

## Research Article

# The Reconstruction of Indigenous Science into Scientific Knowledge in the Natural Color Process from Lurik Klaten

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Teaching science in schools rarely includes local wisdom. Local wisdom-based learning is more suitable for the regional characteristics and students' daily life experiences and also supports sustainability and cultural diversity. The reconstruction of indigenous science into scientific knowledge will show the part of local wisdom that is suitable for science learning. This research aimed to reconstruct indigenous science into scientific knowledge from the process of natural color that was conducted in the community of Lurik Klaten in Pedan and Cawas Subdistrict, Klaten Regency, Central Java, Indonesia. The outcome of this research was scientific knowledge from the result of indigenous science reconstruction that was based on society's culture about the process of natural color. The expected benefit of this research was to be the contextual educational resource for teachers of science in the school. The method of this research was qualitative descriptive through visceral interviews, direct observation and document study about the traditional process of natural color. The research focused on natural color production, especially on knowledge of traditional lurik craftsman related to the raw materials of natural color and also the process of coloring lurik. The obtained data were analyzed, verified, and constructed into scientific knowledge and were interpreted to get meaningful information. The conclusion was that there was five indigenous science from natural color production which could be reconstructed into scientific knowledge and also appropriate with several competences in science education.

**Keywords:** Indigenous Science, Natural Color Process, Lurik Klaten

## 1. INTRODUCTION

Science learning which applied in Indonesia is Western Modern Science (WMS) [1]. Western scientific knowledge is better known as scientific knowledge which is in the form of reproducible concepts, principles, theories, or laws (tested experimentally in the laboratory and has been recognized by the scientific community) in contrast to original science or public science which is still in the form of concrete experience knowledge (concrete experience knowledge) [2]. Even though Regulation of the Minister of Education and Culture Number 58 of 2014, in the Curriculum 2013 it is emphasized that

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learning based on local wisdom so that it is in accordance with regional characteristics and daily life experiences and supports the preservation of cultural diversity or called ethnoscience.

Ethnoscience or indigenous science as a set of knowledge possessed by a society/ethnic group which is obtained by using certain methods and following certain procedures that are part of the traditions of certain communities, and the 'truth' can be tested empirically [2]. Indigenous science is related to concrete daily activities that occur in society which are closed, unsystematic, holistic rather than analytical, progressing based on experience and not based on deductive logic [3]. Indigenous science can be used as a source of learning based on local wisdom, but it is necessary to analyze or transform the indigenous science into scientific knowledge through the reconstruction process which include identification, verification, formulation, conceptualization of scientific knowledge through the process of accommodation, assimilation, and interpretation. The reconstruction will give positive impact to student which improve the strengthens student's view of the universe and the result is inculturation (strengthening existing cultural values) about matters related to daily life [2].

The difference potential between communities will produce different local wisdom, so learning resources are obtained in order to preserve the potential of each region [4]. The range of indigenous science knowledge includes chemistry, biology, physics, agriculture, ecology, and medical [5]. For medical and medicines, society indigenous science knowledge can be seen in the use of traditional medicine compress ball [6]. Meanwhile, in the field of education, science learning based on local wisdom which include indigenous science has not been widely applied. Indonesia has rich in local wisdom but has not been widely used as a source of learning optimally. One of the local wisdoms that exist in the Klaten area is the tenun lurik which is also one of Klaten's superior products. Lurik woven fabric is one of the superior products of Klaten Regency. There are 2 types of lurik which are traditional and modern. Traditional lurik only consists of 2 colors are black and white which depict rocks and plants. At this time it can be profane and can also be magical. Woven fabrics are profane, meaning that they are used for daily clothing, this is in accordance with the life of modern society which tends to be profane without symbolic meanings, but only to fulfill market tastes as commodity materials. Meanwhile, the function of lurik related to magical and spiritual values is often used during certain ceremonies and with certain motifs. The form and function of lurik does not only stop at the aspect of tradition but also adapts to the current situation [7]. The process of making lurik consists of the process of dyeing the yarns, processing, pulverizing, nyekir, embedding and weaving [8]. The craftsman of Lurik Klaten consists

of several stages, one of which is the coloring stage using natural and synthetic dyes. Natural dyes can use the leaves, bark, roots, seeds and others derived from extracts of tingi, tege, secang, gambier and indigo with the mordanting process (fixation stage) which also uses natural ingredients such as tunjung and alum [9, 10].

