

THE EFFECTIVENESS OF NATURAL DYE BATIK ETHNOSCIENCE-BASED PICTURE STORY BOOKS ON ELEMENTARY SCHOOL STUDENTS' SCIENCE CONCEPT MASTERY

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ABSTRACT

This study aims to examine the effectiveness of using an Ethnoscience-based Picture Story Book focusing on natural dye Batik to improve science concept mastery among fourth-grade elementary school students. The specific science concepts addressed are "States of Matter and Their Changes" and "Parts of Plants." The study employed a Quantitative approach with a Pre-Experimental One-Group Pretest-Posttest Design. The sample consisted of 30 Grade IV students at SDN Sumurwuni, Cirebon City, selected using purposive sampling technique. Data were collected using a concept mastery test administered before (pretest) and after (posttest) the treatment. Data analysis was performed using the Paired Sample t-test and Normalized Gain (N-Gain) score. The results indicated a significant improvement in the students' average score from 60.75 to 87.75. The N-Gain analysis yielded a score of 0.69, categorizing the improvement as Medium. The visualization of the Batik process within the storybook proved effective in helping students concretize abstract science concepts. This study concludes that integrating local wisdom into visual literacy media is effective in enhancing science learning outcomes for elementary school students.

Keywords: Picture Story Book, Ethnoscience, Natural Dye Batik, Science Concept Mastery

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INTRODUCTION

Science education in elementary schools plays a vital role in establishing a foundation for students' logical and scientific thinking from an early age. Science is not only related to concept mastery but also to process skills and scientific attitudes. However, based on the latest Programme for International Student Assessment (PISA) results, the scientific literacy of Indonesian students remains in the low category (Budiawan & Nurul, 2025). One fundamental cause of this low literacy is the gap between the formal "scientific science" taught in schools and the "indigenous science" embedded within the students' cultural community (Sudarmin, 2017).

At the elementary level, specifically Grade IV (Phase B of the Merdeka Curriculum), students are at the concrete operational stage of cognitive development (Piaget, 1965). Students often experience difficulties in understanding abstract science concepts, such as "Changes in States of Matter" (Melting, Freezing, Evaporating), if learning is delivered solely through lectures or verbal texts. Difficulties in visualizing particles or state change processes often lead to misconceptions (Suparno, 2013).

On the other hand, the students' environment is rich in local wisdom, such as Batik culture, which is inherently laden with scientific applications (Alimah, 2012). The process of making natural dye Batik involves concepts of physical changes (wax melting and freezing) as well as biological concepts (plant parts producing pigments). Unfortunately, this potential has not been optimally utilized as a learning resource in the classroom. Science learning is often isolated from the students' cultural context, making it appear foreign and difficult to understand.

The use of appropriate learning media is essential to bridge the gap between abstract concepts and the students' real world. Picture Story Books offer a potential solution by combining the power of narrative and visualization (Matulka, 2021). Dual Coding Theory (Lulus Anggun Listiyani et al., 2025) suggests that information presented through two channels (verbal and visual) is processed more effectively by the brain.

Although research on ethnoscience has been widely conducted, most studies are limited to the development of modules or Student Worksheets (LKS). Research specifically integrating natural dye Batik ethnoscience into a Picture Story Book format for Grade IV matter-change materials remains limited. Based on this background, this study aims to examine the effectiveness of a Batik ethnoscience-based Picture Story Book on Grade IV elementary students' science concept mastery. The novelty of this research lies in the narrative visualization of scientific processes within Batik culture to explain the concepts of changes in states of matter.

LITERATURE REVIEWS

Theoretical Framework: Constructivism and Dual Coding Theory

The primary foundation for using Picture Story Books in science learning is rooted in cognitive theory. According to Piaget's Theory of Cognitive Development, elementary school students (aged 7-11 years) are in the concrete operational stage, where they require manipulative visual aids to understand abstract concepts (Ifda, 2015).

