The 10th 2024 ISETH
International Summit on Science Technology and Humanity
ISETH 2024
ISSN: 2615-1588 (online)

# Lurik Fabric Production in Klaten: Science Learning Resource in Elementary – Ethnoscience Perspective

Khoirun Nisa[1], Ika Candra Sayekti[1,*]

[1] Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

[*] Corresponding author: ics142@ums.ac.id.me

**Abstract**

*Purpose*: The purpose of this study is to analyze the ethnoscience elements in the Klaten Regency's lurik fabric production process and to identify how these ethnoscience aspects can be used as a science learning resource in elementary schools.
*Methodology*: This study used a qualitative approach with a phenomenological design and was conducted in Bendo and Beji villages in Pedan District, Klaten Regency. Data were collected through observation, open interviews, documentation, and a literature review related to Klaten's lurik fabric, using technique and source triangulation to ensure data validity. The data analysis included data collection, data reduction, data presentation, and conclusion drawing.
*Results*: The results showed that the lurik fabric production process consists of six main stages that can be integrated into elementary science learning. For grade 3, relevant topics include forms of energy, energy sources, and changes in the form of objects; for grade 4, plant organs, energy changes, and types of forces; for grade 5, heat transfer, simple machines, and magnetism; and for grade 6, the motion system. Beyond content integration, the lurik fabric ethnoscience can also develop students' process skills such as observing, planning and conducting investigations, processing and analyzing data, as well as evaluating and reflecting. Furthermore, it can cultivate scientific attitudes like curiosity, discovery and creativity, accuracy, resilience in facing failure, and collaboration.
*Applications/Originality/Value*: The application of this research is to provide an authentic, local-culture-based learning resource that enriches science education with contextual, meaningful experiences connected to students' cultural heritage.

## Introduction

Indonesia has an enormous cultural diversity spanning various regions from Sabang to Merauke. Each area has its own unique way of defining its culture or local wis-dom (Zulkhi, 2022). Local wisdom refers to a concept that emerges and evolves over time within a community through conventions, rules/norms, culture, language, be-liefs, and daily routines (Pingge, 2017). However, along with the progress of civili-zation, local wisdom is impacted by the strong currents of modernization. Rapid modernization, if not balanced with an understanding of local wisdom, can erode the younger generation's enthusiasm for cherishing local culture, leading them to forget their regional heritage (Nadlir, 2016).

Elementary school students represent a generation responsible for preserving and safeguarding cultural heritage (Adelia & Galura, 2024). However, in reality, today's elementary students are more drawn to modern trends, such as social media, often without considering whether these trends have positive or negative impacts, thus neglecting their own local wisdom. To preserve local wisdom from being overshad-owed by modernization, schools can integrate the concept of local wisdom into the learning process as a valuable resource. Culture-based learning facilitates students' understanding and appreciation of culture while also reinforcing their cultural iden-tity and local wisdom (Cahyani et al., 2023). Local wisdom can serve as a learning resource by integrating indigenous knowledge from local communities with Western scientific concepts, a method commonly known as the ethnoscience approach (Zidny et al., 2020).

Knowledge from local culture is the basis for the ethnoscience method, which aims to comprehend how that culture and contemporary natural sciences interact (Jihannita et al., 2024). Sudarmin (2015) asserts that the following constitute the essence of ethnoscience: 1) classification using local terms and regional language or categories; 2) development of regionally based norms and ethics; 3) description of indigenous knowledge systems within a specific local culture or community group (Widyaningrum & Prihastari, 2021). Constructivist ideas are the foundation of eth-noscience, which emphasizes the value of meaningful learning (Solihin et al., 2024). Because meaningful learning is tailored to each student 's individual needs, it allows for learning by doing., students can acquire deeper and more significant knowledge by relating the course material to their own experiences using ethnoscience (Suryanti et al., 2021). This supports the findings of Kantina et al., (2022), who claim that science learning which is integrating ethnoscience give positive impact to students especially those who are more involved in their learning process. A cultur-ally teaching strategy that complements the subject matter is introduced by the eth-noscience approach (Ardianti & Raida, 2022). This is consistent with the rationale of Natural and Social Sciences in the Merdeka Curriculum, where students are encour-aged to explore, investigate, and enhance their understanding of their surrounding environment (Kemendikbud, 2024) but in this study it is limited in science.

Science is a subject to provide students the skills they need responsibly manage the environment and its resources while also actively contributing to the preserva-tion (Kemendikbud, 2024). Science component aims to equip students with orga-nized knowledge, ideas, and concepts about the environment through processes such as inquiry and present the ideas about science concepts (Mukhbitah et al., 2019). Science learning inherently involves understanding science as a product, a process, and a scientific attitude (Muliadi et al., 2022); thus, science education should bridge theory and real-world conditions, enabling students not only to grasp scientific con-cepts but also to apply them in daily life and interact with their environment. There-fore, studies linking science education to the environment including local knowledge are essential.

The study of ethnoscience grows various parts of the world and provides deep in-sights into the relationship between local culture and traditional knowledge in natu-ral resource management. Research conducted by Yuenyong & Yuenyong (2012) in three regions of Thailand namely Khon Kaen, Nongbualumphu, and Kalasin showed people's explanations about culture, way of life and lifestyle of these communities that can be reconstructed into scientific concepts such as physics, chemistry, and biology. Adenkule (2017) also researched the effects of ethnoscience-based learning in Nigeria, South Africa with the results that rural students performed better than urban students, ethnoscience teaching encourages student's attitudes towards science so there is a need to explore the use of ethnoscience in teaching education. Research in ethnoscience can also be conducted in the production of local foods, as has been done in various studies (Tupas & Banas, 2021) in Ajuy, Philippines, and found nine science concepts in the unique cuisine of Ajuy obtained from cooking techniques, traditional utensils, flavors, health benefits, local resources, preservation, fermenta-tion, safety, and packaging. Indonesia has many local wisdoms, one of the which integrate ethnoscience is making process of Klaten Regency's lurik fabric.

