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Exploring Indigenous Knowledge of the concepts of Physics in the Northern Coast, Indonesia

Yuni Ratnasari[a], Anti Kolonial Prodjosantoso[b], Dadan Rosana[c], Irwanto Irwanto[d], [a,c]Department of Science Education, Yogyakarta State University, Indonesia, [b,d]Department of Chemistry Education, Yogyakarta State University, Indonesia, Email: [a]yuni.ratnasari_3.2017@student.uny.ac.id,yuni.ratnasari@umk.ac.id, [b]prodjosantoso@uny.ac.id, [c]danrosana@uny.ac.id, [d]dr_irwanto@yahoo.com

Indigenous knowledge should be acquired as early as possible to form a well-cultured millennial generation. The integration of Indigenous knowledge and the concept of Physics in elementary schools should be promoted. This study was conducted to explore the integration of the concepts of Physics and Indigenous knowledge in the Northern Coast of Java, Indonesia. A total of 20 respondents (10 teachers and 10 experts) participated in this study to determine their understanding and application of the concepts of Physics. Data was collected through semi-structured interviews, which showed that teachers had integrated Indigenous knowledge into the concepts of Physics including Jepara Carving Art, Jenang Kudus, Bakaran Batik and Rembang Salt Processing. Some of the physical concepts discussed include change of state, conductors and insulators and heat transfers. Experts have confirmed conformity between Indigenous knowledge and the concept of Physics, but some beliefs have been passed through generations. Teachers' understanding of Indigenous knowledge was limited to a theory, resulting in less appropriate facts from actual conditions in the community which caused misconceptions.

Keywords: *Indigenous knowledge, concepts of Physics, elementary school.*

Introduction

The millennial generation was born in the midst of the globalisation era when Science and Technology have been well-advanced. The development of Science and Technology can have both positive and negative impact on the millennial generation. One of the negative impacts relates to the erosion of native culture due to the influence of foreign cultures in the era of globalisation. Imbalances are expected to occur in the community in which cultural values and local wisdom began to erode (Handayani, Wilujeng & Prasetyo, 2018).Cultural reinforcement that emphasises the values of Pancasila should be encouraged for a stronger millennial generation (Srinanda, 2019). Indigenous knowledge is unique to a particular community (Shiza, 2007). Incorporating Indigenous knowledge into the classroom is a way of recognising the diversity and values of Indigenous knowledge (Khupe, 2014). Some Indigenous knowledge can be integrated in the school curriculum to improve learning outcomes (Kaino, 2015). Proper integration of Indigenous knowledge into Science learning activities greatly supports Science teachers in Africa (Abah, Mashebe, & Denuga, 2015). Indigenous knowledge presented in Science classes has the potential to provide meaningful education and connect students to the knowledge they obtain at schools and the communities (Handayani et. al., 2018). Unfortunately, only few teachers have integrated Indigenous knowledge in Science learning in elementary schools, especially in the Northern Coast of Java, Indonesia.

Problems occurred related to the integration of Indigenous knowledge into learning Science in primary schools in Zimbabwe (Shiza, 2007). Lack of access to education that respects the diverse cultures and languages of Indigenous people also frequently occurs (Rosnon & Talib, 2019). Teachers often do not emphasise cultural values in their teaching practices (Thaman, 2009). As a result of the formal education system, teacher-centred learning has created a gap between students and their parents. Consequently, parents have become less able to pass Indigenous knowledge on to their children (Abah et. al., 2015). Teachers need to realise that local knowledge and Scientific knowledge in the classroom can synchronise and support each other (Regmi & Fleming, 2012). In recent years, the National Science Foundation has included Indigenous knowledge in climate change studies, the development of Indigenous knowledge-based mathematic curriculum, geo-spatial mapping programs, the effects of contaminants on subsistence foods, observations of auroras and alternative technologies for waste disposal (Barnhardt, 2015).

