopedia. Encyclopedias present accurate and reliable scientific information, so they can be a good reference source for students in improving their scientific literacy (Fajrin et al., 2025). Ethnoscience-based science and science integrated with role-playing methods not only

functions as a learning resource containing scientific information but also presents role-playing activities relevant to local culture (Nurbatra et al., 2022).

An ethnoscience-based science encyclopedia with an integrated role-playing method is expected to improve elementary school students' scientific literacy through contextual, interactive, and enjoyable learning experiences. The innovation in this research is the product developed emphasizing context-based learning and ethnoscience integrated with a role-playing model. Learning designed by presenting students' real-life contexts not only improves academic achievement but also fosters positive attitudes, curiosity, and social skills. The similarity of these findings is limited to the theory and methods applied. Therefore, this research aims to develop an ethnoscience-based science encyclopedia integrated with a role-playing method that is expected to be a real contribution in improving the quality of science learning in elementary schools while strengthening the scientific literacy of Indonesian students in the future.

METHOD

This study uses the research and development method (R&D) with the ADDIE model. Development research is a process used by researchers to develop and validate educational products (Wei et al., 2019). The ADDIE development model consists of five interrelated elements that are systematically arranged. The research process begins with the analysis stage, which includes analysis of needs, audience, targets, as well as topics and tasks. At the design stage, the steps taken include: (1) designing images and writings used in the science encyclopedia by including attractive visual elements, challenging interactivity, and relevant and easy-to-understand learning content; (2) researchers create a design for the contents of each page that is easy for students to use; (3) description of the material in the science encyclopedia based on ethnoscience integrated with role-playing methods containing four main components (science/encyclopedia concepts, local ethnoscience of Klaten, role-playing integration, and increasing scientific literacy); (4) researchers design the closing section of the science encyclopedia from the reflection section, glossary, bibliography, and developer biography.

The selection of an encyclopedia design should consider aesthetic elements such as color, illustrations, animation, video, and sound, all of which should be open to multiple interpretations (Sari et al., 2020). The implementation mechanism for role-playing should be designed with clear scenarios to ensure unambiguous learning and maintain the impression of upholding the concept of ethnoscience. The integration of science learning materials should be linked to a consistent ethnoscience approach, with a shared conceptual goal.

The development phase of this science encyclopedia used a flipbook application with FLIPHTML5, due to its ability to build responsive and interactive multiplatform applications, particularly for Android devices commonly used in elementary schools. This application allows developers to design an engaging and child-friendly user interface with animations and visual elements that support enjoyable science learning (Ekici & Erdem, 2020)

The fourth stage is implementation. The product that has been declared feasible is then tested. A limited trial is applied to fourth-grade students of Sawit 2 Public Elementary School. The results of the limited trial are then revised and researchers can conduct a broad trial luas (Jannah & Julianto, 2018). The broad-scale trial was conducted by involving fifth-grade students of Mutihan Public Elementary School as the experimental class and fifth-grade students of Gesikan Public Elementary School as the control class. The implementation stage is carried out to determine the effectiveness of the product after using interactive multimedia project-based science to improve critical reasoning. A critical reasoning test is also conducted at this stage to evaluate the quality of the test that will be given, both before and after the treatment.

The fifth stage is evaluation, the revised product is then evaluated and refined to be applied to the product testing step of the science encyclopedia. The product testing of the science encyclopedia based on ethnoscience integrated with the role-playing method is carried out through an experimental method to measure the effectiveness of the teaching materials used based on the test results. The effectiveness test is carried out through several steps, including: a normality test to determine whether the data is normally distributed or not; a

homogeneity test to check whether the research samples have similar variances or not (using SPSS); and an effectiveness test to assess the effectiveness of product users in large-scale tests.

The data sources for this study were fifth-grade teachers and students in Klaten Regency. The sample was selected using a purposive sampling technique. The teachers selected were senior-grade teachers with extensive science teaching experience and a willingness to fully participate in the validation and implementation stages of the product. A total of 41 students and two teachers participated in the implementation of the interactive multimedia science learning program.

This study used questionnaires, tests, and observation sheets as the primary data collection instruments. These questionnaires were systematically compiled to gather information from students regarding the situation and conditions of science learning, problems and expectations in learning, and scientific literacy. The observation sheets were used by researchers to obtain data on how teachers improve scientific literacy. The purpose of analyzing these three sources was to identify areas of most pressing need, thus providing a basis for designing and developing an encyclopedia that meets the needs of fifth-grade elementary school students in science learning.

This study used a questionnaire (validation by teaching materials and subject matter experts), observations, and cognitive tests. Validation of the teaching materials included aspects of the cover design of the science encyclopedia, relevance, contextuality, quality of the science encyclopedia, and layout. Validation by subject matter experts included aspects related to information accuracy, systematic content structure, communicative language, attractive visual design, and ease of access (Muhajir et al., 2021). Validation by practitioners consisted of several aspects, including subject matter design, operational aspects, material quality, and visual communication.