Klaten lurik fabric is a prominent product of Klaten Regency, which established in 1938. The inception of Klaten lurik fabric is closely tied to the "Sumber Sandang" home weaving initiative by Suhardi Hadi Sumarto in Jalinan Hamlet, Kedungan Village, Pedan District (Ismadi et al., 2020). The production of lurik fabric is not a simple process, as it involves multiple stages, including likas (preparing the yarn), kelos (winding the yarn), wenter (dyeing the yarn), kanji (starching), palet (arrang-ing the pattern), sekir (aligning the yarn), nyucuk (threading the yarn onto the loom), and tenun (weaving) (Ramadhani & Sukmawan, 2022), these stages can be recon-structed into science learning, particularly within the science content. However, interviews with elementary school teachers in Pedan District revealed that current science instruction has yet to incorporate lurik fabric production. This is largely due to the limited ethnoscience studies on lurik fabric at the elementary level, resulting in science lessons that rely solely on textbooks provided by the Ministry of Educa-tion. Integrating local wisdom into science education has the potential to enhance students' skills, as evidenced by Anggraini & Kristi (2024), who found that imple-menting a PJBL model based on ethnoscience positively impacted the critical rea-soning abilities of fourth-Grade students at SD Negeri 1 Cibeureum.

An ethnoscience study on the lurik production process was conducted by (Sholihah et al., 2024) reconstructing one of the stages, specifically natural dyeing, into five science topics at the junior high school level. However, this study focused solely on natural dyeing and has not yet been integrated at the elementary school level. A similar study in Klaten Regency by Utami & Sayekti (2023) integrated the ethnoscience study of knife-making from grades one through six in elementary school. The research by Indah Pranata et al., (2024) applied the cultural reconstruc-tion of the Cap Go Meh festival originating from Singkawang, Central Kalimantan to sound properties material for fourth-Grade elementary students using audio-visual video media, enhancing students' comprehension as the material became more meaningful when combined with local culture. This approach also aligns with the developmental stage of elementary students, who are still in the concrete operational phase and benefit from tangible objects to make science learning more meaningful and relevant (Anggriani et al., 2024). These studies demonstrate that local wisdom has the ability to be included into scientific instruction in classrooms, underscoring the need for further efforts to explore and utilize cultural aspects as learning re-sources to enhance student understanding and engagement.

According to the explanation above, ethnoscience based learning can be used as a substitute educational tool to maintain local knowledge and promote more meaning-ful science education. Thus, an ethnoscience investigation into the creation of Klaten lurik fabrics as a teaching tool for science in elementary schools is of interest to the researcher. The study aims to analyze ethnoscience elements of the Klaten Regen-cy's lurik fabric production process and to identify how ethnoscience in lurik fabric production can be used as a science learning resource in elementary school.

## Method

This study used a qualitative approach with a phenomenological research design. According to Nasution (2023) phenomenology is a micro-subjective type of re-search, which aligns with this study as it interprets the personal experiences of arti-sans in producing Klaten lurik fabric, which is then reconstructed as a learning re-source for elementary science. The purpose of the study is to examine the ethnosci-ence elements of the Klaten Regency's lurik fabric production process and to deter-mine how ethnoscience in lurik fabric production relates to its use as an science learning source in elementary school. The study was conducted at two lurik produc-tion sites in Pedan District, Klaten Regency: Lurik Prasojo and Lurik Rachmad. The research object is the ethnoscience aspects of lurik fabric production in Klaten Re-gency. The selected subjects are lurik artisans in Pedan District who meet specific criteria: they are native residents of Pedan District, are lurik artisans, and possess knowledge about Klaten lurik fabric. Additionally, elementary school teachers in the vicinity of the lurik production sites were included as subjects to gain insight into the science learning approaches applied around the Klaten lurik production area.

Both primary and secondary data were used in this research. While primary data came directly form observations and interviews, secondary data came from docu-ments, images, and videos pertaining to the creation of Klaten lurik fabric as well as a literature review employing keywords associated with lurik fabric in Klaten Re-gency. The data collection techniques included observation, open interviews, docu-mentation, and literature review. The validity of the collected data was confirmed through source triangulation by cross-referencing responses among artisans and technique triangulation by verifying the data from interviews and observations with documentation and literature sources. Following validation, the data were examined using the Miles and Huberman methodology, which include reducing, presenting, and deriving conclusions from data (Nasution, 2023).

## Result and Discussions

Based on interviews with several lurik fabric artisans in Klaten Regency, it was found that knowledge about lurik fabric has been passed down from their ancestors, preserved across generations, forming the unique local wisdom of lurik in Klaten. Some artisans have practiced lurik weaving since elementary school and have con-tinued to do so up to the present. Moreover, some artisans have their own looms in their homes. As times have progressed, technology has advanced rapidly, influenc-ing the lurik production process in Klaten. “The earliest loom, called gedogan, re-quired the artisan to sit with the loom on their lap or supported on their back,” ex-plained Mr. AP. This evolved into a Non-Machine Loom, which still uses human power but allows the artisan to sit on a chair, using foot pedals and hand levers. Eventually, motorized looms were introduced, commonly referred to as Machine Looms. Observations and interviews revealed that the Klaten lurik production pro-cess comprises six main stages: 1) dyeing, 2) yarn spinning (kelos and palet), 3) yarn arrangement (nyekir), 4) threading the yarn into the reed (nyucuk), 5) weaving, and 6) inspection. The reconstructed ethnoscience aspects of the lurik production process as an elementary science learning resource are presented in Table 1 below.

**Table 1.** Ethnoscience Reconstruction in Klaten *Lurik* Fabric Production as a Science Learning Resource in Elementary School