Indigenous Knowledge

Local wisdom or Indigenous knowledge refers to local knowledge that is unique and attributed to a particular culture or community (Utari et. al., 2016). Local knowledge, folk and Indigenous knowledge (Shava, 2020), skills and attitudes shared by the community arise

from personal and community experiences (Ocholla & Onyancha, 2005). Local knowledge that is unique to a particular culture or society continues to be influenced by internal creativity and contact with external systems (Shiza, 2007). It also refers to the body of knowledge, and complete practice that is nurtured and developed by the community in rural areas from history and interaction with the natural environment (Nakashima, 2000).

Indigenous knowledge is an important basic knowledge for prospective Science teachers to preserve culture and pass it on to the next generation (Parmin & Fibriana, 2019). Exploring Indigenous knowledge needs to be integrated into Science learning as it will be more meaningful if it is associated with knowledge around students. Knowledge has the potential to be a source of Science learning and can be an alternative to the implementation of the concept of "back to nature" (Parmin & Fibriana, 2019).

Dynamic products of contact between various cultures and the local environment include collection, hunt, agriculture and animal husbandry; struggle against illness and injury; technological and engineering innovation; naming and explaining natural phenomena; maintaining a balance between the community and the environment and adaptation to environmental changes (Nakashima, 2000). Indigenous knowledge is embodied in practice and verbally communicated through copying, illustration, painting and other artefacts (Zinyeka et. al., 2016). It Indigenous often employs strong scientific principles which are usually empirically derived yet do not have to be explained in conventional scientific terms (Baquete et. al., 2016).

Physics Teaching in Elementary Schools in Indonesia

Beginning in 2013, the 2013 curriculum has been applied. The Psycho-pedagogical foundation of the 2013 Curriculum emphasises integrated thematic learning, where several subjects are presented as a theme (MoE, 2014). The themes for lower grades (grade 1, 2 and 3) are dominated by Indonesian subjects, which are expected to integrate basic competencies of Science and Social Science subjects. Natural Science is an integrated theme of Physics, Biology and Chemistry. Distribution of low class themes that contain Science content include the following topics; Myself, My Activities, Clean and healthy environment, Objects, animals and plants around me, and Natural Events (class 1); Clean and healthy life, Water, Earth and Sun, and Caring for animals and plants (class 2); Breeding animals and plants, Changes in nature, Caring for the environment, Energy and its changes, as well as the Earth and the Universe (class 3). The concept of integrated Physics in Science includes My Activities, Clean, healthy environment, Objects, Natural Events, Water, Earth and Sun, Changes in Nature, Energy and changes as well as the Earth and the Universe.

Science learning for higher grades (4, 5 and 6) varies from lower grades. Science is presented as a separate subject based on a multidisciplinary integration approach where integrated thematic learning still applies. Distribution of themes for grade 4 includes The beauty of togetherness, Always saving energy, Caring for the environment, Occupations, My hero, The beauty of my country, My dreams, Where I live and Healthy and nutritious food. The distribution of themes for grade 5 consists of Objects in the Environment, Events in life, Harmony in society, Health is important, Proud as an Indonesian nation, Human and animal organs, History of Indonesian civilisation, Ecosystems and the environment of our friends. Distribution of 6th grade themes includes Saving sentient beings, Unity in diversity, Figure and inventor, Globalisation, Entrepreneurship, Public health, Organisations around me, My Earth and Exploring outer space. For example, in Grade 4 several concepts of Physics are taught in Always Save Energy including energy sources, changes in the form of energy, alternative energy sources and changes in the state of objects.

The concept of Physics in elementary schools is integrated in Science learning. Science has become a strong intellectual institution that has a broad and deep influence on our daily lives, regulating our relationship with our environment, systems, and values (Nakashima, 2000). Natural science does not only teach facts, laws and theories but also educates about human activities such as investigations, processes, attitudes and beliefs (Handayani et. al., 2018; Irwanto et. al., 2019; Rohaeti et. al., 2020). In brief, Science consists of (a) a process; (b) product and (c) scientific attitudes (Lawson, 1995).