Based on the description above, it is necessary to reconstruct indigenous science and analyze to scientific knowledge based on local wisdom about the use of natural coloring process of Lurik Klaten. This analysis is not only to raise local wisdom from superior products of an area as national identity, but also to be used as a science learning resource.

## 2. RESEARCH method

This research was conducted in Titang, Tlingsing Village, Cawas subdistrict and Jalinan, Kedungan Village, Pedan Subdistrict, Klaten Regency by including three Lurik Klaten maker. This location was chosen because three of subject research which are Mrs. Ratmi, Mrs. Nurul and Mr. Hasta Yoga are the only craftsmans who still maintains the natural coloring process of Lurik Klaten. This research used the qualitative research approach through phenomology ethnoscience which a study of organized knowledge of community culture and events or phenomena related to local wisdom based on [1, 11]. In this research, the researcher became the main instrument of the research, from the beginning of the data collection include the indigenous knowledge on the natural coloring process of Lurik Klaten until the reconstruction and analysis into scientific knowledge. The subject of the research subjects are taken based from which the phenomenology research the range is between three to ten research subject [12].

There are 3 steps in this research: a) Preparation : In this step, researcher seek and collect information through literature studies from various articles related to the object of original knowledge, namely the natural coloring of Lurik Klaten. Furthermore, the researchers arranged a field study instrument in the form of an interview sheet. The validation of the interview instrument sheet was carried out by the expert; b) The implementation, the step where researcher observe and in-depth interviews Lurik Klaten craftsmen; c) The final step (reconstruction and analysis): In this step the researcher analyzes the data from the exploration results based on the results of observations and in-depth interviews [13]. The results of exploratory data analysis in the form of indigenous knowledge from the coloring of Lurik Klaten then reconstructed into science knowledge through analysis of scientific articles and literature studies. After the researchers analyzed the data from the exploration results, the researchers drew conclusions from the

results of the analysis. The procedure for analyzing original scientific knowledge into scientific knowledge so that it can be used as a learning resource is as follows: a) Data collection, it has been carried out at the implementation step; b) Verification, at the verification step, an examination of the correctness of the data that has been obtained with relevant previous research is carried out. Verification was carried out on data obtained from lurik craftsmen regarding the process of natural coloring and managing coloring waste against relevant previous journals; c) Reconstruction, the original scientific data that has been verified and then reconstructed (transformation occurs) into scientific knowledge through literature study. Data obtained from interviews with striated fabric coloring are transformed with scientific knowledge or modern science with the help of existing literature; d) Formulation and Conceptualization, Scientific knowledge that has been reconstructed is formulated and used as a scientific concept to be formalized so that it can be used as an alternative source of learning based on local wisdom. The reconstructed scientific knowledge comes from striated craftsmen regarding striated coloring and waste management [1, 11].

Primer data collection technic was through observation, visceral interview, discussion, and direct observation on the field. While, secondary data were achieved by relevant previous journals of Lurik Klaten production. To ensure the criteria of confidence in the data obtained, the researchers made several efforts among others, a) conduct research in the field with intensive observations, b) triangulate the data and methods, c) provide adequacy of reference, and d) conduct a study case negative [14]. Data analysis process was conducted continuously and intensively investigated, categorized and then constructed into scientific knowledge. After analyzing the data, the study continued to reconstruct the original findings in the form of science in order to develop local culture-based science education in schools.

### 3. result and discussion

From the observation result and in depth interview towards Lurik Klaten maker, it was obtained an information that the people's knowledge in daily life is a knowledge that came from their own experience and had not been influenced western knowledge or science. Responders knowledge about the way and system of natural coloring from Lurik Klaten production is a hereditary knowledge from their ancestors.

The result of society original science exploration about natural color in Lurik Klaten production that has been reconstructed into scientific knowledge can be seen on Table 1.