The scientific literacy observation sheet covers aspects of understanding scientific concepts, scientific process skills, and scientific application and participation. Meanwhile, the scientific literacy test includes scientific concepts. These scientific concepts consist of indicators explaining natural phenomena, understanding conceptual and factual scientific content, and recognizing cause-and-effect relationships in phenomena occurring in the surrounding environment.

The data obtained in this study were qualitative and quantitative (Denny & Weckesser, 2022). Prior to analysis, the questionnaire data were converted into quantitative form and then analyzed using descriptive statistical methods. Data from observation processing and validator suggestions were analyzed qualitatively. The measurement scale used in this study was a Likert scale converted into percentages according to the reference (<25% means very inadequate, must be revised; 26-50% means less adequate, requires revision; 51-75% means adequate, with revisions according to expert advice); and 76-100 means very adequate, does not require revision) (Sugiyono, 2019).

Data processing techniques were carried out descriptively by calculating the mean and percentage of each item to obtain an overview of students' scientific literacy skills. Data were analyzed using an independent sample t-test using IBM statistic 29 to see the difference in the improvement of scientific literacy skills before and after the implementation of the ethnoscience-based science encyclopedia integrated with role-playing. Before conducting the independent sample t-test, the research data were tested for normality and homogeneity using the Kolmogorov-Smirnov and Levene tests (Fiandini et al., 2024).

RESULT AND DISCUSSION

Feasibility of an Ethnoscience-Based Science Encyclopedia Integrated with Role-Play Methods to Improve Science Literacy

The success of implementing an ethnoscience-based science encyclopedia integrated with play methods is measured based on the level of validity, effectiveness, and practicality of the teaching materials. Validity measures the suitability of the material to the learning outcomes and characteristics of students. Furthermore, effectiveness measures the extent to which the use of the encyclopedia influences students' scientific literacy, especially regarding aspects of

conceptual understanding, scientific processes, and the application of science in everyday life. Meanwhile, practicality is used to determine the ease of use of the teaching materials in their learning, which is

reviewed from teacher responses. Validation of the science encyclopedia is an important initial stage in the process of developing teaching materials, because it is the main basis for assessing the cover design, quality, and layout of the science encyclopedia.

The validation process is not only quantitative based on assessment scores, but also qualitative through notes and recommendations for improvement from the validator. The validation data from the teaching materials experts are presented in Table 1.

Table 1. Validation Results by Teaching Materials Experts

No	Assessment Aspects	Scor
1.	Science Encyclopedia Cover Design	3,83
2.	Science Encyclopedia Quality	4
3.	Science Encyclopedia Layout	3,83
Average score		3,89
Product quality percentage		97,22%
Category		Very worthy

The percentage of teaching materials experts on the developed science encyclopedia obtained very decent results with a percentage of 97.22%. There are several notes including: improvements according to suggestions in the encyclopedia (pages, writing layout, improvements to the content of the material that stimulates students to identify a problem, adding images, adding descriptions related to the distribution of role cards, and ethnoscience related to the local culture of the people of Klaten).

Several revisions to the encyclopedia were made based on expert advice and input. The first improvement concerned the placement of the names of the authors. The cover, shown in Figure 4.12, was suggested to be revised by placing it in the upper right corner so that the title and image representing the material on the encyclopedia cover are clearly visible. Improvements were made by moving the names of the authors to the upper right corner. Layout arrangement must be applied to all types of books. A well-designed cover arrangement will attract students to the book. If the layout arrangement on the cover is not proportional, the illustration will appear unbalanced.

Second, improvements were made to the font type of the foreword. Improvements were made by rearranging each paragraph to make it easier for readers to focus and be more interested in reading the foreword section of the encyclopedia. The title of the foreword uses block letters, while the contents of the foreword use Times New Roman font. The overall attractiveness of the design of the encyclopedia of natural sciences can make it easier for readers to understand the content. \ The impression of crowded fonts makes it difficult for students to recognize letters, especially if the sentences in the encyclopedia are quite long. Figure 1 presents a comparison of the initial appearance and improvements with a more proportional layout arrangement.


KATA PENGANTAR

Assalamu'alaikum Warahmatullahi Wabarakatuh,Salam Sejahtera bagi kita semua,

Halo, Sahabat IPAS!

Selamat datang di petualangan yang luar biasa!
Pernahkah kamu berjalan-jalan di sawah dan mengamati seekor katak yang melompat? Atau berpikir, bagaimana bisa ikan badut hidup aman di dalam anemon laut yang menyengat? Mengapa di alam, jumlah rumput harus jauh lebih banyak daripada jumlah harimau ?

