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Exploration of Ethnoscience in Sidoarjo Batik as a Local Wisdom-Based Learning Resource for Elementary School Students

Nur Fitriyah*
Master's Program in Elementary Education, State University of Surabaya, Surabaya, Indonesia

Wahono Widodo
Master's Program in Elementary Education, State University of Surabaya, Surabaya, Indonesia

Ganes Gunansyah
Master's Program in Elementary Education, State University of Surabaya, Surabaya, Indonesia

***Corresponding Author:** 24010855141@mhs.unesa.ac.id

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Abstract
This research explores the integration of ethnoscience within the traditional batik-making process in Sidoarjo as a contextual learning resource for elementary school students. The study aims to identify scientific concepts embedded in local cultural practices and analyze their relevance to the IPAS (Integrated Science and Social Studies) curriculum. Using a qualitative ethnographic method, data were collected through participatory observation, in-depth interviews, and documentation at Batik Tulis Al-Huda in Sidoarjo. Findings reveal that each stage of the batik process—from *molani* (sketching motifs), *malemi* (applying wax), *nyolet* (coloring), to *nglorod* (wax removal)—reflects basic scientific principles such as heat transfer, changes in states of matter, diffusion, and evaporation. These concepts align with key IPAS learning objectives at the elementary level. The study highlights how incorporating local wisdom into science education can foster scientific literacy, cultural identity, and contextual understanding among students. The research contributes to the development of culturally responsive teaching strategies and supports the Merdeka Belajar (Freedom to Learn) curriculum by linking classroom content to students' cultural environment. It is recommended that future studies expand to other regions and examine how ethnoscience-based resources impact student learning outcomes. This study includes 25 references, 7 observation photos, and qualitative analysis tables to support the findings.

INTRODUCTION

Learning in elementary schools requires innovative learning resources that can connect knowledge with students' daily lives (Juraidah & Hartoyo, 2022). One of the approaches that is being developed is the integration of local wisdom into the learning process so that students can more easily understand the material being taught (Umam & Husain, 2024).Local wisdom not only contains cultural values but also encompasses traditional knowledge that can be studied scientifically (Affandy, 2017).Batik Sidoarjo, as a local cultural heritage, has great potential as a contextual learning medium.The production process involves scientific concepts relevant to the Natural and Social Sciences (IPAS) subjects (Rosyadi et al., 2024).The integration of ethnoscience in batik opens up opportunities for the simultaneous strengthening of cultural literacy and scientific literacy (Yasir, 2024).Therefore, it is important to explore the potential of Sidoarjo batik as a locally enriched learning resource for elementary school students.

Integrating local wisdom such as batik into science education is theoretically supported by constructivist learning theories, particularly those of Vygotsky, which highlight the importance of cultural and social contexts in cognitive development. The ethnoscience approach aligns with this view by connecting scientific concepts with learners' lived experiences and community knowledge. Moreover, inquiry-based learning theory supports the idea that students develop deeper

understanding when they actively explore real-world phenomena, which in this case includes the traditional process of batik-making. Through these theories, the use of Sidoarjo batik is justified not only as a cultural preservation effort but also as a strategic pedagogical approach that enhances student engagement, scientific thinking, and cultural identity development in elementary education.

Previous studies have shown that the application of ethnoscience in learning can enhance students' conceptual understanding and learning motivation.A study by (Abi, 2017) revealed that the integration of local culture in science can bridge students' understanding of abstract material.Furthermore, (Nurjanah et al., 2025) found that culture-based learning media enhances students' interest in learning and a sense of ownership towards local wisdom.In various regions of Indonesia, there has been significant development of teaching materials that highlight local culture, such as traditional food, folk games, and arts.However, there are still few who specifically study batik as an object of ethnoscience, especially in the context of primary education.However, the batik-making process contains many scientific concepts that can be studied scientifically and are relevant in IPAS learning.This opens up great opportunities to be developed as a contextual and meaningful learning resource.

