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An Ethnoscience Study on The Making of Pandan Mats as Science Learning Resources

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Abstract. This study aimed to implement ethnoscience in analyzing pandan mat making in Wewewa Tengah and evaluating its implication as a learning source in science education. This research focused on studying the pandan mat-making process in Wee Patando Village and identifying its scientific contributions to traditional practice. Applying a qualitative research method, the data were collected through observation, interviews, and documentation. Meanwhile, the research instruments used are observation sheets, interview guides, and documentation. The data were analyzed through several stages: reduction, data presentation, and conclusion drawing. The results reveal that the pandan mat-making process involves several stages, including collecting pandan leaves, sorting, removing its thorns, drying, *ware* (scraping), rolling, *tirri* (dividing), weaving, *melekuk* (locking), and *dumbi* (placing pandan). The main challenge is in the drying process of pandan, which is affected by high humidity during the rainy season and may impact the quality of the mats. This study's contribution lies in applying scientific concepts to the traditional pandan mat-making process, such as plant physiology, the leaf structure and its function, the physical properties of materials, and principles of heat transfer and friction. The findings emphasize that the pandan mat-making process can serve as a concrete example for understanding science subjects, particularly in plant physiology and material physics. In science education, this research recommends integrating ethnoscience knowledge from pandan mat-making into the curriculum to enrich students' learning experiences. By understanding how scientific concepts are applied in traditional practices, students can see the relevance of science in daily life and enhance their comprehension of academic material through concrete and relevant examples.
Keywords: ethnoscience; pandan mats; science learning resource

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INTRODUCTION

Ethnoscience refers to a discipline that studies the knowledge obtained by an ethnic group or tribe. The knowledge obtained by a particular country or society is called ethnoscience, while the knowledge can be obtained through certain techniques according to the rules. The knowledge is going to be tested in order to check its credibility and to make sure it is not just an opinion or speculation but a fact. Therefore, ethnoscience can be interpreted as a branch of science with techniques and rules to collect information from a community and to allow empirical

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verification of information (Wahana, 2016). Ethnoscience can be interpreted as a system of knowledge typical of a particular culture (Dewi et al., 2019; Koirala, 2023; Verawati et al., 2022). The word 'typical' focuses on the concept of local wisdom. Local wisdom values can be introduced by combining learning resources with scientific knowledge oriented towards culture or ethnoscience (Khoiri et al., 2022; Sholahuddin et al., 2022; Sturtevant et al., 2014).

Local wisdom is a system of cultural knowledge, customs, and abilities inherited from local communities from generation to generation that can meet their basic needs (Fitriah et al., 2021; Hidayati, 2017; Misbah et al., 2024). Local wisdom is defined by Suhartini in Sari (2019) as an ancestral heritage that is concerned with life values. A culture that successfully adapts to its environment will produce useful ideas or tools for meeting its basic needs. Over time, there has been an increase in young people who need to be made aware of local wisdom in their area. Therefore, to maintain its sustainability, it is important to emphasize the values of local wisdom.

Utilizing local wisdom as a learning resource can be an appropriate strategy. All sources of information that students can use to achieve learning goals, including people, data, and certain formats, are considered learning resources (Cahyadi, 2019). Therefore, by utilizing local wisdom as a learning resource, teachers can ensure that students understand and present the learning materials more effectively (Misbah, 2020; Wati et al., 2020). Many younger generations are now unfamiliar with traditional crafts in their regions, such as making pandan mat. In addition, only a few people are still using the weaving technique, according to current observations. Therefore, support for making pandan mats is necessary to raise the enthusiasm of the younger generation in the future and maintain the sustainability of preserving local wisdom (Suryanti, 2018).

One inherited culture from one generation to another is making a pandan mat using the weaving technique due to artistic and cultural activities. The culture created by humans is used as a tool in every activity by the society that upholds it. Hence, culture is not static but dynamic. Many variables, such as geographical location, the surrounding environment, and interaction with other foreign cultures, influence the dynamism of a culture. Geographic determinism describes several elements that determine the style used in a culture more than the geographical location. Humans are placed according to their geographical location, creating opportunities for obtaining new needs. Hence, the correlation affects both individuals and their environment.