Semua jawaban dari pertanyaan hebat itu ada di dalam buku yang sedang kamu pegang ini! Ini bukan buku IPAS biasa. Ini adalah "peta ekspedisi" untuk menjelajahi dunia kita yang menakjubkan, yaitu **EKOSISTEM.**
Di dalam ensiklopedia ini, kamu tidak akan sekadar membaca. Kamu akan kami ajak untuk:

- **Menjelajah** berbagai "rumah" di Bumi, mulai dari hutan hujan tropis yang lebat hingga terumbu karang yang indah di dasar laut.
- **Bermain Peran** menjadi seekor katak , cacing , atau bahkan berdrama seru tentang simbiosis.
- **Mengenal Kearifan Lokal** nenek moyang kita dalam menjaga alam melalui **Pojok Etnosains,** seperti sistem Subak di Bali ; Sasi Laut di Maluku , dan Lubuk Larangan di Sumatera.
- **Mengasah Pikiran** dengan pertanyaan kritis di **Pojok Literasi Sains** dan menguji pemahamanmu lewat **Kuis Interaktif** serta **Video** di setiap babnya.

Kami menyusun buku ini khusus untukmu, siswa Kelas 5 yang hebat. Tujuan kami adalah agar kamu tidak hanya tahu apa itu ekosistem, tapi juga merasa menjadi bagian penting di dalamnya.
Ilmu Pengetahuan Alam (IPAS) itu ada di sekitar kita. Mari kita jelajahi bersama!
Selamat membaca dan selamat berpetualang!

Klaten, November 2025

Penyusun


KATA PENGANTAR

Assalamu'alaikum Warahmatullahi Wabarakatuh,

Puji syukur ke hadirat Allah SWT yang telah melimpahkan rahmat dan karunia-Nya, sehingga penulis dapat menyelesaikan penyusunan buku **"Ensiklopedia Sahabat IPAS: Mengenal Ekosistem Kita"** ini dengan baik.

Buku ini disusun khusus untuk kalian, para siswa Kelas 5 yang cerdas dan penuh rasa ingin tahu. Melalui buku ini, kita tidak hanya akan membaca teks, tetapi kita akan berpetualang menjelajahi "rumah" besar kita yang disebut **Ekosistem.**

Apa yang membuat buku ini istimewa? Di sini, kalian akan belajar Ilmu Pengetahuan Alam dan Sosial (IPAS) dengan cara yang berbeda. Kami mengajak kalian mengamati alam sekitar di daerah kita tercinta, Klaten. Kalian akan menemukan bagaimana tradisi nenek moyang kita, seperti menjaga kebersihan Umbul, sistem irigasi di Sungai Dengkeng, hingga budidaya ikan di Rawa Jombor, ternyata adalah penerapan ilmu sains yang luar biasa dalam menjaga keseimbangan alam.

Buku ini juga dirancang secara interaktif. Kalian bisa memindai **QR Code** yang tersedia untuk menonton video penjelasan seru dan mengerjakan kuis tantangan. Selain itu, terdapat fitur **"Ayo Bermain Peran"** agar kalian bisa merasakan langsung bagaimana menjadi bagian dari rantai makanan atau simbiosis di alam.

Terima kasih kami ucapkan kepada semua pihak, termasuk dosen pembimbing, validator ahli, serta rekan-rekan yang telah membantu penyempurnaan buku ini.
Semoga ensiklopedia ini dapat menjadi teman belajar yang menyenangkan, menumbuhkan rasa cinta terhadap lingkungan, serta menjadikan kalian penjaga bumi yang bijaksana di masa depan. Selamat membaca dan selamat berpetualang, Sahabat IPAS!
Wassalamu'alaikum Warahmatullahi Wabarakatuh.

Klaten, November 2025

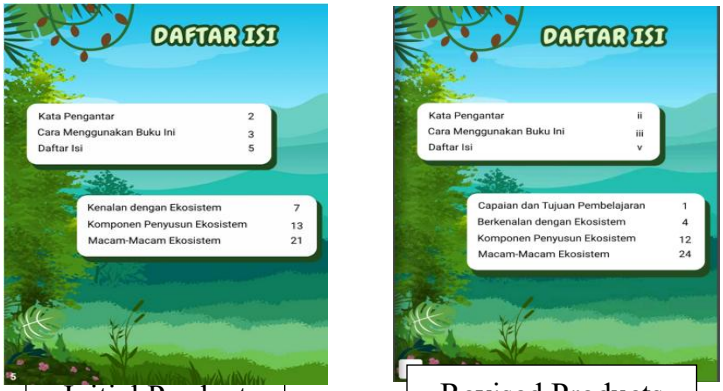
Penyusun

Initial Product

Revised Products

Figure 2. Comparison of the Appearance of the Foreword Before and After Revision

Third, improvements to the numbering style in the table of contents. Improvements were made by differentiating the use of Roman numerals on the foreword, instructions for using the encyclopedia, and the table of contents. The pages in the foreword, instructions for using the book, and the table of contents use lowercase Roman numerals, while the pages in the main text use Arabic numerals to improve consistency, neatness, and ease of navigation of the science encyclopedia teaching materials. Numerical page numbering is applied to the learning outcomes and objectives sections and several sections of the material, namely getting to know ecosystems, the components of ecosystems, and various ecosystems. As a form of comparison, the initial display and improvements are presented as in Figure 3.