| *Lurik* Fabric Production Process | Indigenous Science | Reconstruction Into Elementary School Science Learning |
|---|---|---|
| 1) Dyeing<br><br>**Fig 1.** Color Cooking Process<br><br>**Fig 2.** Scale Used for Weighing Dye<br><br>**Fig 3.** Yarn Drying | The dyeing process begins with weighing the dye, which is then heated over coals according to the yarn to be colored. There are two types of dyes used in this process: synthetic and natural dyes. The natural dyes used include mahogany tree, teak leaves, and yellow wood. The yarn is then placed in a container with the dye solution and manually mixed by hand. Once the yarn is thoroughly soaked and evenly mixed, it is wrung out and dried by being hung under sunlight. | • The natural dyeing process can be integrated to the topic of plant organ parts in Grade 4. Certain plant parts, such as leaves, seeds, rhizomes, and bark, can be simply processed to produce color (Nomleni et al., 2019).<br>• The process of synthetic dyes changing from solid to liquid when dissolved in water can be connected to the topic of changes in states of matter in Grade 4. A solid transforming into a liquid is referred to as melting (Wandini et al., 2022). Changes in states of matter are also observed in combustion, where wood turns to ash. This is an example of a chemical change, a process that produces a new substance (Sayekti & Desstya, 2017)<br>• During the dye cooking and yarn drying processes there is a transfer of heat. This can be connected to the topic of temperature and heat in Grade 5. Heat transfer involves the movement of energy (heat) due to temperature differences through three mechanisms: conduction, convection, and radiation (Maulani et al., 2023). Additionally, the materials used in cooking the dye, such as containers are related to the properties of heat conducting materials, which are insulators and conductors. A pot used in cooking is an example of a conductor because it can transfer heat.<br>• The yarn drying process can be linked to the topic of energy sources in Grade 3. One example of an energy source is heat energy, with the sun serving as a primary source of energy on Earth |

| *Lurik* Fabric Production Process | Indigenous Science | Reconstruction Into Elementary School Science Learning |
|---|---|---|
| | | (Amalia et al., 2021). Additionally, the topic of energy forms in Grade 3, can be connected to the dye-cooking process, where burning wood serves as an example of chemical energy.<br>• In the series of yarn dyeing processes, artisans must observe the color on the yarn to ensure an even application. This can be linked to process skills, where students are encouraged to observe phenomena or events in a simple way (Kemendikbud, 2024). Additionally, the weighing process can be related to process skills achievement, as students practice making observations using simple measuring tools. The multi-stage dyeing process and color changes can further stimulate students' curiosity. |
| 2) Yarn Spinning Process (*Kelos* and *Palet*)<br><br>**Fig 4.** Spinning Yarn<br><br>**Fig 1.** Yarn Spinning Using a Machine | Two types of yarn are used to create a single piece of *lurik* fabric: warp yarn (running lengthwise) and weft yarn (running widthwise). The process of spinning warp yarn is called *kelos*, while the process of spinning weft yarn is known as *palet*. The traditional methods of *palet* and *kelos* use human power, while more advanced or innovative equipment uses machines for spinning the yarn. | • The traditional yarn spinning tool can be linked to the topic of simple machines, specifically the wheel and axle. Yarn spinning using an automated machine can be associated with the topic of energy forms in Grade 3. Any moving object possesses energy, known as kinetic energy (A. Fitri et al., 2022). In addition to kinetic energy, another form of energy powers the yarn-spinning machine that is example of electrical energy. An energy transformation also occurs in this process, as electrical energy is converted into kinetic energy in modern spinning equipment.<br>• Traditional spinning is performed by artisans who manually rotate the spinning tool (*erek*), allowing free movement of their hands. This can be connected to the topic of the skeletal system, specifically joints, in Grade 6. Diarthrosis joints are joints that allow free movement, such as ball-and-socket, pivot, and hinge joints (Sayekti & Desstya, 2017). The force artisans use to operate the erek in the spinning process can be linked to the topic of types of forces, specifically muscular force, in, Grade 4.<br>• The spinning process is performed to separate the yarn, which has been dried in skein form, into smaller spools. This can be related to the nature of science as a process. In this process, artisans must observe the yarn being spun to prevent tangling. This act of observation can be connected to one of the process skills in sciences, specifically the skill of observing. |
| 3) *Nyekir* Process (Arranging Yarn)<br><br>**Fig 2.** Artisan Arranging Yarn on the Beam | The yarn that has been processed through the *palet* is then arranged on a large beam according to the desired pattern. This process requires a high level of visual precision, as any misalignment in arranging the yarn will prevent the intended pattern from forming. | • In the *nyekir* process, there is a stage where the artisan turns a lever to operate the tool. This action can be connected to the topic of simple machines, specifically the wheel and axle, in Grade 5. The force applied can also relate to the topic of types of forces, specifically muscular force, in Grade 4.<br>• The *nyekir* process requires a high level of precision, serving as an example of the scientific attitude of accuracy. In addition, the arrangement of line motifs can also be used as an example to develop creativity. |
| 4) *Nyucuk* Process | *Nyucuk* is the process where yarn, after being wound in the *kelos* stage, is threaded through the eye of the | • The process of *nyucuk* involves artisans exerting muscular force to thread yarn through the loom's components. This action exemplifies the concept |

| *Lurik* Fabric Production Process | Indigenous Science | Reconstruction Into Elementary School Science Learning |
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| <br>**Fig 3.** Artisan Threading Yarn into the Reed | heddle and directed into the reed before being placed on the loom. This process involves two people and requires cooperation. One person separates and pulls the yarn through the heddle eye, then hands it to their partner to thread it into the reed. | of force, specifically muscular force, as discussed in Grade 4. Force is defined as a push or pull acting upon an object (Amaya, 2023). Muscular force refers to the force generated by humans or animals through the contraction of muscles within their bodies (Amalia et al., 2021).<br>• The collaborative process in the *nyucuk* stage can serve as an example of the scientific attitude of collaboration. collaboration is essential to facilitate a process or activity. |
| 5) Weaving Process<br><br>**Fig 4.** Weaving with a Machine<br><br>**Fig 5.** Artisan Weaving with a Traditional Loom | The weaving process is the stage where threads are combined to form a complete piece of *lurik* fabric. Warp threads are interwoven with weft threads using a loom, and two types of looms are used by artisans. Those who preserve traditional methods use traditional loom, which operates manually with human power, while those who have adopted innovations use a machine loom that incorporates a dynamo and electrical power to operate the loom. | • The weaving process involves interlacing warp threads with weft threads, creating friction between the two types of threads. This can be related to the concept of frictional force in Grade 4. Frictional force is the force that occurs due to the contact between opposing moving objects (S. N. Fitri et al., 2024).<br>• Muscular force is observed in artisans operating the Non-Machine Loom through pulling and pushing movements on the loom. This stage can be connected to the topic of forces in, Grade 4. This aligns with the statement by Suci & Mahrudin (2022) that muscular force can be generated through pulling and pushing movements that utilize muscle strength.<br>• The Machine Loom (ATM) operates using a dynamo, which can be connected to examples of magnetic force in everyday life, covered in Grade 5.<br>• The loom involves several movements, one of which is the launching of the weft thread over the warp thread. The shuttle launch utilizes the principle of springs by storing energy and releasing it suddenly. This process can be connected to the topic of spring force in Grade 4. When a spring is stretched, it releases mechanical energy that can cause an object to move (Haidar et al., 2022).<br>• The loom mechanism includes a wheel and axle, which can be related to the topic of simple machines in Grade 5. Simple machines are devices that consist of one or more components, either moving or stationary, which utilize basic mechanical principles to help people complete tasks more easily (Andini & Kurniawati, 2023). |
| 6) Inspection Process<br><br>**Fig 6.** Artisan Checking the Quality of Finished *Lurik* Fabric<br><br>**Fig 7.** Artisan Inspecting Fabric Quality with the Aid of a Tool. | The woven fabric is then inspected to ensure quality. If there are any loose threads, the artisan trims them. The inspection process can be conducted traditionally by relying on sunlight for illumination, while modern inspection methods use machine-assisted tools for checking. | • Artisans who rely on sunlight and lamps for illumination during inspection can be linked to the topic of energy forms in Grade 3. The sun and lamp light are examples of light energy.<br>• Artisans use their physical strength to inspect the fabric. This activity can be connected to the topic of types of forces, specifically muscular force in Grade 4.<br>• In this process, artisans are assisted by light from a machine. This can be connected to the topic of energy transformation, specifically from electrical energy to light energy, in Grade 5. A lamp is an example of electrical energy being converted into light energy (Rusyani et al., 2021).<br>• In the machine-assisted tool, there is the concept of a simple machine, specifically the wheel and axle, which allows the fabric to move |

