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Indigenous science constructs based on Troso woven fabric local wisdom: a study in ethnoscience and ethnoecology

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ABSTRACT
Troso woven fabric is a kind of weaving fabric produced in a village in Indonesia called *Troso*. The aim of this study was to identify the detailed process of manufacture of *Troso* woven fabric and reconstruct it related to several scientific concepts. Research method started by observe several local cultures in this city, and found that students can better understand the science concept and increase their environmental awareness when it is exemplified by circumstances in their surrounding environment. The results of Troso woven fabric reconstruction can be used as a contextual alternative learning resource and increase students' awareness in protecting their environment. This study uses a qualitative research approach through ethnoscience and ethnoecology. The two aspects of the study were carried out through the process of reconstructing indigenous science into scientific science. The research stages include pre-research preparation, primary data collection through observation, in-depth interviews, discussion, and direct observations. The next step was collecting data from the study of cultural documents on the manufacturing of Troso woven fabric as well as verifying, reconstructing, formulating, and conceptualising into science. Various scientific studies relate to the measurement process, compounds and mixtures, heat, and energy transfer associated with ethnoscience. Ethnoecologically, the community does not know yet about the environmental impact that has occurred, resulting in environmental damage even though the community has not directly observed it. By associating science material with the local culture, it is hoped that the understanding of science will become more meaningful and contextual.

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Introduction

Education has several functions, including the preservation of cultures, and enhancing changes towards a more innovative life (Suastra et al., 2011). However, the current of globalization has significantly shifted the values of many original Indonesian local cultures. Moreover, there is a phenomenon of school students increasingly believing that the concepts of scientific knowledge are more important, more needed, and as if not related to the culture of the local community (Parmin, 2015). In fact, the original knowledge in the culture of a community often contains concepts, principles and other scientific knowledge that has not been formalised (Duit, 2007). Furthermore, most of these traditional knowledges have been forgotten and lost due to a lack of understanding about conservation and the importance of preserving the traditional knowledges (Halim et al., 2013)

Ethnoscience is etymologically derived from the word "ethnos" from Greek which means "*nation*" and "*scientia*" from Latin which means "knowledge". Ethnoscience means knowledges possessed by a nation or more precisely a certain ethnic group or social group (Sudarmin, 2015). Ethnoscience can connect humans or culture with science learning (Dewi et al., 2021). Ethnoscience constructs can be used as a learning resource that moreover encourages learners to remain in accordance with the norms or culture that exists in their society. This is in line with the development of science and technology which is certainly beneficial for human survival as the positive impact. (Sari et al., 2017).

Natural sciences and social sciences can be bridged with ethnoecological studies. The scope of ethnoecology is not only related to natural aspects but also human aspects with various political, economic, social, and cultural aspects. Ethnoecology discusses the close relationship between humans, living space, and all human activities on earth (Hilmanto, 2010). Research that has been carried out previously include an ethnoscientific study on the manufacture of palm sugar (Sumarni, 2016), the production of traditional herbal medicine (Sudarmin & Asyhar, 2012), and a study on the culture of the Samin tribe in Sukolilo Pati (Khusniati, 2017).

Humans adapt to changes in ways that may be beneficial for the natural environment such as preserving tropical forest ecosystems, their water sources and rare plants. Ethnoscientific concepts have been woven into school science teaching materials such as an ethnoscience-based science module on the theme of energy in life (Rahayu and Sudarmin, 2015), additives in food (Rosyidah et al., 2013), plant cultivation (Nailiyah et al., 2016), and ecosystems (Mahendrani & Sudarmin, 2015). The novelty of this research lies in the ethno-scientific study of the manufacture of *Troso* weaving fabric, as well as ethnoecological aspects. *Troso* weaving fabric was chosen as the object of research because *Troso* weaving fabric is a local wisdom that has existed since 1935 (Budiman et al., 2020). The existence of *Troso* Weaving fabric, which has existed since ancient times, shows that *Troso* Weaving fabric is an ancestral heritage that has taken root as the culture of the Indonesian nation. The process of making *Troso* weaving fabric can be used to introduce various scientific concepts. Thus, school pupils can learn science through the local wisdom around them, and also raise their awareness towards protecting the environment by knowing the impact of human behaviour.

Among the obstacles faced is the lack of efforts to explore pure scientific potential in the production of *Troso* weaving fabric, both in terms of content and pedagogical context. The study of ethnoscience on the manufacture of *Troso* weaving fabric has not been studied, as well as ethnoecological studies. *Troso* weaving fabric is a form of local wisdom is still done using simple traditional technology (Triyono, 2021). The original or indigenous science in the process of making *Troso* weaving fabric contains values that are full of local wisdom. Indigenous science is typically only expressed verbally, based on personal experience and symbolically, resulting in limited knowledge transmission through modern models. In fact, the outcomes of original science reconstruction into scientific science based on local culture can be used as an alternative science learning resource (Sumarni, 2016).