Some studies examine batik only from the artistic or aesthetic side, without linking it to the scientific potential contained in its production process.For example, the dyeing of batik cloth using certain chemicals can be studied in the context of learning about the properties of substances and changes of state.The process of heating wax in the malemi stage can be linked to heat transfer in science.The nglorod stage, which involves boiling the cloth, represents the concept of phase change from solid to liquid.In addition, the activity of drawing local flora and fauna motifs in batik can also be integrated with learning about biodiversity.Therefore, the development of learning resources from batik requires studies that are not only aesthetic but also scientific.This is what constitutes an important research gap in this study.

Batik Sidoarjo as a research object has uniqueness because it contains distinctive motifs such as sugarcane flowers, wutah rice, and bandeng shrimp that reflect the environment and livelihoods of the local community (Afrianti & Camelia, 2022; Sawitri, 2018).These motifs can serve as a starting point for learning about ecosystems, natural resources, and the classification of living things.The experience of direct observation at the Sidoarjo batik center also shows that each stage in the batik-making process contains scientific processes that can be explored in the context of learning.This makes batik more than just a cultural product; it is also an authentic and contextual source of knowledge.Teachers can invite students to observe, ask questions, and analyze scientific phenomena from the batik-making process.Thus, the learning activities are no longer purely abstract and theoretical, but are directly connected to local social and cultural life.This potential will be systematically explored in this research.

This research aims to explore the ethnoscience values found in the batik-making process of Sidoarjo and analyze its relevance as a learning resource for IPAS for elementary school students.Using a qualitative approach, the researcher will delve into each stage of the batik-making process and relate it to scientific concepts in the curriculum.This research also aims to produce an integrative description that can be used by teachers in developing teaching materials based on local wisdom.This exploration is expected to make an important contribution to the development of contextual learning in Indonesia.In addition, this research aims to address the need for teaching materials that not only bring students closer to their surroundings but also strengthen cultural identity.The main focus of this study is to make Sidoarjo batik an educational medium, not just a cultural heritage.Through this research, local values can be packaged in a scientific and enjoyable learning format.

The novelty of this research lies in its approach that combines two dimensions: science and culture, through the exploration of ethnoscience in the batik-making process of Sidoarjo.Previous research has been limited to the development of culture-based learning media without delving deeply into its scientific aspects.This research attempts to explore and organize the systematic process of

batik-making into an authentic IPAS learning experience.Thus, students can learn scientific concepts through real practices rich in cultural values.This study also reinforces the Merdeka Belajar approach, which encourages environment-based learning and meets students' needs.In addition, the presence of local learning resources such as batik can simultaneously strengthen cultural and scientific literacy.This significantly contributes to the development of a more contextual and transformative curriculum.

Etnosains itself is a learning approach that integrates modern science with the practices and traditional knowledge of the community (Djarwo et al., 2025; Halimah et al., 2025).In the context of IPAS learning, ethnoscience allows students to understand scientific concepts more easily because it is linked to real experiences within their culture.The process of making batik is one of the traditional practices rich in ethnoscience content.Starting from the wax heating stage, dyeing, to the drying of the fabric, all contain scientific processes that can be simply explained to students.The ethnoscience approach also trains students' critical, collaborative, and creative thinking skills from an early age.Therefore, exploring the ethnoscience values in batik is very important to make it an effective learning resource.With a good understanding, teachers can package the batik-making process into an enjoyable and meaningful IPAS learning experience.

Considering the various descriptions above, the research question in this study is: What are the ethnoscience values found in the process of making Sidoarjo batik? What is the relevance of these values to IPAS learning in elementary schools? This research also aims to formulate strategies for utilizing batik as a learning resource that aligns with the curriculum and student characteristics. Specifically, this research is expected to serve as a reference for teachers in developing culture-based learning. Additionally, this research contributes to cultural preservation efforts through a scientific approach in primary education.This research also contains elements of novelty in terms of the systematic integration of local wisdom with the curriculum content.Therefore, the results of this research are expected to enrich the repository of learning resources in elementary schools.