Research Methodology

Study Design

This study explores the integration of Indigenous knowledge into the concept of Physics taught in elementary schools. In this qualitative study, an ethnographic approach is employed (Berg, 2004). Reeves et. al. (2013) and Reeves. et al. (2008) explain that ethnography aims to produce detailed and comprehensive findings on various social phenomena that occur in groups and communities through observation and interviews. The current study was intended to analyse the implementation of Indigenous knowledge in Science by elementary school teachers.

Setting and Participants

A sample of 20 adults (13 males and 7 females) in the Northern Coast of Java, Indonesia participated in this study. Respondents consisted of two groups: group I (10 experts; 7 males and 3 females) and group II (10 public and private elementary school teachers; 6 males and 4 females). Interviews with teachers and experts were conducted separately. Pantura Timur consists of 5 districts, including Demak, Kudus, Jepara, Pati and Rembang. This location

was selected as the first author came from the area and can speak the local language which is Javanese.

Data Collection

Semi-structured interviews were administered to collect data. During the interviews, the interviewer carefully listened to personal opinions that might relate to scientific concepts. Follow-up questions were provided to explore other ideas that might arise during the interview.. Some examples of questions include: 1) how to make *Jenang* Kudus? 2) what distinguishes *Jenang* Kudus from other regions? 3) how is the finishing process of Jepara's sculpture during the rainy and dry season? 4) Have you ever experienced salt harvest failure and what is the cause? 5) What is undertaken in a pond during the rainy season? and 6) Has the traditional batik process changed?

Data Analysis

Interviews were recorded using an audio recorder, transcribed verbatim using Microsoft Word and analysed to identify ideas related to physical concepts. The researchers then translated the interview transcripts into English.

Findings

This section presents the activities of local people in producing Jepara Sculpture, *Jenang* Kudus, *Bakaran* Batik and Rembang Salt that are related to the concept of Physics. During the interview, we identified and presented Indigenous knowledge that could be related to Physics concepts such as change of state, conductors and insulators and heat transfers.

Change of State

In a one-to-one interview, respondents were asked to convey any object they knew in the process of making sculpture, *jenang*, batik and salt. Then the researchers inquired further about the nature of objects, chemical and physical changes and changes in the state of objects that might occur. Their responses are shown as follows.

Interviewer : What objects do you know of based on your Indigenous knowledge in the making of Jepara Sculpture, *Jenang* Kudus, *Bakaran* Batik and Rembang Salt?
Teacher 1 : I know of wood, shape paper, saw, chisel, other carpenter tools and varnish paint, paint and thinner.
Teacher 2 : Glutinous rice flour, rice, brown sugar, white sugar, coconut milk, water and

cooking utensils such as large pans, stirrers, wood-burning stoves, pans and dipper.

Teacher 4 : Sea water, mill, salt crystals, rakes, screw, diesel engine.

Teacher 8 : Cloth, candles, stoves, small pans, canting, liquid wax, gas oil and colouring powders. Melted wax, gas oil and water including liquid items, other solid objects.

Interviewer : Is there no gas?

Teacher 5 : In the process of making salt, evaporation of sea water will change the water into gas.

Teacher 9 : The solid wax heated on the stove will melt and evaporate. Gas is formed through the evaporation.

The above script shows that the teacher cited several examples of solid, liquid and gas objects. They mention objects related to the Indigenous knowledge mentioned. The teacher clearly had adequate knowledge of various objects according to the concept of Physics. Teacher 5 explained that gas is produced during the evaporation of sea water. Teacher 9 outlined the evaporation of the heated candle that produces gas. The results of interviews from expert groups are presented as follows.

Interviewer : What objects do you know of based on your Indigenous knowledge in the making of Jepara Sculpture, *Jenang* Kudus, *Bakaran* Batik and Rembang Salt?