The goal of this research was to identify and describe indigenous science in the process of manufacturing *Troso* weaving fabric, as well as related scientific concepts. The study also discusses people's behaviour towards the environment in relation to the needs of *Troso* weaving fabric. The benefit of this research is that the results of this reconstruction can be used as an alternative source of

contextual science learning. By knowing human interaction with the environment including the impact it causes, students are also expected to make more efforts to protect the environment. Local wisdom was used as a source of knowledge for pupils related to the processing or utilisation of waste in the form of solid, liquid or gas, for the sake of environmental sustainability.

Methods

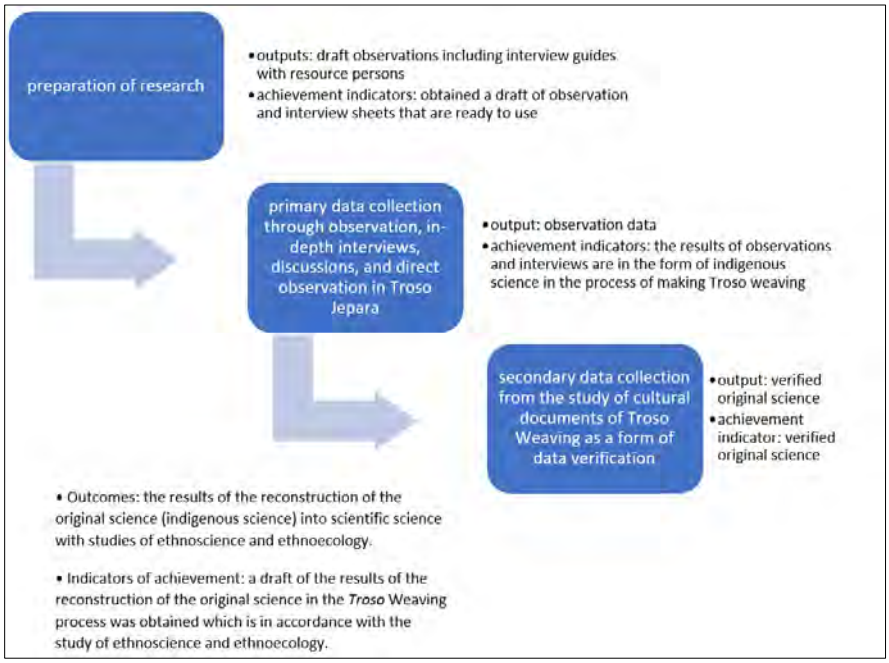
This research was conducted in *Troso* Village, Pecangaan District, Jepara Regency, Central Java, Indonesia, by involving three *Troso* weavers who had been weaving for at least 10 years (R1, R2, R3). Age restrictions are carried out to obtain original science from people who have been engaged in the craft for so long from generation to generation in order to maintain existing local wisdom. This location was chosen because this village is a producer of *Troso* weaving fabric which is actually taken from the name of the village. Until now, the process of making *Troso* weaving fabric still maintains local tradition by using looms instead of machines (traditional loom). The makers vary from household scale with several workers, to individual ones by taking yarn back to their own homes.

This study used a qualitative research approach through ethnoscience and ethnoecology. These two studies were carried out through the process of reconstructing indigenous science into scientific science, according to the concepts, principles and laws of science, and focusing on the field of waste management studies. The research flow can be seen in Figure 1.

In this reconstruction, the focus is on the culture of the people of *Troso* Village which has been organised in its scientific system and is believed by the surrounding community at a certain time where the knowledge is built according to the geographical conditions of the place. During data collection, the researcher had a direct influence on the life activities of the *Troso* weaving fabric? makers who were observed.

Figure 1

Flowchart of the Study



Primary data collection techniques carried out through observation, in-depth interviews, discussions, and direct observation in the field. Meanwhile, secondary data was obtained from the study of cultural documents regarding the making of *Troso* weaving fabric. In this study, the researcher becomes the main instrument for collecting as much scientific data as possible from the

community, verifying, reconstructing, formulating, and conceptualising it into a scientific science. To ensure the reliability criteria for the data obtained, the researcher made several efforts, including:

(1) conduct research in the field with intensive observation,
(2) triangulate data and methods,
(3) provide adequate references, and
(4) conduct a negative case study.