Initial Product

Revised Products

Figure 3. Comparison of the Table of Contents Display Before and After Revision

Fourth, improvements in the content structure begin with a question, stimulating students to identify an existing problem. This encyclopedia not only presents material in the form of memorized concepts but is designed to foster understanding of scientific processes and the application of knowledge in everyday life. The designed material is linked to regional ethnoscience culture as a form of utilizing local wisdom in learning. The subject matter is directed toward active, discovery-based problem-solving. Figure 4 below presents a comparison of changes in the material content before and after the improvements.

Initial Product

Revised Products

Figure 4. Comparison of Material Appearance Before and After Revision

Fifth, improvements were made by selecting images that needed to be adjusted to the context of the material. The selection of images for abiotic components was intended to make it easier for students to understand and recognize real-life examples of abiotic components in

their surroundings. Changes in the appearance of the abiotic material are presented in Figure 5 below.

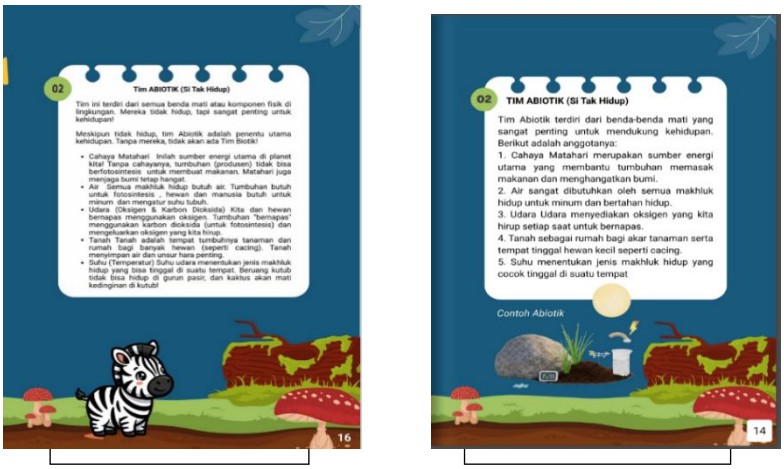


Figure 5. Comparison of Image Appearance Before and After Revision

The content in the ethnoscience-based science encyclopedia integrated with role-playing is the result of development tailored to learning needs based on analysis in the initial development stage. Indicators used in assessing the depth of the material include information accuracy, systematic content structure, communicative language, attractive visual design, and ease of access. The results of the validation by material experts on the developed product are presented in Table 2.

Table 2. Validation Results by Material Experts

No	Assessment Aspects	Scor
1.	Accuracy of information	3,67
2.	Systematic content structure	3,375
3.	Communicative language	4
4.	Attractive visual design	3,33
5.	Ease of access	3,67
Average score		3,61
Product quality percentage		90,21
Category		Very worthy

Table 2 shows the results of the material validation test, which was declared very feasible with a percentage score of 90.21%. There were several inputs from the validators regarding: improvements in linking the material to indicators for formulating scientific questions, collecting data, and interpreting the results of investigations in ethnoscience-based ecosystem materials, adding clarity to the role-playing steps, and adding learning outcomes and objectives, adding examples to clarify the content, improving the writing design of sentences, and also improving the suitability of images or illustrations used in the material.

First, improvements in linking with indicators for formulating scientific questions. Each content material in the encyclopedia contains scientific questions that stimulate students to identify a problem that is linked to the cultural, geographical, and social context of the local community. The ethnoscience content added to this encyclopedia is in the form of a mutualistic symbiotic relationship between starlings or egrets with cows or buffaloes that are often found in rice fields in Klaten. The ethnoscience content added to this encyclopedia is in the form of a mutualistic symbiotic relationship between walking birds and buffaloes. Improvements in the presentation of content in the encyclopedia are presented in Figure 6 below.

Figure 6. Co Present ter Revision

Second, collecti a case study by guessing various ecosystems. The problem topic is a puzzle related to the characteristics of the target ecosystem type. This activity not only stimulates conceptual mastery but also critical thinking and problem-solving skills. Improvements in content and design are necessary to make it easier for students to grasp the essence of the puzzle. The consistency of the content or description of the material is a key point to consider to attract readers to explore the breadth and depth of the encyclopedia's contents. Improvements in the presentation of content in the encyclopedia are presented in Figure 7 below.