Expert 3 : The main materials are teak wood, pattern paper, saws, chisels of various sizes ..... and varnish paint, paint, thinner ..... .

Expert 6 : 12 kg sticky rice dough, 10 kg coconut sugar, 14 kg white sugar, coconut milk from 10 coconut fruits, 3 buckets of water and cooking utensils such as cast iron skillet, *udak-udak* which is a wood stirrer with an iron tip, a coconut grinder, a wood-burning stove, a plastic bucket and a dipper.

Expert 1 : *Bakaran* batik is made of various kinds of *Mori* cloth, dark brown, young and white brown, fabric dye powder. The tools include canting, stove, frying pan, colouring barrel, wood stove and bamboo clothesline for the *mlorot* process.

Expert 7 : 16 kg sticky rice, 7.5 kg palm sugar, 30 kg white sugar, sesame, 10 buckets of coconut milk, steel skillet, cooking tools, stirring machine, firewood stove, plastic bucket.

Expert 5 : Sea water, mill, salt crystals, rakes, shoulder basket, diesel engine.

Expert 4 : There are *mori* cloth, wax, fabric dye. Utensils consist of stove, pan, canting, big pan, gas stove, clothes line.

Expert 8 : Sea water, mill, diesel engine, tarp, rakes, *arko*, salt crystals.

The responses of the expert group indicate some differences. In the Kudus language, a pan is referred to as *Krenyeh* steel by modern experts, while traditional experts call it *Kawah wojo*. These terms refer to objects with similar shape made from different manufacturing materials. Modern experts use a stirring machine while traditional experts use *udak-udak*, a bamboo mixer with *wawal* (steel)in the end, operated by human power. Traditional experts in the Rembang area still use baskets (*kranjang)*, while modern experts use *Arko*, a tool to convey salt from ponds to storage sheds. *Arko* is a simple machine. Modern experts have used tarpaulins as a base for ponds to obtain whiter and higher quality salt. The makers of batik *Bakaran* in Pati explained that they used the same ingredients that were all solid. Liquid materials were made when the wax melts to heat. A different tool is used as a stove for the *Mlorot* process, in which traditional wood stove is used, while the modern one uses gas stove. Experts have knowledge about solid and liquid objects and they mention gas objects which are tangible stoves made from gas. They mention things based on experience. The response shows that the expert has knowledge of various objects according to the concept of Physics.

Practical knowledge about the properties of materials and tools used in Indigenous knowledge relates to the basic concept that each object has different properties. The following are the properties of materials and tools in Indigenous knowledge according to the teacher group.

Interviewer : Do those stuff have similar characteristics?
Teacher 3 : Different. Flour, sugar, cooking utensils ... are solid objects, it's difficult to change their shape unless using forces such as being cut, pressed or hit. Water, coconut milk are liquid objects that are easily conveyed to another place. *Jenang*, which is still hot is easily shaped. Cold *jenang* should be sliced using a knife, or pressed by hand into a preferred shape.
Teacher 6 : Wood, shape paper, saws and equipment ... are solid objects. The shape of wood can be changed using chisels or saw. Papers can be torn or cut. Varnish paint and paint are liquid objects that easily stick to wood.
Teacher 4 : Sea water is a liquid object. Windmills, salt crystals, machinery, scratching are solid objects that are difficult to change shape. Water that evaporates in the form of gas easily spreads throughout the room.
Teacher 7 : The materials for *Bakaran* batik are difficult to change shape. For example, wax should be cut or heated to change shape. The fabric needs to be sheared to turn into smaller pieces. The fabric has a white section that can be painted to form batik and coloured to produce a certain motif. Melted wax is easier to form in a certain container, and its shape will adjust to the container.

The above quote explains that it's rather difficult to change the state of solid objects. The shape of solid objects can change by force. The shape of liquid objects can change easily based on the container. Gas objects evaporate or spread throughout the room. Responses to the properties of objects according to experts are described as follows.