To increase the level of dependence and certainty of research results, an effort was made to examine all traces of research activities and study informants. The process of data analysis was carried out continuously and intensively investigated, categorized and then constructed into scientific knowledge. Data interpretation was carried out through discussions with competent experts in the field of local culture. After analyzing the data, the study continued to reconstruct the original findings in the form of science in order to develop science education based on local culture in schools. The final product of this research was the original science of *Troso* Weaving culture, which has been reconstructed into a scientific science through ethnoscience, and also and also knowing the views of the community through ethnoecological studies.

Result and Discussion

The observation process is presented in Figures 2 and 3. During the interview and observation process, the results of the reconstruction of the original science became scientific science. These results are presented in Table 1.

Figure 2

Discussion Process with the Troso Weavers

Figure 3

Troso Weaving Process

Table 1

The Result of Reconstruction of Original Science into Scientific Science in the Troso Weaving Process

No.	Topic	Indigenous Science	Scientific Science
	Weaver Production Processes		
1	*Ngeteng* (The yarn is stretched in the wood) How the yarn can be arranged properly on the *plankan*? 	The yarn is arranged on the *plankan* by pulling it, but not too tight because it can break the yarn.	This stage is the initial stage in the production process of *Troso* Jepara woven fabric at this stage the yarn is separated from the original spools. This stage is dependent on the tension of the thread. Thread tension that is too large can cause the thread to break easily because the force generated is large. On the other hand, a tension that is too small can cause the pattern of the woven fabric to be not optimal because the force applied is not enough (the thread becomes easily tangled) (Alamsyah et al., 2013).
2	*Ditangsuli* (The process of binding the parts that are not colored using raffia. Raffia rope is a material made of plastic) Why using *rafia* used as a material that covered undyed yarn?	The part that is not colored is closed with raffia, to make sure that the color will not get through	Before the colouring process was carried out, the parts that were not coloured were tied using plastic-based **raffia**. This is due to plastic which has the characteristics of the constituent components being very tight and impermeable to

			water, so that the absorption of the dye liquid on the fabric cannot occur. Plastic is a type of polymer with a low absorption rate (Vadicherla & Saravanan, 2014), so that in the colouring process, the parts covered by raffia were not stained.
3	*Wenter* (dyeing process by dipping the yarn into the dye solution) How is the *wenter* process carried out? Why can the yarn become coloured after being dipped in a dye solution?	*Wenter* is done by boiling the dye solution then the yarn is inserted. The yarn becomes coloured because it absorbs the colour from the liquid.	In the process of dyeing woven fabrics, heat is needed because heat can help activate the dye and facilitate the absorption of the color into the fabric fibers. Yarn can become colored due to absorption (absorption) of dyes by fabric fibers. This process occurs due to the interaction between the dye and the fabric fibers which allows the dyeing of the fabric to occur permanently.
4	Drying process  What is the aim of drying process? Why the yarn can be dry?	The yarn is dried in the sun to dry	The drying process (with solar energy) makes the cloth that was previously exposed to the dye solution becomes dry. In this case the evaporation process occurs. Evaporation or evaporation is the process of changing molecules in a liquid state (eg. water) spontaneously into a gas (eg. water vapor). The dye solution consists of water molecules (H_2O) and dye particles. Water molecules have high volatility.
5	*Malet* (the process of winding yarn, which had previously been dried and the *rafia* is taken) How can yarn be wound with this tool? 	Yarn can be rolled because it is attracted by the wheel that is rotated.	In this *malet* process using a tool with a pulley working principle to make it easier to roll the yarn. Yarn can be wound because of the tension in the yarn.

6	Weaving process (Yarn is woven to make woven cloth) How can this tool turn yarn into cloth? 	because the loom can make the thread attracted.	Weaving is the process of combining and organizing two different sets of yarns together to make fabric is called weaving. It can be done on looms that are either - hand operated or power operated. Weaving is a method of textile production in which two definite sets of threads are braid together at right angles forming a fabric or cloth.
	The Loom		
7	Why can a loom be used for weaving 	because it's pulled	The loom used has a tread or pedal in the form of two long pieces of wood located at the bottom of the loom, the tread will be moved with the feet and serves to adjust the rise and fall of the warp threads as they go through the process of going in and out of the weft thread series in the weaving process (Isbandono, 2016).
8	What is the difference between a long loom and a short loom?  The long loom  The short loom	It's different, it's lighter if you use the long one. Faster finish.	Basically, long and short looms have the same principle. The fulcrum used is both on the pedal. The lighter "feel" felt by the weavers is possible because the weaving work is completed faster when using a long loom so that the use of a long loom is felt lighter. However, in principle, non-machine looms, both long and short, have the same working principle.