Furthermore, Dual Coding Theory, proposed by Paivio (Lulus Anggun Listiyani et al., 2025) asserts that human cognition processes information through two separate but interconnected channels: verbal (text/language) and non-verbal (images/visuals). Research by (Clark & Paivio, 1991) and recent findings by (Durrutunnisa & Nur, 2020) indicate that when science material is presented through the simultaneous integration of narrative text and illustrative images, students' long-term memory capacity improves significantly compared to using text alone. In this context, picture storybooks function as "cognitive bridges" that transform abstract science concepts into concrete visual representations.

Integration of Ethnoscience in Science Learning

Ethnoscience is defined as the transformation of indigenous knowledge (indigenous science) into scientific knowledge (Sudarmin, 2014). Integrating ethnoscience into science learning aims to create contextual learning relevant to the students' cultural background. Several empirical studies have demonstrated the effectiveness of this approach. Research by (Fitriyah et al., 2025) on Sidoarjo Batik found that ethnoscience exploration effectively improved elementary students' scientific literacy. Similarly, (Angraini et al., 2025) and (Fionita & Wulandari, 2024) revealed that the batik-making process—from tool preparation to dyeing—is replete with science concepts that can train critical thinking skills. Specifically, (Putri et al., 2024) identified concepts of changes in states of matter (physics) and characteristics of natural materials (biology) in the batik-making process relevant to the elementary science curriculum.

The Effectiveness of Picture Story Books in Elementary Science

Picture Story Books possess a unique characteristic where images and text share a balanced portion in constructing meaning (Matulka, 2021). A study by (Rosyana et al., 2021) showed that scientific approach-based storybooks were able to significantly increase students' learning interest. In the context of specific materials, the use of visual narrative has proven effective in helping students visualize invisible processes.

Research by (Ira Darmayanti, 2022) found that ethnoscience-themed picture books positively influenced students' scientific literacy because they presented familiar real-world problem contexts. The hypothesis of this study is: There is a significant difference in science concept mastery between students using the Ethnoscience-based Picture Story Book and students using conventional textbooks.

RESEARCH METHODOLOGY

Research Design

This study employs a quantitative approach with a **Pre-Experimental Design**, specifically the **One-Group Pretest-Posttest Design**. This design was selected because the research focused on a single subject group to observe the magnitude of competence improvement before and after treatment without using a control class. The research design is depicted as follows:

$O_1 X O_2$

Keterangan:

O_1 : initial Test (Pretest) before treatment.

X : treatment in the form of learning using the Picture Story Book "Rahasia Warna Alam Batik" (The Secret of Natural Batik Colors).

O_2 : Final Test (Posttest) after treatment.

Population and Sample

The population of this study was all Grade IV students at SDN Sumurwuni, Cirebon City. Sampling was conducted using purposive sampling or total sampling techniques (given the small population). The sample consisted of 30 students.

Research Instrument

The data collection instrument was a Concept Mastery Test in the form of Two-tier Multiple Choice questions. The instrument covered indicators for: 1) Identifying changes in states of matter (melting, freezing, evaporating) in the batik process; and 2) Identifying plant parts as sources of dyes. The instrument was validated by subject matter experts and media experts, and tested for reliability with a Cronbach's Alpha value of 0.87.

Data Analysis

Data analysis included descriptive and inferential statistics. The normality test used the Shapiro-Wilk test. Hypothesis testing employed the **Paired Sample t-test** with a significance level of 5%. Learning improvement was analyzed using the Normalized Gain (N-Gain) formula according to (Hake, 1998).

RESEARCH RESULTS

Description of Research Data. Data on students' science concept mastery test results before (pretest) and after (posttest) the use of the Picture Story Book media are presented in Table 1.

Table 1 Comparison of Pre-test and Post-test Scores

Jenis Test	Jumlah Siswa (N)	Rata-rata (Mean)	Standar Deviasi	Nilai Minimum	Nilai Maksimum
Pre-test	30	60,75	20,86	46,0	75,5
Post-test	30	87,75	15,20	77,0	98,5

Based on Table 1, a very significant improvement in learning outcomes is evident. The students' initial average score was 60.75. After learning using the Ethnoscience-based Picture Story Book, the average score increased sharply to 87.75. Additionally, the minimum score increased drastically from 46.0 to 77.0. This indicates that all students (100%) successfully surpassed the Minimum Completeness Criteria (KKM) after receiving the treatment. The decrease in standard deviation from 20.86 to 15.20 shows that the distribution of student abilities became more homogeneous (even) at the posttest.