| *Lurik* Fabric Production Process | Indigenous Science | Reconstruction Into Elementary School Science Learning |
|---|---|---|
| | | independently. This process can be linked to the topic of simple machines, focusing on the wheel and axle, in Grade 5.<br>• Artisans observing for defects or loose threads in the *lurik* fabric can be associated with process skills, particularly in the observation stage.<br>• In the inspection stage, artisans must exhibit accuracy when thoroughly examining the finished *lurik* fabric. This attitude can serve as an example of a scientific attitude that students can emulate. |

One of Klaten Regency's local wisdoms, lurik fabric, has a lot of information that can be turned into scientific knowledge, so it can be used as a learning resource for science subjects at the elementary school level. Sciences at the elementary level is introduced to students starting from Grades 3,4,5, and 6. The curriculum encom-passes two elements in its learning objectives: the understanding element and the process skills element. Process skills are the methods used to gain understanding (Kemendikbud, 2024). Therefore, when students learn science, the two elements are presented in an integrated manner and not separated as stand-alone learning objec-tives. As seen in Table 1, the results of the reconstruction of Klaten lurik fabric pro-duction in sciences learning can be integrated into both of these learning objectives.

The ethnoscience study in Grade 3 includes a dyeing process that is integrated with the topic of energy, specifically different forms of energy in the surroundings. In the dye-cooking process, burning wood is an example of chemical energy, as the wood undergoes a transformation and producing new substances such as ash and smoke (Sayekti & Desstya, 2017). After the yarn is fully dyed and the color has spread evenly across all parts, it is dried by placing it under the heat of the sun. The sun is an example of heat energy, allowing humans to dry objects effectively (A. Fitri et al., 2022). Another form of energy is observed in the spinning process after the yarn has dried, involving both traditional and modern spinning tools. This pro-cess can be integrated into the study of energy, specifically kinetic energy. Accord-ing to (Hartmann & Priemer, 2019), state that energy is something that can be fun-damentally observed and directly measured, making it essential to provide examples from daily life, such as the yarn spinning process in Klaten lurik fabric production. In addition to kinetic energy, modern spinning tools also utilize another form of energy, electrical energy which is used to operate the equipment. In the inspection process of lurik fabric, artisans use sunlight and lamp light to help check for loose threads and fabric defects. Sunlight and lamp light are examples of light energy. The forms of energy found in the lurik fabric production process include chemical ener-gy, heat energy, kinetic energy, electrical energy, and light energy. The ethnoscience integration of lurik fabric production, specifically in the yarn drying stage, can be applied to the topic of energy sources. The sun, which produces heat energy to help in the drying process, is an example of a natural energy source on Earth. Additional-ly, the sun is considered a renewable energy source on Earth (A. Fitri et al., 2022). Well-managed energy sources can provide positive benefits for everyday life (Saifudin et al., 2020). Additionally, the wood-burning process used in dye prepara-tion can be connected to the topic of changes in states of matter, specifically in the subtopic of types of changes in matter. This process demonstrates the transformation of burning wood into ash and smoke, which is a clear example of a chemical change. A chemical change is a process that transforms matter into a new substance (Anwar et al., 2018).

The ethnoscience study in Grade 4, can be observed in the natural dyeing pro-cess, which can be integrated with plant-related topics, specifically plant organs. This aligns with the findings by Çìl (2016) who suggested that integrating various disciplines in studying plants is the best way to introduce plants to students. Stu-dents can explore the natural dyes used in lurik fabric production, as explained by Mr. AP: black is obtained from cashew, brown from mahogany wood, and yellow from turmeric. This statement aligns with the research by Salam (2014) that certain parts of plants contain color pigments. Furthermore, the wood-burning process used to prepare the dye can be connected to the topic of energy transformations. The chemical energy from burning wood produces new energy forms: heat energy and light energy (Sayekti & Desstya, 2017). Another example of energy transformation can be found in the spinning, weaving, and inspection processes, specifically in modern machines that use electrical energy converted into kinetic energy. However, in the inspection process, there is not only a transformation into kinetic energy but also light energy, which helps artisans detect defects or loose threads in Klaten lurik fabric. Further ethnoscience integration is seen in the yarn-spinning process using traditional spinning tools. Artisans use their hands to move the erek, which moves because a force is applied to it. This can be connected to the topic of force in every-day life. Force is defined as a push or a pull (Amaya, 2023). Another example for illustrating the definition of force can be taken from the nyucuk process, where the thread is pulled and moves from the eye of the heddle into the reed because a force is applied. In addition to the concept of force, various types of forces can be demon-strated through the processes involved in Klaten lurik fabric production, such as muscular force. Artisans use muscular force in activities like spinning, nyekir, and inspecting the fabric. Muscular force is energy derived from body muscles, which is flexible and controllable by humans, enabling movement (Suryanti et al., 2021). Besides muscular force, frictional and spring forces are also present in the weaving process. During weaving, the warp and weft threads intersect and come into contact to form the fabric. The interaction between the weft and warp threads aligns with the definition of frictional force, which is a force that occurs due to contact between two surfaces moving in opposite directions (Develi & Namdar, 2019).