Based on Table 1, there is a lot of original science that can be reconstructed into scientific science. These results can later be used as a contextual science learning resource.In the manufacture of *Troso* weaving, there are two kinds of threads used, namely warp threads and weft threads. The warp thread is a type of thread that will be used in a longitudinal position while the weft thread will be

used in a transverse position. The initial stage carried out is the process of installing the weft thread into the *plankan* or wood called the *ngeteng* process. The elongation of the thread on the supplied wood is highly dependent on the tension of the thread. The resulting tension must be appropriate so that when added warp yarn, the yarn series can be aligned and matched (Roy, 2017). Thread tension that is too large can cause the thread to break easily because the force generated is large. On the other hand, a tension that is too small can cause the pattern of the woven fabric to be not optimal because the force applied is not enough (the thread becomes easily tangled) (Alamsyah et al., 2013).

After arranged in the *plankan*, then the colouring process was carried out. Before the colouring process was carried out, the parts that were not coloured were tied using plastic-based raffia (Figure 3). This is due to plastic which has the characteristics of the constituent components being very tight and impermeable to water, so that the absorption of the dye liquid on the fabric cannot occur. Plastic is a type of polymer with a low absorption rate (Vadicherla & Saravanan, 2014), so that in the colouring process, the parts covered by raffia were not stained.

After dyeing, the threads were dried and untied. The drying process is carried out so that the water molecules contained in the dye solution can evaporate and left on the dye itself. The dye solution consists of water molecules (H_2O) and dye particles. Water molecules have high volatility. Volatility or evaporation is a tendency of a substance to evaporate. Volatility is directly related to the vapor pressure of the substance. In a room with a certain temperature, a substance with a high vapor pressure will be more volatile than a substance with a low vapor pressure (Agarwal et al., 2015; Kavitha, 2015). Therefore, when the evaporation process occurs, these water molecules evaporate. Particles of colouring matter are liquids that contain solids in them. This solid if it goes through the evaporation process is not easy to evaporate so it is left on the fabric and gives colour to the fabric (Ab Ghani & Ahmad, 2011; Dissanayake et al., 2017). Basically, heating will speed up the reaction rate due to the increase in kinetic energy so that collisions between particles occur faster. However, not all dyes are heat resistant.

After that, the spinning process was then carried out through a process called *malet*. The *malet* process uses a tool that resembles a bicycle and there was wood beside it which can also rotate along with the rotation of the bicycle wheel. The tool uses the working principle of a pulley. A pulley is a simple type of machine. The machines were used to facilitate human work by utilizing mechanical advantages (Maulik et al., 2014). This is in accordance with interviews conducted with respondents who said, "use wheels to make it lighter, sis". There are three types of simple machines, namely levers, inclined planes, and pulleys. Pulleys were divided into three types, namely compound pulleys, movable, and fixed, all pulleys have the same working principle that is rotation. In the *malet* process, the pulley used was a compound pulley type. A compound pulley is a combination of a fixed pulley and a free pulley. There were two types of pulley models, the top pulley is a fixed pulley and the bottom pulley is a free pulley, both of which were connected by a rope. The mechanical advantage of a compound pulley is equal to the number of ropes or the number of pulleys used to lift the (Bendimerad et al., 2016; Hager et al., 2016; Ramdan et al., 2018).

In the next process, the yarn that has gone through the afternoon machining process was used to weave together the warp yarn. It was yarn that must be improved in quality because in the weaving process, the warp yarn was subjected to more workloads, such as pulling and friction. When the warp was opened, the thread was pulled, while friction occurs between the thread and the back roller, dropper, gun, comb, binoculars or with the thread itself, so the warp threads must be strong, have good frictional resistance, and have high elongation (Jaber & Ali, 2019; Polach et al., 2015). This was in accordance with interviews with respondents who said that "warp threads must be stronger than weft threads".

In addition, respondents also mentioned that the strands and arrangement of the threads must be even, otherwise the threads will easily fall apart and break. One of the causes of yarn unevenness is the unequal tension of the strands. If the applied tension is too low, at the time of dry dividing rod, the yarn will run out. This thread crossing occurs because of the large angle, so that the thread is forced and eventually breaks (Bhushi & Pharsiyawar, 2004; Gangadia et al., 2014). However, the consequence

of applying tension to the yarn is that the stretch ability of the yarn will decrease (Tanusree, 2015). The greater the applied tension, the lower the thread's elongation ability. If the elongation is low, it will not benefit the weaving process, because if the yarn is not able to withstand the stress with its low elongation, the yarn will break. With the number of warp breaks, the weaving process will be disrupted.