Figure 7. Comparison of the Appearance of the "Guess the Ecosystem" Content Before and After Revision

Third, the addition of learning outcomes and learning objectives, which are part of the design elements in the encyclopedia. Learning outcomes relate to the mission to be solved, namely investigating the relationship between living things (biotic) and non-living things (abiotic) that can affect the surrounding ecosystem. Figure 8 below shows the addition of learning outcomes and objectives in the encyclopedia display.

Figure 8. Addition of Learning Achievements and Objectives in the Science Encyclopedia

Overall, the results of quantitative and qualitative validation of the ethnoscience-based science encyclopedia integrated with role-playing were stated to have a very high level of feasibility, with the percentage of feasibility from teaching material experts (97.22%) and material experts (90.21%). The practicality assessment data for the ethnoscience-based science encyclopedia integrated with the role-playing method was assessed by the practicing teachers at the end of the trial phase with the aim of enabling the practicing teachers to provide a more comprehensive assessment of the development of the teaching materials being tested. The results of the practicality assessment by the practicing teachers can be seen in the following table. The average result for the five teachers reached 95.5% with very high qualifications.

The Effectiveness of an Ethnoscience-Based Science Encyclopedia Integrated with Role-Play Methods to Improve Science Literacy

The item validity test was conducted to determine the level of accuracy and suitability of each item in measuring each aspect to be assessed. The statement items used in the extensive trial were 10 multiple-choice questions with r count > r table, with an n value of 33 and r table of 0.344. All questions from the three aspects in the pre-test and post-test questions were greater than 0.344, so they can be declared valid. The results of the item assessment also need to be tested for reliability to determine the level of consistency of the instrument in providing stable measurement results. The instrument is said to be reliable if the Cronbach's alpha value is greater than 0.70. Conversely, if the value is less than or equal to 0.70 then the instrument is declared unreliable.

Students in both the experimental and control classes underwent a pre-test to determine their initial scientific literacy skills before being given the treatment. Students in the experimental class implemented the science encyclopedia teaching material product based on ethnoscience integrated with role-playing methods, while students in the control class used the teaching materials available in the module. The effectiveness of the science encyclopedia product based on ethnoscience integrated with role-playing methods was analyzed by comparing pre-test and post-test scores between the control and experimental groups. The scores from both classes are presented in Table 3 below.

Table 3. Pre-test and Post-test Results of Science Literacy Questions

Elementary School	Amount	Pre-test			Post-test		
		Average	Min	Max	Rerata	Min	Max
Mutihan	26	61,15	30	90	81,46	60	100
Gesikan	41	46,83	20	80	74,15	40	100

The table above presents a summary of students' scientific literacy results during the pre-test and post-test in the experimental and control classes. The average pre-test difference between the two classes was 14.32. The average pre-test score for the experimental class was 61.15, while the control class was 46.83. The post-test score for the experimental class averaged 81.46, while the control class averaged 74.15. These findings indicate an increase in average scores from the pre-test to the post-test in both classes. The next stage, normality and homogeneity tests were conducted to ensure that the data met the requirements for statistical analysis.

The normality test was analyzed using the Kolmogorov Smirnov method, with data considered normal if the significance value is greater than 0.05. The significance value of the pre-test for the experimental group's scientific literacy was 0.059 (> 0.05), while the control group obtained a significance value of 0.3079 (> 0.05). For the post-test, the experimental group obtained a significance value of 0.924 (> 0.05), while the control group obtained 0.061 (> 0.05). The results of the normality test showed that the pre-test and post-test scores in both groups had significance values above 0.05, indicating that the sample used in this study was normally distributed. Data is said to be normally distributed if its significance value is greater than 0.05.

In addition to the data being declared normally distributed, a homogeneity test was conducted to determine the similarity of variances between groups (Nahar et al., 2022). Based on the results of the students' post-test, analyzed using the Levene's test, a significance value of

0.126 was obtained. This value is greater than 0.05, so it can be concluded that the data variance is equal or homogeneous. After going through the prerequisite test, the data was declared to meet the requirements of being normally distributed and homogeneous, so further analysis could be continued with the independent samples t-test.

The effectiveness test in this study was conducted by comparing students' post-test learning outcomes. Effectiveness was measured using an independent samples t-test on two samples assuming equal variance, with a significance level of 5% (α = 0.05). The complete calculation results are presented in Table 4.