The ethnoscience of Klaten lurik fabric production in Grade 5, is exemplified in the dyeing process, specifically in the color-cooking stage, which is related to heat transfer. Heat moves from a higher-temperature material to a lower-temperature one (Shin & Park, 2024). Heat transfer occurs in three ways which are convection, con-duction, and radiation. Convection happens in the dye liquor that is being cooked. When the lower part of the dye liquid is warmed, molecules in that area move faster and rise, while cooler molecules sink. Conduction occurs when the dye is heated over a wood fire, as heat from the embers flows directly into the container holding the dye. Next, the dyed yarn is dried under sunlight, an example of heat transfer through radiation. Additionally, several tools in the process utilize the concept of simple machines, which can be integrated as examples of simple machine applica-tions in daily life, particularly the wheel and axle. The wheel and axle mechanism is found in both traditional and modern spinning tools. A wheel and axle is a basic device that consists of two wheels of varying sizes rotating in tandem to increase force (Andini & Kurniawati, 2023). A wheel and axle is a kind of basic machine that has two rotating wheels of varying sizes (Ratnawati et al., 2024). The wheel and axle concept is also found in the weaving machine, as shown in Figure 6, and in the in-spection machine, as seen in Figure 9. Another topic is found in the machine loom, which operates with the help of a dynamo as a power source. This operational pro-cess can be integrated into magnetism studies, specifically as a real-world example of objects that use magnetic concepts. A dynamo consists of a coil located at the center of a magnetic field; when the dynamo's rotor moves, the coil moves with it (Rahmawati et al., 2024). After the fabric is finished with the weaving process, it enters the inspection stage. During inspection, a lamp is placed beneath a glass sur-face, specially designed to assist artisans in checking the fabric quality. The func-tioning of this lamp can be integrated into the study of light, specifically the proper-ties of light. The lamp and glass provide an example of light's ability to penetrate transparent objects (Erfan & Maulyda, 2020).

The ethnoscience of Klaten lurik fabric production in Grade 6, is shown in the yarn-spinning process, where artisans freely move their hands to turn the grek. This activity can be linked to the topic of joints, specifically within the subtopic of joint types. When the artisan turns the grek, the shoulder joint, located at the end of the humerus bone and shaped like a ball, is an example of a ball-and-socket joint, while the elbow, which bends and straightens, is an example of a hinge joint (Sayekti & Desstya, 2017).

The results of reconstructing the Klaten lurik fabric making process for science learning in elementary school sub element of science understanding include eleven materials, with three materials for Grade 3, three materials for Grade 4, four materi-als for Grade 5, and 1 material for Grade 6. The distribution of material from the reconstruction of Klaten lurik fabric making to science material in elementary school can be seen in chart 1 below.

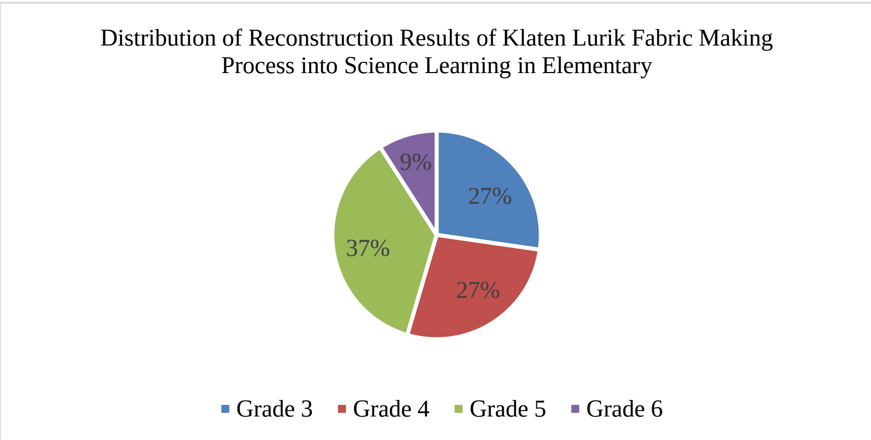


**Chart 1.** Distribution of Reconstruction Results of Klaten *Lurik* Fabric Production Process in Grade 3,4,5, and 6.

The sub-element of process skills in achieving learning outcomes in siences can be observed as students absorb ethnoscience, transitioning from local knowledge to scientific knowledge. Process skills are essential because, as noted by Rillero and Kazeni as cited in Rahayu & Anggraeni, (2017), state that scientific process skills are used in everyday life, so students who cannot apply these skills may face difficulties. Process skills are not only valuable in educational contexts but are also applicable in daily life. Scientific process skills in the production of Klaten *lurik* fabric are evident in the first stage: the dyeing process. Here, students can observe the change in color of the yarn. Artisans must carefully monitor the color of the yarn to ensure even coverage. This activity relates to the process skill sub-element of observation, to enable students to observe phenomena or events in a simple manner (Kemendikbud, 2024). Not only in the coloring stage, but the observation activity is also found in other processes, such as when spinning yarn and performing *nyekir*. Artisans must observe carefully to ensure that the threads are neither tangled nor broken. Planning and conducting an investigation can be done before starting the process of making *lurik* fabric. Artisans need to determine the pattern of *lurik* fabric they intend to create to then decide on the number of materials and color variations required for production. In the coloring process, artisans use scales as a tool to ensure accuracy and consistency in material usage; this can be integrated into the observation category by involving simple measuring tools, which are components of planning and conducting an investigation. Processing and analyzing data and information, this process skill can be applied when artisans complete the entire production plan for Klaten *lurik* fabric. Evaluation and reflection are found in the fabric inspection process, where the quality and conformity of Klaten *lurik* fabric are checked against the set plans and standards. This stage can serve as a basis for providing suggestions and improvements to enhance product quality in the future.