The weaving process in the manufacture of *Troso* weaving uses a Non-Machine Weaving Tool (ATBM). ATBM is a tool for weaving that is driven by humans. ATBM can be used while sitting (usually in small and traditional textile industries) or standing. In the large textile industry, ATBM is not possible to use. ATBM can speed up and simplify the manufacture of woven fabrics that previously only used traditional looms or *gedokan* looms. The parts of the ATBM include: (1) Warp rolls, as warp edge guards. This tool is in the form of a long log with a radius of about 7 centimeters and on both sides there are wooden plates; (2) Rub axles, serves as a warp road.

The main movements of the weaving process are as follows: (1) The movement of opening the warp mouth, which is a movement that occurs due to the upward movement of certain groups of warp threads and downward movement of certain groups of warp threads. As a result of the opening of the warp mouth a gap is formed which is called the warp mouth. The opening of the warp mouth occurs due to the presence of equipment: treads, tie ropes, kamran, guns, connecting ropes, and windlass. (2) Weft launching movement, namely the movement of inserting weft threads into the warp mouth that has been formed. Equipment that serves to launch the weft: rod, picker pull rope, picker (batter), binoculars drawer, binoculars, and pallets. This movement occurs because the binoculars carrying the weft are struck by the picker back and forth from right to left through the warp mouth. (3) Pressing movement, namely the movement of closing the weft yarn that has been launched with the cloth. This movement occurs because of the back and forth movement of the lade which has a weaving comb that is moved by hand.

There were two types of scrubbing axles, long and short. A loom that has a long rubbing axle will increase the area of the warp thread so that with a small pressure (in this case human power) the rubbing axle can obtain a large force so that it can work optimally. This is in accordance with the respondent's statement which revealed that "a long loom is lighter, sis"; (3) Cross wood, serves to keep the warp threads in a parallel state in order to make it easier to find broken threads and put them back in the gun so that the warp threads are not confused with each other; (4) Gun or often called *kamran* consists of two wooden frames connected by two pieces of iron. The function of the gun is to divide the warp thread which is raised and lowered into the warp mouth. It is in the mouth of the warp that the weft thread is launched to then cross with the warp threads which eventually becomes a piece of cloth.

In this process, the tension of the thread must be right so that the thread is not easily broken (Gangadia et al., 2014); (5) A winch, made of long wood with a radius of 4 centimeters, serves to hang the gun; (6) Comb, serves to weft yarn that has been launched in the mouth of the warp in the weaving process as well as to adjust the frequency of the warp yarn which is adjusted to the fine/roughness of the fabric made; (7) Drawer woven to hold the comb in the form of a frame made of wood. On both sides of this tool there is a binocular box in which there is a picker or a tool for throwing binoculars from one box to another; (8) Chest axle, serves as a fabric path before being rolled; (9) Rolls of cloth, located in the front under the chest axle but slightly into the loom. This tool is made of long round wood with the same radius as the warp roll. At one end of the roll is given a *walang* gear and equipped with a retaining pal so that the warp roll can no longer rotate. Another pal uses a handle that functions to turn the roll when rolling the newly woven fabric; (10) Brake axle to loosen the warp if the fabric has to be advanced because it has been partially woven; (11) Stepping, in the form of two long pieces of wood which are located under the loom and have a turning point on the back; and (12) A bat, in the form of several sticks connected by a rope. If one of the sticks is moved by pushing the weaving drawer back, all sticks move and the last stick will pull the picker string until it jerks to throw the binoculars (Gopalakrishnan et al., 2021).

The reconstruction of the original science in the study of ethnoscience above can be used as a source of teaching materials for students. The concepts in the *Troso* weaving process are related to the Junior High School material content, as shown in Table 2.

Table 2

Troso Weaving Process Are Related to The Junior High School Material Content

Troso weaving process	Class (JHS)	Science material content
Fabric measuring process	VII	Scientific method and measurement
Drying process (evaporation and use of solar energy)	VII	Temperature and thermal
	VIII	Solar system
Thread tension in the stretching (*Ngeteng*) process	VIII	Work and Energy
The use of a tool to wind the thread		
Weaving process		
Use of dyes	VII	Atoms, molecules, compounds, mixtures and their separation

Scientific concepts that can be found in the local culture of making *Troso* weaving make students closer to the environment and appreciate the existing culture. The process of learning these concepts is also easier because they are around them. This is in line with Suastra et al. (2011) who revealed that education has a twin function, which is not only to create change towards a more innovative life but also to preserve a positive culture.