Table 4. Independent Sample Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Hasil Literasi Sains	Equal variances assumed	2.406	.126	-2.195	65	.016	.032	-7.392	3.368	-14.119	-.665
	Equal variances not assumed			-2.330	62.617	.012	.023	-7.392	3.173	-13.734	-1.050

The science encyclopedia based on ethnoscience integrated with role-playing method has been proven to be effective in improving science literacy. The results of the sign test showed an accumulated value of 0.032. This significance value is smaller than 0.05 (0.032 < 0.05), so it can be concluded that there is a significant difference between literacy skills before and after using the science encyclopedia based on ethnoscience integrated with role-playing method. This difference is shown from the results of the N-gain test of 0.52 or 52% which is included in the moderate criteria. This finding is also reinforced by the N-gain score obtained for each aspect of science literacy. The aspect of explaining natural phenomena is 58%, understanding science content (conceptual and factual) is 49%, while the aspect of recognizing cause-and-effect relationships in phenomena that occur in the surrounding environment obtained a value of 52%. The data from these findings show that the application of the science encyclopedia based on ethnoscience integrated with role-playing method is effective in improving the science literacy of fifth-grade elementary school students.

The integration of an ethnoscience approach and role-playing methods allows students to understand science concepts contextually, thus optimally developing their scientific literacy skills. Ethnoscience integrated into learning can make education more humanistic, contextual, and character-based, in line with 21st-century learning goals that emphasize sustainability and global cultural awareness.

DISCUSSIONThe assessment stage of this science encyclopedia has been revised once until it was declared suitable by experts, both in terms of teaching materials and content. The assessment process by teaching materials experts focused on several revisions to the cover design, font type, numbering, content organization, and the selection of images tailored to the material's context. Meanwhile, material experts focused more on several improvements to the material content related to indicators for formulating scientific questions, the data collection

process, the addition of sections on learning outcomes and objectives, and the clarity of role-playing steps.

First, improvements were made to the placement of the title and authors' names. The front cover of the book contains information about the title and an explanation of the subject matter. The title is written in a large font that dominates the front cover, followed by an image that matches the book's theme (Sittariandani & Rahmawati, 2022). Improvements were made by moving the authors' names to the top right corner. The layout elements on the cover are a unique selling point for the book (Setiawan & Amayati, 2025). Layout must be applied to all types of books. A well-designed cover layout will attract students to the book. If the layout is not proportional, the illustrations will appear unbalanced.

Second, improvements to the font type used in the foreword. Efendi & Kristiana (2024), expressed a similar sentiment, stating that the use of appropriate fonts, consistent colors, attractive placement of design elements, and a clear and concise message are key factors contributing to reader comprehension. One of the most well-known serif fonts is Times New Roman, which is the standard for writing scientific articles, journals, theses, and books (Lestari & Rohmaniyah, 2024). The impression of a font that is crowded together makes it difficult for students to recognize letters, especially if the sentences in the encyclopedia are quite long. They will need more time to try to read the series of words. Therefore, improvements to the font are used to improve the readability of a sentence by using a font with a thin thickness, but still clear and easy to read.

Third, improvements focused on the numbering used in the table of contents. The table of contents is designed to make it easier for students to find pages in the teaching materials quickly and systematically (Rofi & Susilo, 2023). Pages in the foreword, user manual, and table of contents use lowercase Roman numerals, while pages in the main text use Arabic numerals to improve consistency, neatness, and ease of navigation of the science encyclopedia teaching materials.

Fourth, improvements in the structure of material are linked to questions that can stimulate students to identify a problem. Sitorus & Naibaho (2023), similarly expressed that teachers who use open-ended questions effectively can present material in a way that stimulates deeper understanding. The subject matter is directed toward active, discovery-based problem-solving. Teachers begin with something students are already familiar with, then introduce something contradictory. This avoids the occurrence of contradictions, stimulating students to investigate the problem, formulate hypotheses, and try to discover the concepts or principles underlying the problem ((Hatip & Setiawan, 2021).Fifth, the selection of images adapted to the context of the material. Improvements to the images were made to avoid confusing readers because the material related to abiotic components contained images of animals, so they were revised to images of rocks, water, and light that represent the content of the material. The use of visuals in this textbook includes the use of images, diagrams, tables, and photos adapted to the context of the text content or learning evaluation materials (Liu & Khine, 2016). According to Febrianto & Puspitaningsih (2020), explaining material accompanied by visuals can make it easier for learners to master the material thoroughly.

Furthermore, the improvement suggested by the first material expert is to link the material with indicators for formulating scientific questions, especially in content related to the cultural, geographical, and social context of the local community. This is in line with the opinion of Halisa & Eralita (2025), that activities like this can provide space for students to explain scientific phenomena logically, formulate relevant scientific questions, and interpret data and scientific evidence observed. The ethnoscience content added to this encyclopedia is in the form of a mutualistic symbiotic relationship between walking birds and buffaloes. Students can observe phenomena encountered in the surrounding environment through these examples, so that learning becomes more contextual and meaningful.