**Figure 1:** (a) The yarn before natural coloring, (b) The yarn after natural coloring which aerated under the shade.

From Table 1, it can be seen that natural coloring indigenous science could be reconstructed into scientific knowledge. It was found there were 5 indigenous science that could be explained by scientific knowledge which were divided into several science concepts. If this indigenous science will be integrated for example on junior high school's science learning, this natural coloring in Lurik Klaten production culture will at least can be related to 4 Standard Competence at class 7 junior high school that are relevant as it is written on Table 2.

The analysis result of indigenous science that had been found on natural coloring of Lurik Klaten production in Cawas and Pedan Subdistrict it was found that their society indigenous science has still been preserved and it is believed the existence is appropriate if it will be integrated into science learning. This statement is an indicator that indigenous science still being preserve by people then it will be a learning source if it is discovered and have the relation to scientific knowledge. The indigenous science have seen and experienced the truth by themselves according to life experience (scientific experiment) for years. This indigenous science knowledge was transform one generation to the next generation through trial and error process. This indigenous science knowledge was transformed through oral tradition from their parents for the next generation and concrete experience in their environment interacting. During the process of time, it is possible that the new culture come according to the development of technology and science, but the way of thinking (belief) that is a heritage from the previous generation is still preserved [1].

Natural and social environment are learning source that are exist around the students and can be used by teachers in arranging learning according to learning material given. The reconstruction will give positive impact to student which improve the strengthens student's view of the universe and the result is inculturation (strengthening

TABLE 1: Indigenous science and scientific knowledge about natural coloring of Lurik Klaten.

Research Question Contains of Scientific Concepts	Indigenous Science	Scientific Knowledge
<p>What are the main materials (type of yarn) and supporting materials (type of color) used in coloring Lurik Klaten's yarn?</p>	<p>The type of yarn used here is cotton yarn which is derived from cotton. For natural color using various types such as mongkrong leaves, mahogany bark, mango leaves, guava leaves, kersen leaves, teak leaves, indigo paste, jolawe fruit peel, secang bark, tegeran bark.</p>	<p>Yarn and the color both have the same taxonomy at the level of kingdom Plantae, Division: Spermatophyta, Subdivision Angiospermae and Class Dicotyledoneae. The difference at the next taxonomic level which are: Yarn (derived from cotton) Order: Malvales Family: Bombacaceae Genus: Ceiba</p>
		<p>Species: <i>Ceiba petandra</i> The color from mongkrong leaves Ordo : Solanales Famili : Convolvaceae Genus : Ipomoea Spesies : <i>Ipomoea carnea</i> The color from mongkrong leaves mahogany bark Ordo : Sapindales Famili : Meliaceae Genus : Swietenia Spesie : <i>Swietenia mahagoni</i> The color from mango leaves Ordo : Sapindales Famili : Anacardiaceae Genus : Mangifera Spesies : <i>Mangifera indica</i> The color from guava leaves Ordo : Myrtales Famili : Myrtaceae Genus : Psidium Spesies : <i>Psidium guajawa</i> The color from kersen leaves Ordo : Malvales Famili : Muntingiaceae Genus : Muntingia Spesies : <i>Muntingia calabura</i> The color from teak leaves Ordo : Lamiales Famili : Lamiaceae Genus : Tectona Spesies : <i>Tectona grandis</i> The color from indigo paste Ordo : Fabales Famili : Fabaceae Genus : Indogofera Spesies : <i>Indigofera tinctoria</i> The color from jolawe fruit peel Ordo : Mrytales Famili : Combretaceae Genus : Terminalia Spesies : <i>Terminalia bellirica</i> The color from secang bark Ordo : Fabales Famili : Fabaceae Genus : Caesalpinia Spesies : <i>Caesalpinia sappan</i> The color from tegeran bark Ordo : Fabales Famili : Fabaceae Genus : Peltophorum Spesies : <i>Peltophorum pterocarpum</i> Science concepts: Taksonomy and types of plants</p>
<p>How is the process of making the colorliquid?</p>	<p>In comparison, for coloring 1 kg of coloring materials we use 5-6 liters of water (color liquid). The color is mixed with water, then boiled until the water is reduced, for example, before the water was 10 liters, only half of the water was left.</p>	<p>How to get natural dyes or known as the isolation of natural pigments/color from plants can be done by extracting plant parts using a solvent that is in accordance with the polarity of the substance to be extracted [15]. And the craftsmen use the aqueous method of extraction which uses water as the solvent. Sources of natural dyes can be in the form of powder or small pieces that are dried and then boiled at a certain temperature for a certain time. This method is the most economical and easy method in extracting colors from natural dye sources [16]. Science concept: the concept of mixtures, heat convection events and changes in substances</p>

existing cultural values) about matters related to daily life [2]. Combination of learning science and local wisdom, in addition to exploring and participating in preserving local potential, students will also be more interested, enthusiastic, challenged and respond

TABLE 1: Continued.