The results of this study indicate that the culture of making *Troso* Weaving is still preserved today, and has become local wisdom that can be used as a source of learning science. The use of local culture as a learning resource is expected to make it easier for students to understand science, appreciate local culture more and strive to preserve it. Not only towards understanding science concepts, science learning with an ethnoscience approach is also able to improve students' scientific attitudes (Dewi et al., 2021**.** In addition to the ethnoscience review, this study also looks at the ethnoecological side which focuses on human interaction with nature. The results of the ethnoecological study can be seen in Table 3.

Table 3

Ethnoecological Studies on the Making of Troso Weaving

No	Topic	Responden's Answer
1	What dyes are used? Are these dyes safe for the environment? 	Use the dye that I bought at the shop. Just choose what colour you want according to the picture. This dye is also easy to use and the colour comes out fast. Until now it's safe because nothing ever happened.
2	How is liquid waste disposed of? Doesn't it damage the environment? 	Just throw it in the *blumbang* or in the river if the house is near the river. (*Blumbang*: a hollow deliberately made in the ground as a place for liquid waste) It doesn't damage the environment (The results: The area around the *blumbang* is still overgrown with trees and lush. The area around the river is also still overgrown with many trees, and there

		are several species that can still live in the river)
3	What kind of waste is produced besides dye waste? how is it processed? 	Used yarn spools, which are usually purchased for making crafts. (remark: these rolls are usually purchased by outsiders to be used as local crafts)
4	Have *Troso* weavers ever tried to use natural dyes that are safer for the environment?	Someone has tried but didn't continue because the color was not good (the color didn't come out enough), and the process was longer.
5	Are you willing to use a more environmentally friendly dye?	I am, as long as easy to use.

In ethnoecological studies, it can be seen how humans interact with the environment. From here it can also be seen how the impact arising from human treatment on the environment. In the process of making *Troso* cloth, one of them is through the colouring process. This colouring process is one of the factors that affect the quality of the *Troso* weaving where all the people of *Troso* Village use textile dyes in the process of making their *Troso* fabric. This was conveyed by research respondents where they said that "I use dyes that I bought at the shop next door because there are many colours". People choose to use textile dyes on the grounds that the colour choices are quite varied which can be adjusted to the image designs they have previously designed and practicality in the purchasing process so that the work is more effective and efficient. If studied in the perspective of the concept of environmental ethics which questions how one's actions should be towards their environment, the behaviour of people in choosing textile dyes is a reflection of anthropocentrism which prioritises the selfish side in humans in fulfilling their needs. In torso ikat craftsmen, it can be seen that the selfish side of humans appears when they prefer textile dyes to natural dyes. They consider that textile dyes are easier to obtain, practical in use and the colour is seen more quickly on fabrics that have been dyed. This is where it needs to be seen that craftsmen do not care about the negative impacts caused by the use of textile dyes on various other biotic and abiotic components when the dye is no longer used. This is in line with what was expressed by Keraf (2010), that anthropocentrism views humans as the centre or focal point of all systems in the universe. Petersen (2009), mentions that anthropocentrism is a human-centred ethos that only humans have value, this means that humans do not care directly for non-humans, although they may care if it is further their own interests (for example in terms of welfare or the fulfillment of rights). From an environmental perspective, the use of textile colours is allowed. This is because textile dyes contain chemical compounds such as chlorine, hydrochloric acid, hypochlorous acid and heavy metals (Kong et al., 2009; Zheng et al., 2012). In addition, textile dyes contain compounds that function as activating chromophore and binder between colour and fibre, namely a combination of unsaturated organic compounds, chromophores and auxochromes (Pavithra & Jaikumar, 2019; Velusamy et al., 2021). The colouring process requires water as the solvent medium so that after the colouring stage it will produce liquid waste. This is in accordance with what was conveyed by the response which said that "the colour will be mixed with water after which the threads are dipped after that the coloured water is removed". Liquid waste generated from the colouring process has the potential to pollute the environment with a strong pollutant power when disposed of without any prior treatment. The liquid waste resulting from the

colouring process with reactive dyes has a high pH value, the colour tends to be low and the COD (Chemical Oxygen Demand) level is quite high (de Farias Silva et al., 2016; Kalra et al., 2011). This condition is caused by various factors, one of which is the dyeing process in colouring using alkali in the colour fixation process so as to produce a fairly high pH condition. In addition, the colour results of the liquid waste are dark because not all of the dyes used are carried out with fibre, while the high COD conditions are due to the presence of organic substances in the liquid waste, for example wetting agents, auxiliary used or residual dyes (Bisschops & Spanjers, 2003; Madhav et al., 2018).