Pandan mats are made from woven fibres and used for daily needs and traditional ceremonies. Mat is reflected as a cultural heritage by society, which applies manufacturing techniques inherited from one generation. Ethnoscience studies in making pandan mats have great potential to reveal deeper meanings behind the practice of making mats. Hence, it is important to maintain and preserve local wisdom, such as that contained in the process of making mat, since it is a valuable cultural heritage. Learning Ethnoscience can help to observe, document, and understand these practices in a broader cultural context. It has roles in preserving cultural heritage and enhancing appreciation for these cultural practices at local and global levels.

In facing the pressures of modernization and globalization, many local communities, including the Wewewa community, risk losing their traditional knowledge in making mats. Younger generations may lose interest in the practice, and the knowledge inherited from one generation to other generations

can have extinction risks. This is a serious problem due to the importance of cultural identity and the relationship between humans and nature.

Ethnoscience studies on mat-making are closely related to the context of science, where the making of pandan mats illustrates the understanding of local communities to understand the properties of leaves or fibers used in mat-making, including strength, flexibility, and durability. In learning Ethnoscience, we must also consider the natural and social environment's influences on mat-making techniques. These aspects are seasons, local plants, tools, and inherited knowledge that influence mats making. In addition, ethnoscience can help connect the traditional knowledge possessed by the local communities with modern science (Khusniati et al., 2023; Lasmana et al., 2024; Parmin et al., 2022). This can be the main goal of understanding the sciences such as botany, chemistry, physics, or materials science involved in mat making, as well as using a deeper understanding of how the Wewewa Tengah community interacts with nature in making mats.

One reason for the lack of ethnoscience studies in Wewewa Tengah's educational activities is the need for more research on culture. In addition, the learning materials used in science education still rely on books published by the government, which do not support the students' cultural background and characteristics. Furthermore, more thought is needed in organizing scientific learning with an ethnoscience approach, even though schools have unconsciously included studies exclusive to specific topics such as art and culture.

Based on these problems, the researcher concluded that further research must be conducted as an ethnoscience study of making pandan mats in the Wewewa Tengah community. This can be developed and implemented in science learning, which will help the students in the community grow their pride and love for their culture.

METHOD

This study used a qualitative approach to investigate in a natural context where the researcher is the main instrument. In qualitative research, humans are the research instruments and the results of their writing are elaborated in the form of words or statements that are in accordance with the real situation (Sugiyono, 2016). Data collection was obtained from observation, interviews, and documentation. Observations were conducted to identify the tools and materials used in making pandan mats. In contrast, interviews were conducted to obtain information about the process of making pandan mats, and documentation was carried out to support the research findings in the form of images. The research began on March 26 to April 18, 2024, in Wee Patando Village, Wewewa Tengah District, Southwest Sumba Regency, East Nusa Tenggara Province. The study subjects were the community that was part of the Wewewa Tengah District group, Wee Patando Village, and the craftsmen who make the pandan mats. Meanwhile, the data were collected by: 1). Observations of the tools and materials used in making pandan mats, 2). Interviews to collect the information about the process of making pandan mats, and 3). Documentation includes pictures of tools, materials and the process of making pandan mats during the field research. The instruments used in this study were observation sheets, interview sheets, and documentation. The data analysis techniques used were: 1). Data reductions in the form of data sorting, summarizing data, choosing the main points, focusing on important things, looking for themes and patterns, then eliminating irrelevant data, 2). Data presentation is the summary of data or information organized and arranged in a

framework to make it easier to understand. 3). Concluding is the process of revealing data in the initial stage with important evidence from the research findings. At this point, the conclusion will be credible