Expert 10 : Teak wood can be carved, cut, sanded and varnished. Older teak wood is harder, making it easier to be carved. Young wood will break easily when carved. Wood that has been carved cannot go back into wood log.

In Jepara sculpture, teak is used as the main ingredient. Experts have a practical understanding that wood has hard properties. To change the shape of wood into an attractive sculpture, special treatment needs to be given by cutting the wood, carving, sculpting, sanding and colouring. A sculpture cannot be turned back into a wooden block. Experts understand the change in the state of objects, but they do not understand the fundamental concepts of Physics. Figure 1 shows the making of Jepara sculpture.

Figure 1. The making of Jepara sculpture

Expert 6 : All ingredients are dried at first, then they are easy to stir. The longer the dough is cooked on a wood-burning stove, the more dense (chewy) it will be, making it harder to stir. When cooked, it becomes more solid, non-sticky and the mixture gets heavier. However, if it is overcooked, it will be very stiff and non-elastic, making it difficult to stir. *Jenang* that are well cooked and cold will be denser but still chewy so that it is easy to shape and wrap. *Jenang* that has been shaped is not easy to reshape without pressure.

Expert 7 : The ingredients are put in *krenyeh*, stirred continuously using the mixer. At first, the ingredients are still runny, the longer it is heated the thicker the material will be and change colour to become springy. The water in the

runny material is still visible. It will not be visible anymore in the thick and chewy material. After *jenang* is cooked, it becomes more chewy and solid. A well-cooked *jenang* will expire within 1-2 months.

The makers of *Jenang* Kudus have practical knowledge that solid materials can be mixed with liquid ingredients with certain compositions to form liquid. After the liquid is heated on a furnace, all materials over time will become springy and solid. The shape of the material changes because it is heated. Expert 6 knows that there is a change in the shape of liquid being turned into a solid from a given mixture. A longer mixing process will produce a heavier mixture. In addition, there is a change in colour from liquid whitish brown to solid dark brown. Expert 7 noticed a change in the shape of objects in colour and took a little dough using a spoon. Expert 7 did not notice it due to the automatic stirring process using a mixer which gave stable stir from beginning to end. Hence, they were not aware of the evaporation due to the heating. Both explained that the change in form occurred when sugar and flour were heated, which would eventually thicken and solidify. The process of making *Jenang* Kudus is shown in Figure 2.

Figure 2. The making of Jenang Kudus

Expert 1 : *Mori* cloth cut to size, then made into patterns with certain motifs. The stove is lit. The wax is cut and put in a pan and then heated on the stove. *Mori* cloth that has been patterned is placed on the bamboo mat. The craftsman sits in front of the fabric and the stove is placed beside it. Craftsmen begin to make batik using canting. The tip of the canting is placed in a pan containing a melted night, then the ends are painted on a cloth to form a motif. The liquid wax drawn on the *mori* cloth will immediately dry and resolidify.

Bakaran batik craftsmen have practical knowledge about changes in the shape of objects. In making *Bakaran* batik, a long cloth can change its size by cutting using scissors. Plain cloth can be patterned. Solid wax will melt when heated to be used in the batik process on *mori*

cloth which will turn into solid again. The wax will melt on a frying pan as shown in Figure 3.

Figure 3. The making of Bakaran batik

Expert 8 : Sea water easily flows into ponds. When it becomes salt crystals, it cannot flow. To move it, you need to scratch it using a rake and lift it using *arko*.

Expert 5 : Sea water is channelled into salt ponds through waterways. Seawater is put in ponds for some time. The ripe sea water (levels reaching 20%) is channelled into salt ponds using windmills. Unused water is flowed into the drain by diesel engines. The water in the salt pond will evaporate, after 6-7 days it will change into salt crystals. Salt farmers begin to scratch salt crystals to be collected and harvested. Farmers harvest the salt and move it to the salt storage shed using shoulder baskets.