METHODS

This research uses a descriptive qualitative approach with ethnographic study methods to explore ethnoscience values in the batik-making process of Sidoarjo.This approach was chosen because it is suitable for studying cultural phenomena in a local context in a deep and natural manner.The subject of this research is the process of hand-drawn batik making carried out by artisans at the Al-Huda Batik Gallery, located in the Sidokare Asri Housing Complex, Sepande, Candi District, Sidoarjo Regency. The participants in this study were selected using purposive sampling, focusing on individuals with in-depth experience and knowledge in traditional batik production. Three senior artisans were chosen as key informants due to their active involvement in every stage of the batik-making process and their willingness to explain the cultural and scientific meanings behind each step. As for the research instruments, aside from the researcher acting as a human instrument, observation checklists and semi-structured interview guides were developed based on ethnoscience indicators relevant to IPAS learning content, such as material properties, heat processes, and biodiversity. The data collection procedure followed three main phases: initial rapport-building and environment familiarization, structured observation and interviews during the production stages, and final verification through member checking. Each step was documented in detail to ensure contextual richness and depth of analysis.

Data were collected through participatory observation techniques, in-depth interviews with artisans, as well as documentation in the form of photos and field notes conducted on February 14 and 20, 2025.The main instrument in this study is the researcher themselves, acting as an active observer, equipped with observation guides and interview guidelines based on ethnoscience indicators in IPAS learning. The data obtained were then analyzed using data reduction techniques, data presentation, and conclusion drawing through the Miles and Huberman approach, to find the scientific meaning of each batik-making stage relevant in the educational context. Data validity is maintained

through triangulation of techniques and sources, as well as member checking with subjects to ensure the accuracy of findings and data interpretation.

RESULTS AND DISCUSSION

Result

The initial process in making Sidoarjo batik is the stage of drawing patterns, commonly referred to as molani.At this stage, artisans draw characteristic motifs such as shrimp, milkfish, and wutah rice leaves on plain white fabric.The chosen motifs generally reflect the local identity and the livelihoods of the coastal communities in Sidoarjo.The motif is drawn with a pencil or cold wax to form the initial pattern before being colored.This activity is depicted in the image showing a sheet of cloth spread out on a large work table, with wooden clamps at each corner of the cloth.The molani process requires high precision so that the drawn motifs have detailed and proportional features.This activity contains concepts of symmetry, shape, and order that are relevant in the learning of IPAS and basic mathematics.

Figure 1.

The next stage is the malemi process, which involves applying liquid wax to the drawn motifs to hold the dye in specific areas.In the picture, the artisan can be seen using a canting to flow wax onto the fabric with steady and controlled hand movements.The wax used is first heated until it melts and then poured into the canting.The concept of heat transfer through conduction and the change of state from solid to liquid can be related to this stage in science learning.The dark brown color serves as a boundary between patterns before the dye is applied.This process also emphasizes the importance of perseverance, fine motor coordination, and high attention focus.This activity is very suitable if utilized in thematic learning in elementary schools, especially in the themes of art and science.

Figure 2.

After the malemi process is complete, the fabric then enters the dyeing stage called nyolet.The dye used in this process is remasol, a synthetic colorant that is reactive to the fabric fibers.The dye is applied directly using a brush or a similar tool so that the color can penetrate the fabric's pores.From the visual documentation, brightly colored fabrics with a dominance of red, blue, and yellow are seen as a result of this dyeing stage.This dyeing explains the concept of liquid diffusion into the fabric's pores and the properties of chemical solutions that can be introduced to students.The motifs that have been bounded by wax remain clean from the dye because of their function as resist.This nyolet stage provides an opportunity to explain scientific concepts and also reinforce aesthetics to students through direct observation of color changes.

Figure 3.

The next stage is nemboki, which is the process of coating the already dyed parts with wax so that the colors do not mix when additional dyeing is done.In the picture, this process is not directly visible, but the results of this stage can be observed on the fabric that has more than one color with neat boundaries.This process demonstrates the principle of coating in science and the importance of protecting the material to prevent color contamination.After all the dyeing is complete and the important parts are covered with wax, the fabric then goes through the nglorod stage.The nglorod process is marked by boiling the cloth in hot water to remove the attached wax.This stage involves a scientific process of changing the state of wax from solid to liquid and dissolving it in hot water, which can be explained in the study of physical changes of matter.