Sciences inherently involve a scientific attitude, which can help develop students' moral values (Mardiana, 2018). The dyeing process that changes the color of the yarn can arouse students' curiosity about the mechanism of color change in white yarn influenced by natural and artificial dyes. The process of making Klaten lurik fabric, such as the meticulous nyekir process that requires high accuracy, serves as an example of scientific attitude that can be applied in science learning, reflecting the importance of detail in each production step. Furthermore, the nyucuk stage streamlines and facilitates the production process by highlighting the need of col-laboration among artisans. Thos collaboration creates synergy, which enables arti-sants to help one another, exchange information, and finish projects more quickly. During the inspection phase, artisans must be meticulous and persistent in their ex-amination of the finished lurik fabric. Maintaining high standards of quality requires in this inspection procedure, which entails a careful examination of every compo-nent of the fabric. Based on an interview with Mr. AP, the owner of the lurik making business, revealed that the history of lurik Klaten production had experienced a de-cline in interest due to the influx of imported fabrics. To maintain the existence of lurik and restore public interest, the artisans made a breakthrough in new motifs through a process of trial and error. This reflects a scientific attitude in the form of courage to face failure, never give up, and discovery that should be emulated by students. The attitudes serve as a model for students to develop the scientific atti-tudes necessary for learning, in addition as reflecting professionalism in the work-place.

Teachers can more easily apply ethnoscience based learning as a more compre-hensive educational resource when local knowledge about Klaten lurik fabric is re-constructed within science lessons. Pupils with a wealth of knowledge can help their community's local wisdom flourish. This supports the opinion of Cacciatore et al., (2014)'s assertion that those with more extensive knowledge actively contribute to policy direction and decision making. Effective ethnoscience instruction can help students develop a respect for local culture and a scientific understanding (Ratnasari et al., 2024). Therefore, future researchers may be inspired to investigate the ethno-science of other local wisdom to be further investigated and incorporated into educa-tional programs by the ethnoscience study of lurik fabric in Klaten Regency.

## Conclusions

Based on the research, it can be concluded that the process of making *lurik* fabric consists of six main steps that can be integrated into science learning in elementary schools, there are science understanding elements and process skills. The results showed that the process of making *lurik* fabric consists of six main stages that can be integrated into science learning in elementary schools, that are: 1) in grade 3, the integrated materials include forms of energy, energy sources, and changes in the form of objects; 2) in grade 4 they include plant organs, energy changes, and types of forces; 3) in grade 5 the integrated material includes heat transfer, simple aircraft, and magnetism; 4) in grade 6 the ethnoscience study of Klaten *lurik* fabric can be integrated in the material of the motion system. Beside the content, it also can be integrated in process skills learning outcomes that are the ability to observe, plan and conduct investigations, process and analyze data and information, and evaluate and reflect. It also be able integrate scientific attitudes that are curiosity, discovery and creativity, accuracy, ability to accept failure, and collaboration.

**Acknowledgments.** For academic and non-academic assistance in the planning of this study, the author is grateful to Universitas Muhammadiyah Surakarta. In addition, the author would also like to thank all those who helped to finish this study.

**Disclosure of Interests.** The authors have no competing interests to declare that are relevant to the content of this article.

## References

Adelia, F. D., & Galura, R. G. (2024). PERANCANGAN BUKU MENELUSURI WARISAN BUDAYA BANEN SEBAGAI MEDIA PENGENALAN BUDAYA BANTEN UNTUK ANAK-ANAK. *Art: Jurnal Seni Rupa*, *13*(2).

Adenkule, R. F. (2017). Effects of ethnoscience instruction, school location, and parental educational status on learners' attitude towards science. *International Journal of Science Education*, *39*(5), 548–564. https://doi.org/10.1080/09500693.2017.1296599

Amalia, F., Anggayudha, R. A., & Aldilla, K. (2021). Ilmu Pengetahuan Alam dan Sosial untuk SD kelas V. In *Ilmu Pengetahuan Alam dan Sosial Buku Siswa*.

Amaya, N. S. (2023). Analisis Kesulitan Belajar IPA pada Materi Gaya di Kelas V SD Bina Satria Mulia. *IJM : Indonesian Journal of Multidisciplinary*, *1*, 1395–1402.

Andini, S. A., & Kurniawati, W. (2023). Analisis Pengembangan Media Pembelajaran Interaktif Pesawat Sederhana Pada Pembelajaran Ilmu Pengetahuan Alam di Sekolah Dasar. *Jurnal Pengabdian Masyarakat Indonesia*, *1*(2), 299–306. https://doi.org/10.62017/jpmi

Anggraini, N., & Kristi, A. P. S. (2024). PENGARUH MODEL PJBL BERBASIS ETNOSAINS TERHADAP KEMAMPUAN BERNALAR KRITIS SISWA PADA PEMBELAJARAN IPAS KELAS IV SD NEGERI 1 CIBEUREUM. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *09*, 396–413.

Anggriani, L. A., Hasnawati, H., & Nurhasanah Nurhasanah. (2024). Development of Ethnoscience-Based Teaching Materials in Class V Elementari School. *Insights: Journal of Primary Education Research*, *1*(1), 1–10. https://doi.org/10.59923/insights.v1i1.68

Anwar, Y. A. S., Sukib, S., Mutiah, M., Siahaan, J., & Al Idrus, S. W. (2018). Demonstrasi Menggunakan Bahan Sederhana Untuk Mengenalkan Reaksi Kimia Pada Siswa Sekolah Dasar. *Jurnal Pendidikan Dan Pengabdian Masyarakat*, *1*(2). https://doi.org/10.29303/jppm.v1i2.856

Ardianti, S. D., & Raida, S. A. (2022). The Effect of Project Based Learning with Ethnoscience Approach on Science Conceptual Understanding. *Journal of Innovation in Educational and Cultural Research*, *3*(2), 207–214. https://doi.org/10.46843/jiecr.v3i2.89

Cacciatore, M. A., Scheufele, D. A., & Corley, E. A. (2014). Another (methodological) look at knowledge gaps and the Internet's potential for closing them. *Public Understanding of Science*, *23*(4), 376–394. https://doi.org/10.1177/0963662512447606