RESULTS AND DISCUSSIONS

Connecting the implication of ethnoscience studies with practical benefits in learning science can be applied by explaining how traditional knowledge and culture-based approaches can enrich students' learning experiences and provide a more relevant context for scientific concepts. There are some strategies to explain the correlation:

1. Integrating traditional knowledge into the science curriculum
   Cultural context in science experiments: Ethnoscience knowledge, such as pandan mat-making techniques, can be integrated into science experiments to provide cultural context. For example, students can learn about the physical and chemical properties of pandan fiber and how traditional techniques utilize these properties. This not only teaches science concepts but also knowledge related to cultural values.
2. Increasing Environmental and Sustainability Awareness
   Resource management practices: Knowledge about the management of pandan fiber in mat-making can be used to teach the principles of sustainability and natural resource management. The students can learn about traditional techniques that support sustainability and how these practices contribute to the local ecosystem.

The Knowledge of the Society in Making Pandan Mats

The people in Wewewa Tengah, especially in Weepatando Village, have good knowledge about the history and process of making pandan mats. This knowledge is obtained from their parents from generation to generation. There is no specific data about when the pandan craft business began, but the truth is that making mats and weaving using pandan has met the community's daily needs. Making pandan mats using the weaving technique is easy for housewives in the community. They work as farmers and livestock breeders and make pandan mats as a side job in Wee Patando Village.

The community's knowledge of the technique for making pandan leaves into materials ready to use in making the mats is also very good. They know exactly when and how to pick pandan leaves, sort them, clean the thorns, dry the leaves, do *ware* (scrape) them, *tirri* (divide) them into equal sizes, weave them, and *dumb* (insert) them.

Study of Local Science and Scientific Science in the Process of Pandan Mats Making

The ‘original’ science or local science is obtained by society through local traditions or cultures inherited from one generation to another. Meanwhile, scientific science is knowledge related to concepts, theories, or laws that can provide the same results and are recognized by the scientific community.

a. Harvesting pandan leaves

Local Science:

The community believes that to take or cut pandan leaves, it is best to do it during a full moon or bright moon, with the aim that the pandan leaves taken are stronger, flexible, and brightly colored (as known in the local language as *kakar*). Harvested pandan leaves are shown in Figure 1.

Scientific Science:

Harvesting pandan leaves requires a good understanding of plant physiology material to ensure plant growth and sustainability, such as photosynthesis, respiration, and transpiration.

Figure 1 Ms. AWM is harvesting pandan leaves
(Source: Ngongo, April 2024)

Photosynthesis is an important process by which plants convert solar energy into chemical energy. Photosynthesis carried out by plants is more dominant in one of the plant parts, such as the leaves. Photosynthesis is also a complex activity influenced by many things, both from within and outside the plant. Factors from within the plant involve the condition of the leaves or parts of the plant that carry out photosynthesis, the amount of chlorophyll, the age of the leaves, and other physiological activities such as transpiration and respiration. External factors include air temperature, humidity, wind speed, rain, sunlight, and the amount of CO2 and O2 in the air. In addition, competition with other plants and attacks by disease organisms can also affect this process (Suyitno, 2011). Other factors that affect plant photosynthesis are stress on plants, such as lack of water and exposure to toxic pollutants and other hazardous substances. Unsuitable environmental conditions can also affect photosynthesis performance, including exposure to heavy metals, toxic chemicals, sulfur dioxide (SO2), and abnormal oxygen (O2) levels.

Respiration is the process of breaking down food materials to produce energy. It occurs both during the day and at night (Campbell, 2002; Garcia et al., 2023). Knowledge about respiration is important to ensure that the leaves taken have sufficient glucose levels to support the plant's cell life and whole function.

Transpiration is the process by which plants lose water in vapor through stomata in the leaf tissue. Although water loss may also occur through lenticel cells and other parts, the amount is usually less than when it occurs through stomata (Lakitan, 2007). When harvesting pandan leaves, it is important to pay attention to the plant's transpiration rate. Harvesting pandan leaves when transpiration is low can help reduce excessive water loss and stress on the plant.

b. Sorting the Pandan Leaves

Local Science:

People believe that old pandan leaves are unsuitable since their strength has decreased, and they tend to rot. Sorting pandan leaves is shown in Figure 2.