The second improvement relates to the data collection process for solving case studies presented in puzzle form. Based on the advice of subject matter experts, learning activities were clarified by adding systematic data collection steps, such as observing the presented phenomena, recording important information, asking scientific questions, and discussing

findings in groups. This improvement aims to develop students' scientific literacy skills in solving problems logically and structuredly (Ahid & Chamid, 2021).

Third, the addition of a section on learning outcomes and objectives in the encyclopedia. One important element in this curriculum is the Learning Outcomes, which are designed to ensure students have core competencies in various subjects (Joon & Kwon, 2024). The suitability of the content of books or teaching materials is assessed based on three main indicators: the suitability of the material to the learning outcomes, the accuracy of the content, and the availability of supporting learning materials according to the guidelines from BSNP (Ginanjar et al., 2025). In line with the opinion of Ramadhani et al., (2024) the content of the textbook is then described along with the learning objectives (CP) and skill components that have been developed according to the related curriculum.

Fourth, the addition of a clearer section on the role-playing steps. The role-playing method is a game in which students play characters or objects around them, thereby developing their imagination and appreciation of the material being carried out actively and meaningfully (Yulita et al., 2022). The role-playing method in science learning is suitable for visualizing abstract scientific concepts into more concrete ones (Agustina & Subadia, 2025). The added clarity of the role-playing steps aims to provide systematic guidance for teachers and students, starting from the problem identification stage, role selection, reflection implementation, and evaluation, which serves to form an integrative learning cycle.

Expert validation is also carried out by competent teaching materials and subject matter experts in their respective fields. The developed science and natural sciences encyclopedia for teaching materials must go through a series of validation processes from both teaching materials and subject matter experts, resulting in a feasibility assessment of the encyclopedia. Based on the assessment results conducted by teaching materials experts (97.22%) and subject matter experts (90.21%) with a very feasible category. As stated by Syaflin & Ayurachmawati (2023), the assessment results of subject matter experts were 91%, media experts 90%, and language experts 85.30%. This indicates that the developed digital encyclopedia is included in the very valid criteria. The results of the student response questionnaire obtained a percentage of 93.90% indicating that the developed digital encyclopedia is included in the very practical criteria, so it is suitable for use in learning.

Accroding to Sari et al., (2024) that the percentage value of validation of material experts (92.5%), material experts (92%), practitioners (93%), and student responses (82.5%). So it can be concluded that the development of ethnoscience-based science encyclopedia teaching materials with the theme of various Indonesian herbal medicines can foster interest in learning. In line with the results of research conducted by Mutamima et al., (2024) showed that the development of digital encyclopedias obtained product validity results with an average of 95.8% (very valid), product practicality got an average of 92.6% (very practical), product effectiveness was obtained from completeness which got an average of 97.8% (very effective). The results of effectiveness data are supported by a gain score with an average result of 0.794 (high) and the results of learning implementation and student activities with an average of 93.8% (very good). This was also stated by Sri, Wardani & Astria (2023), who showed that the average validation score for the structure module was 3.89, language (3.67), and display (3.73), with the category being very valid. Therefore, it can be concluded that the development of an ethnoscience-based science education module using a case-based learning model is very valid for application in learning.

Technological advances open up opportunities to package information and knowledge in a more adaptive and flexible manner. The flexibility of using encyclopedias as teaching materials has increased and has features, such as search, hyperlinks between topics, and multimedia integration (images, videos, animations, and diagrams) that support a more interactive and comprehensive understanding of concepts (Masrurah, 2023).

The ethnoscience-based science encyclopedia product integrated with role-playing methods has passed an assessment process and can be an alternative teaching material used by teachers. Research conducted by Sari & Wilujeng (2023), shows that the application of ethnoscience learning can train, improve, and have a positive impact on 21st-century

competencies, such as critical thinking, creativity, generic science skills, conceptual understanding, character, chemical literacy, and scientific literacy. Research conducted by Aviarizki et al., (2024) shows that digital encyclopedias have great potential in improving elementary school students' scientific literacy by providing more interactive and engaging information.

The practicality evaluation included an assessment of the accuracy of the information presented, the systematic structure of the content, the relevance of the material to the learning context, and ease of access and use by users. The evaluation results showed that the developed product met the practicality criteria and could be used effectively in the learning process. High practicality is an important prerequisite for learning materials in the form of an encyclopedia of natural sciences not only to be theoretically superior but also to be realized consistently and meaningfully in the real classroom.

The practicality test results by the classroom teacher reached 93.97%, with very good qualifications. This demonstrates that the ethnoscience-based science encyclopedia integrated with practical role-playing methods used by teachers is not only theoretically superior but can be implemented in real-world and practical applications in learning. Ethnoscience is a manifestation of local knowledge (local wisdom) that reflects how a community understands, explains, and interacts with its natural environment through its cultural values (Cahyani & Fadly, 2024).