Cahyani, A. P., Oktaviani, D., Ramadhani Putri, S., Kamilah, S. N., Caturiasari, J., & Wahyudin, D. (2023). Penanaman Nilai-Nilai Karakter dan Budaya Melalui Permainan Tradisional Pada Siswa Sekolah Dasar. *JUDIKDAS: Jurnal Ilmu Pendidikan Dasar Indonesia*, *2*(3), 183–194. https://doi.org/10.51574/judikdas.v2i3.796

Çil, E. (2016). Instructional Integration of Disciplines for Promoting Children's Positive Attitudes Towards Plants. *Journal of Biological Education*, *50*(4), 366–383. https://doi.org/10.1080/00219266.2015.1117512

Develi, F., & Namdar, B. (2019). Defining Friction Force: A Proposed Solution to a Textbook Problem. *Journal of Education in Science Environment and Health*. https://doi.org/10.21891/jeseh.487399

Erfan, M., & Maulyda, M. A. (2020). Meningkatkan Pemahaman Konsep Sifat-Sifat Cahaya Pada Mahasiswa Calon Guru Sekolah Dasar Menggunakan Game Android. *Palapa*, *8*(2), 418–427. https://ejournal.stitpn.ac.id/index.php/palapa/article/view/925

Fitri, A., Rasa, A. A., Safira, A. M., Ginanjarsari, R. R., & T.Zahroh, A. (2022). *Ilmu Pengetahuan Alam Sosialuntuk Sd/Mi Kelas 3*.

Fitri, S. N., Utami, T. B., & Kurniawati, W. (2024). Analisis Penerapan Gaya Gesek Pada Kehidupan Manusia. *Jurnal Ilmiah Multidisiplin*, *1*(3), 97–100. https://doi.org/10.62017/merdeka

Haidar, D. A., Zaenuri, M. D., Fatahillah, A., Husein, S., & Monalisa, L. A. (2022). Kerangka Aktivitas Pembelajaran RBL-STEM: Pemanfaatan Karet Gelang dalam Pengembangan Perahu dengan Penggerak Gaya Pegas untuk Meningkatkan Metaliterasi Siswa. *Ebook CGANT Universitas Jember*.

Hartmann, B., & Priemer, B. (2019). Teaching kinetic energy as an observable quantity. *Physics Education*, *54*(4), 045003. https://doi.org/10.1088/1361-6552/ab1353

Indah Pranata, T., Sulistri, E., & Mariyam, M. (2024). Kajian Etnosains dalam Cap Go Meh Singkawang sebagai Media Pembelajaran IPA Kelas IV. *Scholarly Journal of Elementary School*, *4*(1), 1–14. https://doi.org/10.21137/sjes.2024.4.1.1

Ismadi, I., Rohidi, T., & Triyanto, T. (2020). *Klaten Traditional Lurik Weaving: Adaptation Strategies and Inheritance Systems in Society*. https://doi.org/10.4108/eai.29-6-2019.2290455

Jihannita, J., Fadly, W., Ekapti, R. F., Luthfiana, D., & Widowati, A. (2024). The Development of Science Module Integrated with Ethnoscience of Singo Barong Mask to Improve Scientific Literacy and Cultural Preservation Attitudes. *Journal of Innovation in Educational and Cultural Research*, *5*(2), 356–363. https://doi.org/10.46843/jiecr.v5i2.790

Kantina, S., Suryanti, S., & Suprapto, N. (2022). Mengkaji Pembuatan Garam Gunung Krayan dalam Etnosains Pembelajaran IPA di Sekolah Dasar. *Jurnal Basicedu*, *6*(4), 6763–6773. https://doi.org/10.31004/basicedu.v6i4.3360

Kemendikbud. (2024). CAPAIAN PEMBELAJARAN PADA PENDIDIKAN ANAK USIA DINI, JENJANG PENDIDIKAN DASAR, DAN JENJANG PENDIDIKAN MENENGAH PADA KURIKULUM MERDEKA.

Mardiana, M. (2018). Penerapan Pembelajaran Ipa Berbasis Konstruktivisme Dalam Meningkatkan Sikap Ilmiah Pada Siswa Madrasah Ibtidayah. *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah*, *3*(1), 61–80. https://doi.org/10.35931/am.v0i0.69

Maulani, M., Ismiatun, A. N., & Khoirunnisa, J. P. (2023). Jurnal Teknologi Pendidikan dan Pembelajaran. *Analisis Pengembangan Keterampilan Literasi Dan Numerasi*, *1*(2), 372-378.

Mukhbitah, I., Mulyasari, E., & Robandi, B. (2019). Penerapan Metode Eksperimen Untuk Meningkatkan Pemahaman Konsep Ipa Di Kelas V Sekolah Dasar. *Jpgsd*, *II*, 312–321. http://ejournal.upi.edu/index.php/jpgsd/index

Muliadi, A., Sarjan, M., & Rokhmat, J. (2022). Pembelajaran IPA Berbasis Bioentrepreneur Pada Etnosains Poteng Jaje Tujak : Perspektif Filsafat. *JPIn: Jurnal Pendidik Indonesia*, *5*(2), 50–70.

Nadlir. (2016). Urgensi Pembelajaran Berbasis Kearifan Lokal. *Jurnal Pendidikan Islam*, *2*, 300–330. https://jurnalpai.uinsa.ac.id/index.php/jurnalpai/article/view/33/33

Nasution, A. F. (2023). *Metode Penelitian Kualitatif*. CV.Harfa Creative.

Nomleni, F. T., Sabuna, A., & Debita, S. S. (2019). Tumbuhan Pewarna Alami Kain Tenun Ikat Suku Meto Di Kecamatan Nunkolo, Kabupaten Timor Tengah Selatan. *Indigenous Biologi : Jurnal Pendidikan Dan Sains Biologi*, *2*(1), 34–41. https://doi.org/10.33323/indigenous.v2i1.25

Pingge, H. D. (2017). KEARIFAN LOKAL DAN PENERAPANNYA DI SEKOLAH CORE View metadata, citation and similar papers at core.ac.uk provided by Jurnal STKIP Weetebula. *Jurnal Edukasi Sumba*, *01*(02), 128–135.