Figure 2 Ms. LP is sorting the pandan leaves
(Source: Ngongo, April 2024)

Scientific Science:

In taking the pandan leaves, the craftsmen must sort them pandan leaves since if it is too old, they tend to be hard and brittle to weave and can produce stiff and inflexible weaves. By using fresh pandan leaves, they can produce weaves with brighter colours and smoother textures. This concept is related to the learning material on the structure and function of leaves, which explains the role of water content in leaf cells in making them strong and elastic and supporting the leaf structure. In addition, the material on the physical properties of materials introduces the physical properties of materials such as solubility, strength and flexibility. It explains how the lignin and cellulose content in leaves

provide strength and flexibility. Some of the contents found in pandan leaves are:

Water content: Water in the cell cavity of the leaves is used for photosynthesis (Haygeen & Bowyer 1996; Roig-Oliver et al., 2020). Old thorny pandan leaves usually contain less water than fresh thorny pandan leaves. Although low water content can reduce the risk of rotting or microorganism growth, it can make the leaves stiffer and difficult to weave properly (Brown & Smith, 2023; Tapia et al., 2020).

Lignin content: Lignin is a complex polymer with a high molecular weight. Lignin is found between cells and in cell walls. Between cells, lignin functions as an adhesive to bind cells together. Lignin is closely related to cellulose in cell walls and provides rigidity to cells (Winarni & Totok, 2006). Thorny pandan leaves that contain much lignin tend to be stronger, more durable, and more resistant to physical damage. Although lignin is important for strength and durability, excessive content can affect the colour and aesthetics of the leaves. Excessive lignin can cause the leaves to become stiffer and less flexible, affecting the weaving process and the aesthetics of the weave.

Cellulose content: Cellulose is a form of polysaccharide produced by photosynthesis in plants. The cellulose structure consists of anhydro glucose bound in the first and fourth C atoms with a beta configuration (Browning, 1963). Cellulose provides tensile strength to a cell due to its strong covalent bonds in the pyranose ring and between the sugar units that make up cellulose. Hence, the higher the cellulose content, the higher the flexibility. Sufficient cellulose content is important for forming a sturdy and durable leaf structure. The cellulose in the thorny pandan leaves contributes significantly to the strength and durability of the weave and tends to be stronger and more durable.

c. Removing the pandan thorns

The pandan leaves taken are then cleaned, while the thorns on the left, right, and back are removed. Next, the tip and base are flattened using a *keto tama* (sharp knife). After that, the craftsman removes the spine of the pandan leaves using a knife or *kalerre pote* (spinning rope).

(a) (b) (c)

Figure 3 (a) Removing the pandan thorns from the left to the right; (b) Removing the thorns in the spine of the pandan; and (c) Removing the spine of the pandan

(Source: Ngongo, April 2024)

d. Drying the pandan leaves

Local science:

The cleaned pandan leaves are immediately dried under the sun to make them flexible in *the ware* (scraped) process. After the *ware* is completed, the pandan leaves are dried for the second time until their color changes. Then, the

leaves are rolled into a circle shape. In order to make them flexible, *the ware* is aimed at softening the leaves and making them flat, straight, thin, and not wrinkled.

Figure 4 Drying the pandan leaves after being cleaned (Source: Ngongo, April 2024)

Local science:

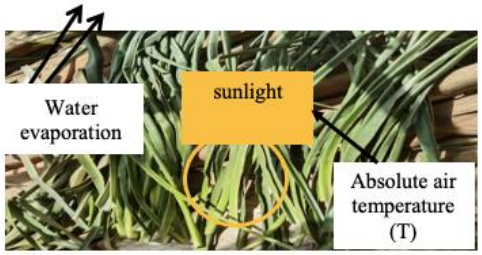

Figure 5 Drying the pandan leaves (Source: Ngongo, April 2024)