Figure 4.

After being boiled, the cloth that has been cleaned overnight is washed again to make the resulting color sharper and to completely remove any wax residue.In this process, water is used to remove chemical residues from dyeing and boiling.This stage is visible in the photo with the final result of the red-colored fabric that has been dried and is ready for sale.This washing process can be linked to the principle of dissolution and the separation of substances in IPAS learning.The washing process is also an important moment in seeing the final result of the entire series of batik-making

stages.The colors that emerge are a combination of the dyeing technique and the quality of the night protective layer in the previous stage.Observing the transformation from plain fabric to ready-to-use batik fabric becomes an authentic and concrete learning experience.

Figure 5.

The final stage in the batik process is drying or "ngangin-anginke."The washed cloth is dried under the sun until it is completely dry.In the documentation, batik cloth is seen hanging between two bamboo poles with the batik production house in the background.This drying process contains scientific principles regarding the evaporation of water due to the heat from sunlight.In IPAS learning, this process is relevant to the material on the water cycle, solar energy, and the changes in the state of matter.Drying also provides an opportunity to explain the importance of renewable energy and its utilization in daily life.This activity demonstrates how natural energy is used in environmentally friendly household industries.

Figure 6.

Batik Sidoarjo has distinctive motifs such as bandeng shrimp, wutah rice, and sugarcane flowers that represent the local geographical and cultural character.These motifs not only reflect the region's characteristics but are also relevant to the study of ecosystems and the classification of living things in elementary school.In the last image, a sheet of batik with diverse flora and fauna motifs is visible, showcasing local richness that can be used as a learning resource.This motif can also serve as a starting point for discussions about human dependence on nature and conservation.With this exploration of ethnoscience, students not only learn science but also get to know their own cultural identity.The integration of art, culture, and science provides a holistic, meaningful, and contextual learning experience.

Figure 7.

Discussion

The research results show that the process of making Sidoarjo batik has ethnoscience values that are highly relevant to be integrated into IPAS learning in elementary schools.Each stage, such as molani, malemi, nyolet, and nglorod, reflects scientific concepts that can be directly observed.These findings are in line with research by (Agil et al., 2023; Halimah et al., 2025; Mukti et al., 2022) which states that the integration of local culture in science education can enhance students' conceptual understanding.Through the ethnoscience approach, students can understand concepts such as heat transfer, changes in the state of matter, properties of liquids, and the water cycle in a contextual manner.The cultural context familiar to students' lives makes learning more meaningful and applicable.The scientific knowledge being taught is no longer abstract because it is linked to real activities in society.Therefore, the batik-making process can serve as an effective medium in place-based learning.

Although integrating ethnoscience into IPAS education shows significant promise, several implementation challenges persist. One critical issue is the lack of teacher readiness and confidence in transforming traditional practices into structured scientific learning. Many elementary educators are unfamiliar with linking local knowledge to formal curriculum standards. Furthermore, disparities in resource availability across regions can hinder equitable access to local wisdom-based content. The rigid structure of conventional assessment and time-bound syllabi also restrict the flexibility needed for contextual integration. Addressing these barriers requires targeted professional development programs, locally adaptable teaching materials, and stronger policy support for culture-based curriculum initiatives.

This study also reinforces the findings of previous research (Fathoni, 2024; Nurlina et al., 2024) which found that the use of media based on local culture can enhance students' interest and active participation in the learning process.This is evident in field observation practices when the process of dyeing and depicting batik motifs fosters curiosity and a spirit of exploration towards natural elements.Batik motifs such as shrimp, milkfish, and sugarcane flowers not only introduce local biodiversity but can also be linked to ecosystem learning and the classification of living organisms.The study of the batik-making process provides students with the opportunity to develop scientific skills through activities such as observing, classifying, and concluding.Thus, batik is not only aesthetically valuable but also serves as a means of learning based on scientific process skills.Etnoscience-based learning also encourages the strengthening of character values such as hard work, diligence, and love

for local culture.This is very much in line with the Pancasila Student Profile, which is the main orientation of education in Indonesia today.