Rahayu, A. H., & Anggraeni, P. (2017). Analisis Profil Keterampilan Proses Sains Siswa Sekolah Dasar Di Kabupaten Sumedang. *Pesona Dasar (Jurnal Pendidikan Dasar Dan Humaniora)*, *5*(2), 22–33. https://doi.org/10.24815/pear.v7i2.14753

Rahmawati, A., Nurlaili, I., Andika Pratama, G., & Kurniawati, W. (2024). Analisis Materi Listrik dalam Pembelajaran IPA di Sekolah Dasar. *Jurnal Ilmiah Multidisiplin*, *1*(12), 532–540. https://doi.org/10.5281/zenodo.

Ramadhani, A. K., & Sukmawan, S. (2022). Eksistensi Lurik Prasojo Klaten: Sejarah Dan Filosofi. *Humanika*, *29*(1), 122–137. https://doi.org/10.14710/humanika.v29i1.45261

Ratnasari, D., Wazni, M. K., Suhirman, S., Yamin, M., & Muliadi, A. (2024). The Effectiveness of Ethnoscience Learning: Perception of Science Teacher Candidates. *Jurnal Penelitian Pendidikan IPA*, *10*(4), 2024–2031. https://doi.org/10.29303/jppipa.v10i4.7396

Ratnawati, D., Karimatunisa, E., Budi, E., Prasetya, N., & Kurniawati, W. (2024). Analysis of the Uses of Simple Planes in Everyday Life. *Educare: Journal Educational and Multimedi*, *02*(01), 87–90.

Rusyani, E., Maryanti, R., Muktiarni, M., & Nandiyanto, A. B. D. (2021). Teaching on the concept of energy to students with hearing impairment: Changes of electrical energy to light and heat. *Journal of Engineering Science and Technology*, *16*(3), 2502–2517.

Saifudin, M., Susilaningsih, S., & Wedi, A. (2020). Pengembangan Multimedia Interaktif Materi Sumber Energi untuk Memudahkan Belajar Siswa SD. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *3*(1), 68–77. https://doi.org/10.17977/um038v3i12019p068

Salam, M. S. (2014). Optimasi Proses Pewarnaan Kain Batik Menggunakan Pewarna Alami Kuning Dengan Pendekatan Design Of Experiment. *Yogyakarta: Universitas Gadjah Mada*, *22*(140), 50–51.

Sayekti, I. C., & Desstya, A. (2017). *Konsep Dasar IPA SD*. Muhammadiyah University Press.

Shin, J. Y., & Park, S. (2024). Analysis of Elementary School Students' Experimental Performance Characteristics and Difficulties in the Inquiry Activities on "Temperature and Heat" Chapter. *New Physics: Sae Mulli*, *74*(5), 461–476. https://doi.org/10.3938/NPSM.74.461

Sholihah, Z., Suciati, , & Setyono, P. (2024). The Reconstruction of Indigenous Science into Scientific Knowledge in the Natural Color Process from Lurik Klaten. *KnE Social Sciences*, *2024*(58), 772–781. https://doi.org/10.18502/kss.v9i13.15996

Solihin, A., Choirunnisa, N. L., & Mintohari, M. (2024). Eksplorasi Etnosains Monumen Kapal Selam Surabaya Sebagai Sumber Belajar IPAS Sekolah Dasar. *Jurnal Review Pendidikan Dasar : Jurnal Kajian Pendidikan Dan Hasil Penelitian*, *10*(2), 137–148. https://doi.org/10.26740/jrpd.v10n2.p137-148

Suci, E. R., & Mahrudin, A. (2022). Upaya Meningkatkan Hasil Belajar Siswa Pada Materi Gerak dan Gaya Menggunakan Pendekatan Inquiry-Discovery Learning. *Jurnal Pengajaran Sekolah Dasar*, *1*(1), 32–41. https://doi.org/10.56855/jpsd.v1i1.56

Suryanti, S., Prahani, B. K., Widodo, W., Mintohari, M., Istianah, F., Julianto, J., & Yermiandhoko, Y. (2021). Ethnoscience-based science learning in elementary schools. *Journal of Physics: Conference Series*, *1987*(1). https://doi.org/10.1088/1742-6596/1987/1/012055

Tupas, F. P., & Banas, L. B. (2021). Traditional Science learning in local recipes: A cross-disciplinary exposition. *Indian Journal of Science and Technology*, *14*(3), 197–207. https://doi.org/10.17485/ijst/v14i3.1332

Utami, A. T., & Sayekti, I. C. (2023). Kajian Etnosains Pembuatan Pisau Sebagai Kearifan Lokal Kabupaten Klaten Pada Materi Pembelajaran Ipa Sekolah Dasar. *Attadib: Journal of Elementary Education*, *7*(2), 7–2.

Wandini, R. R., Bariya, C., Lubis, H. A., Nur, N. M., & Mardhatillah, S. (2022). Metode Eksperimen pada Proses Pembelajaran Perubahan Wujud Benda pada Sekolah Dasar. *Jurnal Pendidikan Dan Konseling*, *4*(3), 1349–1358.

Widyaningrum, R., & Prihastari, E. B. (2021). Integrasi Kearifan Lokal Pada Pembelajaran di SD Melalui Etnomatematika dan Etnosains (Ethnomathscience). *Dinamisia : Jurnal Pengabdian Kepada Masyarakat*, *5*(2), 335–341. https://doi.org/10.31849/dinamisia.v5i2.5243

Yuenyong, J., & Yuenyong, C. (2012). Connecting Between Culture of Learning in Thai Contexts and Developing Students' Science Learning in the Formal Setting. *Procedia - Social and Behavioral Sciences*, *46*, 5371–5378. https://doi.org/10.1016/j.sbspro.2012.06.441

Zidny, R., Sjöström, J., & Eilks, I. (2020). A Multi-Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability. *Science and Education*, *29*(1), 145–185. https://doi.org/10.1007/s11191-019-00100-x

Zulkhi, M. D. (2022). Pengembangan modul elektronik berbasis kearifan lokal Balumbo Biduk menggunakan aplikasi 3D pageflip professional di kelas IV tema 7 Sekolah Dasar. Universitas Jambi.