In drying pandan leaves, several physics concepts can be applied. One relevant concept is the physics concept of Radiation Heat Transfer. Radiation is a heat transfer process that does not require a medium (intermediary). This radiation is usually in the form of Electromagnetic Waves originating from the sun (Mudi, 2013). In this case, the heat from sunlight and the surrounding air is used to evaporate water from the surface of the leaves. According to Steffan-Boltzman, the amount of energy emitted by the surface of an object in the form of heat radiation per unit of time is proportional to the fourth power of the absolute temperature of the surface. The statement above is called Steffan-Boltzman Law. Thus, this heat exchange can be explained by the formula for radiation heat exchange, which can be formulated as follows:

$$\frac{Q}{t} = e\sigma AT^4$$

Explanation:

Q : Radiation heat transfer rate (Watt)
t : time (s)
e : emissivity coefficient of the object N/m^2K)
σ : Stefan-Boltzman's constant (5.672 x $^{-8}$ W/K)
T : absolute temperature of the object's ırface (K)
A : cross-sectional area (m^2)

e. Ware process (scraping the pandan leaves)

Local science:

For the community, *ware* (scraping the pandan leaves) aimed to soften the pandan leaves, making them flexible, straight, and tangle-free (see Figure 6).

Figure 6 *Ware* process (scraping the pandanleaves) by Ms. YRB (Source: Ngongo, April 2024)

Scientific science:

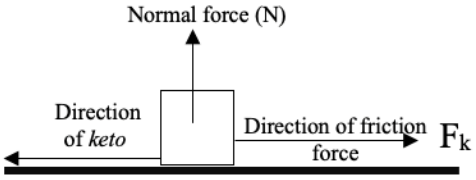

Figure 7 Ware (scraping the pandan leaves) and the Kinetic friction force in scraping pandan leaves
(Source: Ngongo, April 2024)

In scraping pandan leaves, friction occurs between *keto dumbi* and the pandan leaves. When the *keto dumbi* moves along the surface of the pandan leaves to scrape the fibers or outer layers, the surfaces of the keto dumbi and pandan leaves move relative to each other, as well as in the friction that occurs is the kinetic friction force (fk). When the *keto dumbi* is blunt, it increases the kinetic friction force due to its rough surface and contact area larger than the pandan leaves. This kinetic friction force works when the surfaces of objects move together (Riyadi., 2019:18). Kinetic friction force can be formulated as follows:

$$f_k = \mu kN$$

explanation:
f_k : kinetic friction force (N)
μ_k : Kinetic friction force coefficient (N)
N : normal force (N)

f. Tirri (dividing the pandan leaves into equal size)

In this process, they rolled the pandan leaves, while the bases were flattened first and divided equally. This aims to adjust the width of the pandan leaves to suit the needs of its use.

(a) (b)

Figure 8 (a) *Tirri* process and (b) the result
(Source: Ngongo, April 2024)

g. Weaving the pandan leaves

Local science:

The first step in weaving a mat is making *kadebal*, which is a part of the top leaf folded down and up. The second and third leaf strands are continuously added left and right until one weave is completed. The weaver uses an overlapping technique, while each pandan leaf strand is placed repeatedly and intersects with other leaves to create a weave that is strong and durable.

Figure 9 (a) Ms. AWM is making a *kadebal*

Figure 9 (b) Ms. AWM is making a pandan mat
(Source: Ngongo, April 2024)

Local science:

When weaving a mat, when the weaver pulls or rubs the pandan leaf slices, frictional force (fs) occurs. It is called frictional force since the object that provides the force must be in direct contact with the object that is subjected to the force, such as the weaver's hand holding the pandan leaf so that there is

direct friction between the surface of the pandan leaf and the weaver's hand. The frictional force in this weaving process is included in the type of static frictional force. Static frictional force is the frictional force that occurs when two surfaces touch but does not experience relative displacement from each other (Riyadi., 2019:18), systematically formulated as follows:

$$f_{riction} = \mu sN$$

Explanation:
fs = static friction force (N)
μs = friction force coefficient (N)
N = normal force (N)