Research Question Contains of Scientific Concepts	Indigenous Science	Scientific Knowledge
What colors do these plants produce?	The green color of the mongkrong leaves Brown color from mahogany bark Red color from the bark of secang The yellow color from the mango leaves The golden yellow color from guava leaves and kersen leaves Red and purple colors from teak leaves The blue color from indigo paste Black color from the jolawe peel fruit Yellow color from tegeran bark	Indigofera plant leaves contain indikan glucoside which is hydrolyzed by mineral acid, converting indikan into indoxyl and glucose. Indoxyl can be oxidized to indigo and produces a blue color [17] Mahogany bark has a chemical content in the form of flavoidea which is a pigment that produces a yellow-brown color [18]. Secang bark contains anthocyanins which are derivatives of flavonoid secondary metabolite compounds that function as antioxidants. Anthocyanins are also pigments responsible for the colors red, purple, orange and blue [19]. Likewise, teak leaves contain anthocyanins that produce a red color Mango leaves, guava leaves, cherry leaves and have flavonoid pigment pigments that produce a yellow color. Tegeran bark produces a reddish brown color because it contains tannin. Science concept: types of pigments and their uses in life
Are there any other steps after dyeing yarn with natural coloring process?	Color binding with alum, vinegar, lime and tunjung.	Fixation using a variety of fixation Science concept: the concept of mixtures
Why use a different color binder?	After tied with alum, vinegar, lime and tunjung, the resulting color results on the yarn have a difference	In the fixation process using a liquid that will strengthen the color and change the natural dye according to the type of metal that binds it. alum ( $KAl(SO_4)_2$ ), lime ( $Ca(OH)_2$ ), and tunjung ( $FeSO_4$ ). Science concept: the concept of mixtures
What are the wastes produced in natural coloring of Lurik Klaten yarn?	Water used for staining and the dregs	There are two types of waste which is liquid waste and solid waste Science concept: management of waste
How to manage these two types of waste?	The water used for staining is just thrown everywhere you can and some of the dregs are thrown away, some are dried again for firewood	Liquid or solid waste is not harmful to the environment, even leaf dregs can be used for fertilizer Science concept: management of waste

to each lesson better, so that students more easily understand the subject matter [20]. From natural learning source it will be easier for students to relate the material they are learning to their daily life [1].

#### 4. CONCLUSION

Based on the result of research, it can be concluded that from process of natural coloring of Lurik Klatenin Cawas and Pedan subdistrict which is a heritage knowledge from ancestors, there are lots of indigenous science that can be reconstructed into scientific knowledge which can be the science learning source for students. Thus,

TABLE 2: The relation of natural coloring in Lurik Klaten production with junior high school standard competence at class 7.

Standard Competence	Science Concept of Natural Coloring in Lurik Klaten
3.2 Classify living things based on the observed characteristics	Taxonomy, introduction of plant parts and their use, types of plant pigments, utilization of plant pigments in daily life
3.3 Explain the concept of mixtures, substances and examples of their changes in daily life	The concept of mixtures, name of compound and element character's difference of element, compound and mixture
3.4 Analyzing the concept of temperature, heat expansion, heat transfer and its application in daily life, including the mechanism for maintaining a stable body temperature in humans.	The heat convection and change of substance
3.8 Analyzing the occurrence of environmental pollution and its impact on the ecosystem	Types of waste and management of waste

in the process of science learning, teachers are expected to pay attention to local culture spread in society and to relate between concepts, process and contexts so science understanding of student about natural phenomenon will be more meaningful and contextual. Recommended further research on the development of student activity sheet and science teaching materials based on local wisdom in an effort to make science learning resource for students.

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