Furthermore, this research fills the gap left by previous studies that tend to emphasize batik only as a cultural heritage or a creative economy product.Field findings indicate that every batik-making activity contains scientific learning potential that has not yet been widely utilized in conventional teaching materials.As stated by Harjanto & Fauzi (2020), there is a great opportunity to develop contextual teaching materials that scientifically explore local culture (Andini & Sirozi, 2024).The use of batik as a learning resource also has the potential to develop students' scientific literacy, which is the ability to understand and apply science in real life.Batik as a contextual medium is very suitable for the transdisciplinary approach in the Merdeka Curriculum, which emphasizes the holistic integration of knowledge.Therefore, teachers can design thematic learning that combines IPAS, cultural arts, and PPKn with a basis of local activities such as batik-making.This research provides an initial framework for the development of culturally-based teaching materials that are holistic and sustainable.

The direct involvement of students in the batik-making process, such as during the dyeing and drying stages, provides opportunities for experiential learning.This result supports the findings of (Al-Aluf, 2024) which emphasize the importance of authentic experiences in enhancing retention and conceptual understanding.By directly observing the process of the transformation of matter or the reaction of dyes with fabric, students not only understand scientific concepts but also internalize the cultural values embedded in the activity.This direct experience also enhances students' observation, analysis, and critical reflection skills.Such learning is very important in shaping students who are able to think scientifically and appreciate local culture.The learning process is no longer one-way, but becomes collaborative and participatory.Therefore, the ethnoscience approach can be an effective alternative pedagogical strategy in the era of character and context-oriented curriculum.

Research by (Andriani & Widodo, 2018) on the effectiveness of ethnoscience-based worksheets in simple machines material shows that media based on local culture not only significantly improves students' conceptual understanding but also their scientific process skills.In the study, the average N-Gain reached 0.75 with a high category.This shows that the integration of ethnoscience can train students' abilities in observing, formulating problems, formulating hypotheses, and communicating results scientifically.This application is in line with the batik-making process in Sidoarjo, which has clear stages and is rich in scientific concepts, such as heat transfer when heating wax or the diffusion process of dyes.Like LKS, batik practice can be used as a means to train students' scientific process skills.Thus, the use of local activities such as batik-making can be developed into contextual LKS media that not only fosters a love for culture but also enhances students' scientific thinking skills.

Meanwhile, the research results by (Nihwan & Widodo, 2020) on the application of ethnoscience-based science modules in the material of soil and the sustainability of life show that students' science literacy increased with an N-Gain of 0.66 for the experimental class and 0.50 for the control class.These results indicate that the ethnoscience-based module has a significant impact on improving students' science literacy.These findings support a similar approach applied in the exploration of the batik-making process as contextual teaching materials.Batik motifs such as shrimp and milkfish, which originate from the coastal community's way of life, can be used to discuss topics like ecosystems, natural resources, and the sustainability of life.Just like the soil module in the research, batik can serve as a medium to encourage students to think critically, formulate hypotheses, and draw conclusions based on local phenomena.Therefore, culturally-based learning approaches such as ethnoscience not only enhance material absorption but also strengthen the understanding of scientific concepts through students' socio-cultural experiences.

The results of the service conducted by (Nafisah et al., 2024) show that training in the creation of LKPD based on local wisdom can enhance teachers' skills in developing environmentally caring character education.As many as 74% of the training participants stated that their understanding of the integration of local wisdom in education had increased.This aligns with the exploration of Sidoarjo batik as a learning resource, where the batik-making process not only contains cultural values but also

ecological values that can foster a character of environmental care.The dyeing process, the use of natural materials, and the utilization of solar energy in batik drying demonstrate sustainable practices that can be taught to students through the IPAS approach.Such learning provides a dual impact: strengthening science literacy and fostering an environmental love character.Thus, as suggested by the research, the active involvement of teachers in the development of local teaching materials greatly supports the effectiveness of cultural integration in science education.