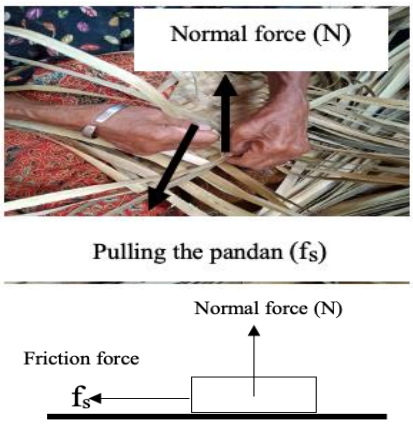

Figure 10 Weaving the pandan leaves and the Static friction force in weaving pandan mats

h. Melekuk (locking the mat weaves)

The mat is finished by locking the mat weave at the edges of the mat, or called *melekuk,* to make the mat look neat and solid and not easily unravel. Then, the mat is tidied up again by inserting pandan leaves or called as *dumbi.*

Figure 11 *Menekuk* (locking the pandan leaves)
(Source: Ngongo, April 202

i. Dumbi

For the society in Wee Patando, Wewewa Tengah, *the dumb* process is defined as the process of inserting the pandan leaves while weaving.

(a) (b)

Figure 12 (a) *Dumbi* process and (b) final process of weaving mat

The obstacles in the process of pandan mat making

The obstacles faced by the craftsmen of pandan mat in Wewewa Tengah, Wee Patando are when drying the pandan leaves since it requires a long and intensive drying process. The rainy season with high humidity can slow down the drying process, extend the manufacturing time, and increase the risk of mats not drying properly, affecting their quality.

Humid and wet weather conditions can affect the quality of the mats. Problems can occur when the mats become damp or more susceptible to other hazardous things. Usually, if the mat is damp, some black spots will appear.

The role of pandan mats in Sumba culture

Sumbanese traditional culture is an ancestral heritage rich in traditional values, rituals, and arts that has been preserved until now. This is reflected in various traditional practices such as traditional ceremonies, weaving arts, and the use of pandan mats. For Sumbanese, the pandan mats are often used in traditional ceremonies, such as events related to marriage, death, and so on.

The use of pandan mats for daily life

For the local community, pandan leaves are used to make various types of woven items that can meet their daily needs. Pandan mats can also be used for sitting and sleeping mats at home.

CONCLUSION

Based on the research results, it can be concluded that scientific concepts related to biology, physics, and chemistry are involved in making pandan mats. The scientific concept in taking pandan leaves: about plant physiology related to photosynthesis, respiration and transpiration. Sorting pandan leaves: The craftsmen must sort them since they tend to be hard and brittle when they are too old, and it is better to use fresh leaves. Meanwhile, thorny pandan leaves are strong, flexible, and brighter because they contain several contents, namely water, lignin, and cellulose. Drying pandan leaves: several physics concepts can be applied. One relevant concept is the physics concept of heat and radiation transfer. Radiation is a heat transfer process that does not require a medium (intermediary). This radiation is usually in the form of Electromagnetic Waves that come from the sunlight. In this case, the heat from sunlight and the surrounding air evaporates water from the leaves' surface. According to Steffan-Boltzman, the amount of energy emitted by a surface of an object in the form of heat radiation per unit time is proportional to the fourth power of the absolute temperature of the surface. In *the ware* process (scraping pandan leaves): In the process of scraping pandan leaves, friction occurs between *keto dumbi* and pandan leaves, which is called kinetic friction (fk). Weaving pandan mats: The weaver pulls or rubs the pandan leaf, causing friction (fs). In the friction process, the object that provides the force must be in direct contact with the object that becomes the subject to the force. Hence, the craftsmen can hold the pandan leaf to make direct friction occur between the surface of the pandan leaf and the craftsman's hand. The friction in this weaving process refers to static friction.

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