Disposal of dye liquid waste into environmental bodies without any treatment will cause environmental pollution. The results of the interview with the respondent "after the process of coloring the water, I throw it into the blumbang or river if the house is near the river". Blumbang is an indentation made in the ground that functions as a reservoir for liquid waste dye for making *Troso* ikat weaving. While the river or river is a surface flow that is elongated and flows continuously from upstream to downstream. A polluted environment will of course interfere with the survival of living things in the surrounding environment, either directly or indirectly. The liquid waste is very disturbing to the surrounding community because it has an unpleasant smell so that it interferes with the comfort of the community in their daily activities. The liquid waste also has the potential to damage river water quality and disrupt and even damage water ecosystems which can have an impact on the death of living things in the river environment (Hong et al., 2020; Jaishankar et al., 2014). Indirectly this can reduce the level of diversity of living things in the surrounding environment, both flora and fauna. To find out that polluted water in an area can be measured using several indicators that can be observed and classified into three, namely (1) Physical observations, namely observations of water pollution based on the level of water clarity (turbidity), changes in temperature, color and any changes colour, smell and taste. (2) Chemical observations, namely observations of water pollution based on dissolved chemicals, changes in pH. (3) Biological observation, namely the observation of water pollution based on the microorganisms present in the water, especially the presence or absence of pathogenic bacteria.

Troso woven liquid waste that is disposed into the surrounding environment causes pollution as seen from the change of river's water colour according to the colour of industrial waste that flows in the area where the sewer meets the river channel. The pollution caused by *Troso* weaving waste is not only a change in the colour of the river water, but also a change in the level of turbidity and the appearance of an unpleasant and pungent odour around the river. Pollution of *Troso* weaving waste water that occurs passes through two areas, namely irrigation canals and ditches to empty into rice fields. Based on this, it can be indicated that *Troso* weaving waste water pollution can cause health problems in humans. It happened because rice fields can absorb *Troso* weaving waste water which contains harmful compounds such as heavy metals which if consumed by humans can cause serious health problems. Heavy metals have carcinogenic properties that can generate cancer cells in the human body when exposed in the high amounts continuously. The negative impact of heavy metals is bound to the human body. Based on research conducted by Nuha & Mubarok (2016) the results obtained from the characteristic test of *Troso* woven wastewater obtained results in Total Suspended Solid (TSS) of 520 mg/l, total chromium 0.003 mg/l, Biological Oxygen Demand (BOD) of 1935 mg /l, Chemical Oxygen Demand (COD) of 5593 mg/l, phenol of 2.348 mg/l and a pH of 8. In accordance with Central Java Provincial Regulation No. 5 of 2012, the parameters TSS, BOD, COD, and phenol have exceeded the required quality standard thresholds, while total chromium and pH are still within the threshold. Referring to this, the samples of liquid waste analysed have the potential to pollute and be harmful to living things and the environment. The TSS content of the liquid waste samples far exceeds the established quality standards because the sampling site in Blumbang contains soil erosion material. The test results for the BOD content far exceeded the quality standards because one of the stages of the process prior to weaving used starch. The COD content which exceeded the quality standard was caused by the presence of phenol and chromium content during the coloring stage. The pH value measured by *Troso* weaving waste is alkaline due to the chemicals used such as NaOH in the mercerization process and detergents and soap during the souring process (Pambudi, 2020).

Substances contained in textile waste that are discharged directly into the waters will be toxic or accumulative to the bodies of aquatic biota through biological processes (Moraes & Bidoia, 2015; Varadarajan & Shikha, 2014). Several studies explained that in 30 samples from dug wells in *Troso* village, there were 26.67% of the samples whose nitrate content exceeded the maximum allowable levels (Sa'adah, 2020; Samawaty, 2002). The results of the statistical analysis showed that there was a significant relationship between the distance of the woven waste disposal site and the levels of nitrate and nitrite in dug well water in *Troso* village. Water from dug wells with high levels of nitrites if consumed will affect health, namely chronic poisoning which can cause Gastro-Intestinal disorders, diarrhoea mixed with blood, coma, and if not helped will cause death (Salam et al., 2021).

Besides dye liquid waste, the manufacture of *Troso* weaving also produces solid waste in the form of used yarn rolls. This waste is not processed by *Troso* weaving craftsmen, but is only collected and later purchased to a third party to be taken and processed into handicrafts that have a high selling value. In principle, solid waste from yarn spools can be processed using the 3R concept, namely reuse, recycle and recovery. However, the concept of proper processing of solid waste can use the concept of reuse or recycle. Therefore, there is a need for training for *Troso* weaving craftsmen on how they can process the waste generated in the *Troso* weaving production process so that later they can implement the zero waste concept in the production of *Troso* woven fabrics.