The results of the validity and reliability tests of observations and scientific literacy questions in the extensive trial were declared valid. All statement items were declared valid with a significance value according to the procedure, which was less than 0.05. The Cronbach's alpha reliability value obtained was 0.742, indicating that the statement items were included in the reliable category. Meanwhile, the results of the scientific literacy instrument validation test showed that the calculated r value in both the pre-test and post-test was greater than the r table of 0.334, so that all questions were declared valid. The results of the scientific literacy questions reliability test showed a Cronbach's alpha value of 0.757 > 0.70 for the pre-test questions and 0.756 > 0.70 for the post-test questions.

The validity and reliability results are in line with Rosnawati, (2021), which shows that the encyclopedia based on Wakatobi's local potential on the Mollusca Phylum developed has specifications with quality criteria (standards) of non-textbooks and has met the validity criteria with a score of (4.56), practicality criteria with teacher response scores (4.18) and student responses (4.07), and effectiveness with (85.37), so that the encyclopedia teaching materials based on Wakatobi's local potential can be used as a learning resource. The same thing was also expressed by Sari, Leksono & Suryani, (2024) showing that the percentage value of teaching material expert validation was 92.5%, included in the very valid category. The percentage value of material expert validation was 92%, included in the very valid category. This indicates that the use of e-encyclopedias can foster students' interest and understanding of science concepts through an ethnoscience-based approach.

The results of the sign test showed an accumulated value of 0.032. The significance value is smaller than 0.05 (0.032 < 0.05), so it can be concluded that there is a significant difference between literacy skills before and after using the ethnoscience-based science encyclopedia integrated with the role-playing method. This difference is shown from the results of the N-gain test of 0.52 or 52% which is included in the moderate criteria. This finding is also reinforced by the N-gain score obtained for each aspect of science literacy. The aspect of explaining natural phenomena is 58%, understanding science content (conceptual and factual) is 49%, while the aspect of recognizing cause-and-effect relationships in phenomena that occur in the surrounding environment obtained a value of 52%. The data from these findings show that the application of the ethnoscience-based science encyclopedia integrated with the role-playing method is effective in improving the science literacy of fifth-grade elementary school students.

The integration of an ethnoscience approach and role-playing methods allows students to understand science concepts contextually, thus optimally developing their scientific literacy skills. Ethnoscience can train, improve, and positively impact 21st-century competencies, such

as critical thinking, creativity, generic science skills, conceptual understanding, character, chemical literacy, and scientific literacy (Sari & Wilujeng, 2023). Ethnoscience integrated into learning can make education more humanistic, contextual, and character-based, in line with 21st-century learning goals that emphasize sustainability and global cultural awareness. Ethnoscience-based learning will be easier to understand if teachers can choose appropriate methods to apply in learning (Wirama et al., 2023). The role-playing method in science learning is suitable for visualizing abstract scientific concepts into more concrete (Schinko & Bednar, 2022).

This study provides a theoretical contribution to the development of science learning studies by strengthening the foundation that the integration of ethnoscience approaches and role-playing methods can improve students' scientific literacy. The findings of this study support the theory of constructivism which emphasizes meaningful learning through active student involvement in constructing knowledge based on experience and local cultural contexts. In addition, the results of this study enrich the development of scientific literacy theory by showing that understanding of scientific concepts is not only influenced by cognitive mastery, but also by the social and cultural contexts inherent in the learning process. Meanwhile, limitations in this study include: The observation and scientific literacy instruments in this study were only tested once, the implementation of the role-playing method was highly dependent on teacher readiness and classroom conditions, and the measurement of scientific literacy improvements was only focused on cognitive aspects.

CONCLUSION

The ethnoscience-based science encyclopedia product integrated with role-playing methods has been proven valid and effective in improving the literacy of fourth-grade elementary school students. This product was declared suitable for use after being validated by teaching materials and materials experts with one revision so that it becomes a quality learning material and is ready to be applied in science learning. The t-test results showed a significance value of 0.032 which is smaller than 0.05, so that the use of the product has a significant effect on improving students' science literacy. The results of the N-Gain test were 0.52 or 52% which is included in the medium criteria. This innovation in science learning is feasible to implement because it utilizes technology-based learning applications that are oriented towards the final learning outcomes. For teachers, this product can help facilitate the delivery of science material by linking it to local culture and encouraging student involvement through role-playing activities. For students, the use of this encyclopedia can improve the understanding of concepts related to science literacy, as well as a caring attitude towards the environment and surrounding culture. In addition, the results of this study can be a reference for teaching material developers and future researchers to develop similar products on different materials and educational levels.

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