Furthermore, (Hakimah & Gunansyah, 2024) in their literature review emphasize that IPAS learning media based on local culture, whether in visual or interactive digital form, has proven effective in increasing students' interest in learning and understanding of cultural diversity.This research supports the idea that the utilization of cultural elements in learning can enrich the understanding of the material and instill a sense of pride in local identity from an early age.In the context of Sidoarjo batik, distinctive motifs such as shrimp and milkfish can be integrated as part of visual media to delve into concepts of ecosystems, classification of living things, and conservation of natural resources.Not only that, batik can also be developed into digital media, such as interactive modules or e-LKPD that include simulations of the batik-making process.Concrete visual support and media interactivity will greatly assist students in understanding the connection between culture and science in a more contextual and enjoyable manner.Therefore, the synergy between ethnoscience and learning technology becomes a potential approach in contemporary IPAS education.

Overall, this research provides theoretical and practical contributions to the development of learning resources based on local wisdom.Its theoretical contribution lies in strengthening the concept of ethnoscience as an integrative approach between science and culture in primary education.Meanwhile, its practical contribution can be seen in how the process of making Sidoarjo batik is systematically utilized as a contextual learning resource for IPAS.This simultaneously emphasizes the importance of teachers being more creative in exploring local potential as teaching materials.This research also serves as a response to the challenges of globalization that tend to erode local cultural values.By presenting batik as a learning medium, students not only learn science but also cultivate a sense of pride and care for their culture.The implications of this research are important to serve as a foundation in the development of curricula and teacher training to be more adaptive to the local context.Therefore, the exploration of ethnoscience in Sidoarjo batik should be developed more widely in various regions of Indonesia, each with its own cultural characteristics.

CONCLUSION

This research concludes that the process of making Sidoarjo batik contains ethnoscience values that are highly relevant to be integrated into the IPAS learning in elementary schools.Each stage in the batik-making process, such as molani, malemi, nyolet, nemboki, and nglorod, presents concrete learning experiences that align with scientific concepts in the curriculum.Through this approach, students can understand science contextually, increase their interest in learning, and strengthen local cultural identity.This research has encouraged the expansion of perspectives in utilizing local resources as a comprehensive learning medium, as well as enriching the literature on ethnoscience in primary education.However, the limitation of this research lies in its scope, which focuses only on one location and group of artisans, thus not representing the diversity of batik techniques in other regions.Therefore, the generalization of the results must be done carefully and contextually.The results of this study provide a foundation for the development of more inclusive and culturally-based teaching materials to support the implementation of the Merdeka Curriculum.

Further research is recommended to expand the study to other batik centers in East Java and Indonesia in general to obtain a more comprehensive picture of the variations in ethnoscience values contained in local batik techniques.In addition, testing the development of teaching modules based on these exploration results is highly recommended to assess their effectiveness in real classroom learning.The involvement of teachers and students in the process of developing batik-based learning media also needs to be further researched to ensure its effectiveness.It is also recommended to

develop teacher guides that support the integration of cultural and scientific aspects, thereby facilitating their application in thematic learning.Local governments and education departments are expected to provide support for the development of these local learning resources through policies and teacher training.Multidisciplinary research that combines anthropology, education, and science will also provide a more comprehensive perspective.Thus, the utilization of batik not only as a cultural heritage but also as a context-based educational tool can continue to develop.

The findings of this study contribute theoretically to the growing body of ethnoscience by demonstrating how traditional practices such as batik-making can serve as valid sources of scientific inquiry in elementary education. This reinforces the premise that scientific knowledge is not exclusively modern or Western, but can be rooted in indigenous practices. The research operationalizes the abstract principles of ethnoscience into practical classroom applications, offering a framework for integrating culture and science within a constructivist pedagogy. Such contributions support the development of curriculum models that recognize and elevate local knowledge as a legitimate foundation for scientific learning.

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