With the decrease in the level of diversity of living things, there will be an imbalance in the ecosystem in the region (Hainzelin & Nouaille, 2013). Marine biota will undergo a bioaccumulation process where there is an accumulation of chemical substances such as pesticides, methylmercury, and other organic chemicals in or part of the organism's body (Neff, 2002; Szynkowska et al., 2018). This biota will later be consumed by the community so that in the long-term diseases such as cancer, poisoning or gene mutations will occur until death. In addition, the dye liquid waste undergoes an absorption process into the soil layer which results in damage to the soil structure so that it affects the level of soil fertility in the area. With the decline in soil fertility, many vegetation will die because they cannot adapt to environmental changes that occur (Bilotta et al., 2007). In addition, dye liquid waste will undergo an infiltration process which will affect the quality of well water in the community (Gray, 2004; Qasim, 2017). This well water will also be contaminated with organic and inorganic compounds which can later interfere with human health and even death due to poisoning.

Referring to the above conditions, it is necessary to make an effort to control environmental pollution resulting from the dyeing process of *Troso* woven fabrics by substituting dyes from textile dyes into natural dyes. In addition, efforts to treat dye waste can also be carried out before being discharged to the environmental agency. Liquid waste treatment does require quite expensive costs so that mutual cooperation from the community is needed to make communal wastewater treatment that can be used together. The *Troso* weaving community can also apply the concept of clean production which is an environmental management strategy that is preventive, proactive, integrated and applied continuously to every production activity from upstream to downstream implementation in every production process in producing a product. The purpose of the application of this clean production concept is to increase efficiency in using natural resources, prevent environmental pollution and reduce the formation of waste starting from the source, so as to minimize risks to human health and safety and environmental damage. This is in line with the ecocentrism view of placing biotic and abiotic components in a position that has a relationship. Ecocentrism puts emphasis on the mutualism relationship of all components of the ecosystem.

In the environmental management process by treating textile dye liquid waste produced from the production process of *Troso* woven fabrics in ethnoecological studies using the ecological approach which is an approach to the study and analysis of ecological phenomena with a focus on the relationship of humans as living beings with their natural environment. In this approach, humans and nature have a form of interaction and adaptation, which can be seen from the existence of human activities that change the landscape on earth, both in biotic and abiotic components (Steffen et al., 2006). Liquid waste generated in the production process which is only disposed of without any treatment will change the balance system between its biotic and abiotic components. In biotic

components such as animals in the process of adaptation to their environment using instincts and instincts. Adaptation in animals leads to behavioural changes which will later affect the anatomy and life cycle (Tooby & Cosmides, 2016). Animal adaptation can be a natural guide to observe natural changes that occur in the surrounding environment. While in plants adaptation can be seen in the form of physiological, anatomical and plant life cycles. Plant adaptation can also be used as a natural guide to observe natural changes that occur in the surrounding environment (Harborne, 2014). In order to apply environmental ethics, certain methods are needed as a way to understand, explore, and develop environmental ethics, so that individuals can become friendly and care for the environment (Hudha et al., 2019). Methods of applying environmental ethics may include (1) teaching, (2) exemplary, (3) habituation, and (4) reflection, and they must be determined based on perception (Hudha et al., 2019; Sukarsono, 2016). This is considering that community perceptions have an important role in sustainable environmental management (Bennett, 2016; Heriyanti et al., 2022).

Ethnoecological studies put forward how humans treat their environment. By studying science through the process of making Troso weaving, students know the effect of this process on the environment. That way, students' awareness to protect the environment becomes higher. In the case of Troso woven waste, for example, students become aware of the consequences if woven waste is not treated properly. Students' knowledge of environmental impacts will make environmental awareness better (Kasuga et al., 2022; Özalemdar, 2021; Yüzüak & Erten, 2022).

Conclusion and Implications

As mentioned, that the study is to identify and describe indigenous science in the process of making *Troso* Weaving, as well as related scientific concepts. In the process of making *Troso* weaving, the results of the reconstruction of the original science into scientific science were investigated. According to ethnoscience studies, various scientific studies have been obtained, especially those related to the measurement process, compounds and mixtures, heat and energy transfer. Ethnoecologically, the community does not yet know the environmental impact that has occurred, resulting in environmental damage even though the community has not directly observed it. By associating science material with the local culture, it is hoped that the understanding of science will become more meaningful and contextual. Students will also try to protect the environment more by knowing the impact of human behavior.

The recommendations include the development of teaching materials based on the results of the scientific reconstruction, and the need to use natural dyes that are more environmentally friendly.

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