Salt farmers have practical knowledge about change in the states of objects from sea water to salt crystals. Both farmers did not explain about liquid and solid objects. Instead, they explained that sea water can be conveyed by flowing through water channels using either windmills or water pumping diesel engines. Salt crystals are formed by scratching and lifting using *arko* or baskets. Basically, farmers understand that sea water containing salt and salt crystals has different properties, but they were unable to explain the basic concepts of science. The Rembang salt pond is shown in Figure 4.

Figure 4. The making of Rembang salt (https://berita3rembang.files.wordpress.com/)


The following script consists of teachers' responses to the physical changes that occur in Indigenous knowledge.

Interviewer : What changes in state can you can recognise from Indigenous knowledge such as in making Jepara Carving, *Jenang* Kudus, *Bakaran* Batik, and Rembang Salt?

Teacher 10 : Wood logs are carved and formed into doors, goalposts, windows and chair tables. Carved goalposts, door pillars, windows and chairs cannot be turned back into wooden logs as before. Burned wood will turn to ash.

Teacher 3 : The mixture of glutinous rice flour, brown sugar, white sugar, coconut milk, and water will turn into a solid, chewy *jenang*. Dense and chewy *jenang* cannot melt again, if it has expired, moulds will be formed on the surface. Firewood will turn to ash, which cannot return to firewood.

Teacher 4 : After being let sit for 6-7 days on the pond, sea water will turn into salt crystals, which if left in a humid place will melt. This means that salt crystals can return to salty sea water.

Teacher 9 : Solid wax will become liquid when heated. A liquid wax left at room temperature will return to solid. *Mori* cloth rolls can be cut into several pieces. Pieces of *Mori* cloth cannot be turned back into a single piece unless sewed.

The following section presents the responses of experts towards physical changes based on their experiences.

Interviewer : What changes of state occur based on Indigenous knowledge in the making of Jepara Sculpture, *Jenang* Kudus, *Bakaran* Batik and Rembang Salt?

Expert 1 : Solid wax heated on stove will melt. The liquid wax is dissolved in the *mori* and will dry quickly and solidify. The liquid wax that is let to sit will solidify and shape like its container. Burned wood will become ash. Long cloth is cut

into *mori* pieces. Fabric dye powder mixed with water will change the colour of the water. The *mori* cloth dip in the colouring water will change colour.

Expert 10 : Wood logs are cut into doors, windows, chairs and pillars and then carved. Doors, pillars, windows and carved chairs cannot be turned back into wooden logs. Wood that is cut, carved and sanded will turn into smaller pieces of wood and sawdust.

Expert 6 : The mixture of glutinous rice flour, brown sugar, white sugar, coconut milk, and water forms into runny *jenang*, which after being heated will turn into a solid and chewy *jenang*. Solid and springy *jenang* cannot melt again. Firewood will turn to ash, which cannot turn back to firewood.

Teacher 4 : Seawater with 20% salinity will turn into salt crystals after being exposed to the Sun for 6-7 days. Salt crystals will melt in a humid environment.

These responses show that teachers and experts have practical knowledge in applying the concept of change of state. However, they not explain it specifically, leading to some misconceptions about changes in Physics, whichPhysics occur where there is change in an object without being followed by the formation of new objects while constituent particles remain the same. The change of wooden blocks into the shape of windows, chairs, carved pillars, small pieces of wood and sawdust is a change in Physics. The change occurs to physically shape an object due to certain forces, yet the structure of the constituent particles remains the same. Similarly, this change also occurs to *Mori* cloth that is cut into smaller sizes. Teacher and expert responses lead to misconceptions, where the change is not in Physics because sculpture and pieces of cloth cannot return to their original forms. They misunderstand that the change is valid regarding whether or not objects can return to their original form without explaining the change in the particles.