Improvement Analysis (N-Gain) To determine the effectiveness of the media more objectively, a Normalized Gain (N-Gain) calculation was performed based on the difference between posttest and pretest scores.

$$N - Gain = \frac{87,75 - 60,75}{100 - 60,75} = \frac{27}{39,26} = 0,69$$

The calculation results show an average N-Gain value of 0.69. Based on (Hake, 1998), this improvement falls into the Medium category (approaching the High category boundary of > 0.70). This proves that the Picture Story Book media has good effectiveness in improving students' science concept mastery.

Hypothesis Testing Before hypothesis testing, a normality prerequisite test was conducted. The Shapiro-Wilk test results showed a Sig. value > 0.05, indicating the data were normally distributed. Subsequently, a Paired Sample t-test was conducted.

Table 2 Paired Sample t-test Results

Pasangan	Mean Difference	t-hitung	df	Sig. (2-tailed)
Pretest-Posttest	-27.00	-7.942	29	0.000

Table 2 shows a Sig. (2-tailed) value of **0.000** < 0.05. The negative t-value (-7.942) indicates the direction of improvement (pretest scores were lower than posttest scores). Since the significance value is < 0.05, H₀ is rejected and H_a is accepted. Thus, there is a significant difference between students' science concept mastery before and after using the Ethnoscience-based Picture Story Book.

DISCUSSION & CONCLUSION

Discussion This study successfully demonstrated that the use of a natural dye Batik Ethnoscience-based Picture Story Book is effective in improving the science concept mastery of Grade IV elementary school students. The average score increase of 27 points (from 60.75 to 87.75) confirms the positive impact of this media. These findings align with research by (Sumarni, 2016) and (Zumaroh et al., 2024) which stated that the ethnoscience approach is capable of reconstructing students' scientific knowledge.

The effectiveness of the Picture Story Book media in this study is driven by three main factors: First, **Concretization of Abstract Concepts through Visualization**. Grade IV students often experience misconceptions regarding changes in states of matter, especially distinguishing

between "melting" and "dissolving." In the storybook, illustrations of the process of melting wax in a hot pan provide a real visualization of the concept of "Melting" due to heat absorption. Conversely, when the wax drips from the *canting* and hardens on the cloth, students learn the concept of "Freezing" (heat release). This visualization aligns with the representational principle of pictures in text (Levin, 1982), which helps students build accurate mental models. Second, **Contextual Teaching and Learning**. Integrating Batik culture makes science feel close and relevant. Students learn to identify plant parts (roots, stems, leaves) not from rote memorization of text, but from the narrative of characters searching for dye materials in nature (such as *suji* leaves and mahogany bark). This enhances meaningful learning because students can connect the subject matter with the culture they recognize daily (Sudarmin et al., 2017). Third, **Emotional Engagement and Cognitive Load Reduction**. The illustrated story format reduces students' cognitive load compared to reading dense textbooks. The adventure storyline creates emotional engagement, which, according to Dual Coding Theory (Paivio, 1991), strengthens long-term memory retention. Students do not feel they are "studying" difficult science, but rather enjoying a story, which subconsciously implants science concepts (subconscious learning).

Conclusion

Based on the data analysis and discussion, it is concluded that the Ethnoscience-based Picture Story Book focusing on Natural Dye Batik has a significant effect on improving the science concept mastery of Grade IV elementary school students, with a medium effectiveness category (N-Gain 0.69). This media is effective in bridging cultural knowledge with scientific concepts (changes in states of matter and plant parts) through engaging visualization. The practical implication of this research is the importance for elementary teachers to utilize local cultural potential as a learning resource. It is suggested that future researchers develop similar media on other ethnoscience topics, such as salt production or traditional food, to enrich the literature on culture-based science education.

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