Another example of changes in Physics regarding Indigenous knowledge is that densely heated wax will melt. The liquid wax drawn on *mori* cloth as batik will easily resolidify. Seawater evaporated by sunlight will turn into salt crystals, which left in a damp place will melt into seawater again. These changes occur due to the release and absorption of heat. The responses of teachers and experts conform with the basic concepts of Physics. Yet, they have not explained the process of heat release and absorption. Expert in particular explained more about the processes of heating and evaporation.

Changes in object state also occur in the process of making *Jenang* Kudus. After all the ingredients are mixed, the liquid is initially heated into solid. Solid materials and *jenang* have the same arrangement of particles. Teachers and experts were rather hesitant in explaining the changes that occur in the process of making *jenang*, because they only emphasised the change of shape. Teachers' doubt arose due to the process of mixing and producing new objects which taste similar to the taste of the ingredients. There is a sweet, savoury taste,

sticky taste and red colour like brown sugar. The teacher also explained that changes occurred as moulds were found on the food as it had been stored for a long time. Expert 7 explained that *jenang* can preserve for 1-2 months. Change is the same as powder dye cloth mixed with water producing coloured water. When *mori* cloth is dipped in coloured water, *mori* will absorb the colour. The teacher could not explain this point properly, Only experts were able to based on their experience.

On the contrary, the change of state that occurs in a wood stove, where wood is burned and turns to ash leaves is a different arrangement of particles. This change is referred to as chemical changes. A new substance is formed with a different arrangement of particles. Teachers and experts could explain this phenomenon because of the new objects formed. However, they did not explain the constituent particles of wood and ash.

Conductors and Insulators

The North Coast is a centre of batik industry which employs conductor and insulator materials in the batik process. In addition, the *jenang* and salt beam industry also frequently use those tools.

In the interview, research subjects explained various methods used in the process of making *jenang*, sculpture, batik and salt. During the discussion, they explained the knowledge they had related to conductor and insulator objects as follows:

Interviewer	:	How do you make *jenang*?
Expert 6	:	*Jenang* is cooked using an iron skillet on a wood stove. The skillet can absorb heat more evenly and it is stronger, even though the dough is very sticky. Hence, the dough must be stirred evenly using *udak-udak*. *Udak-udak* has a wooden or bamboo handle to stop the heat, and its tip is made of iron (easy to heat). Wood stoves are used to save costs, and produce durable heat despite the need to keep checking the fire to make sure that the heat is evenly distributed.
Expert 7	:	It is cooked using *krenyeh* (steel pan) so it will not stick and make a loud sound when being stirred in the machine. The steel pan absorbs and distributes heat that is not too strong. A stirring machine made of iron is used because it is not sticky and easily heated.
Interviewer	:	How do you make batik?
Expert 2	:	Patterned cloth is prepared and wax is heated on a skillet on a small oil burner. The skillet used is made of iron that can withstand the heat and does not burn easily as the stove will be kept light up throughout the batik process. After it is completed, the colouring process will be

carried out by dipping the cloth in coloured water and heated on a wood stove. Drums are used as containers as they contain more water which makes the dye spread evenly on the surface of the cloth. The wood stove is used to obtain more durable heat. Then, the cloth is put under the sunshine to dry.

Interviewer : How do you make Rembang salt?

Expert 5 : We use an aluminium oven to prevent fresh salt from cracking. The oven looks like a cupboard made of aluminium with iron nets as the trays which quickly distribute the heat.

The above excerpt shows that research subjects know about conductors and insulators. Conductors conduct heat (aluminium, iron and steel), including iron, steel and aluminium pans, iron drums, eye stirrers and ovens. Insulators cannot conduct heat properly. *Udak-udak* is an example of an insulator made with bamboo using sharp iron edges. Canting is made of aluminium and the handle is made of wood to stop heat transfer when the tip of the canting is dipped in hot wax. The centre of *udak-udak* and the tip of canting are conductors, while the handle is an insulator.

Figure 5. Conductors and insulators

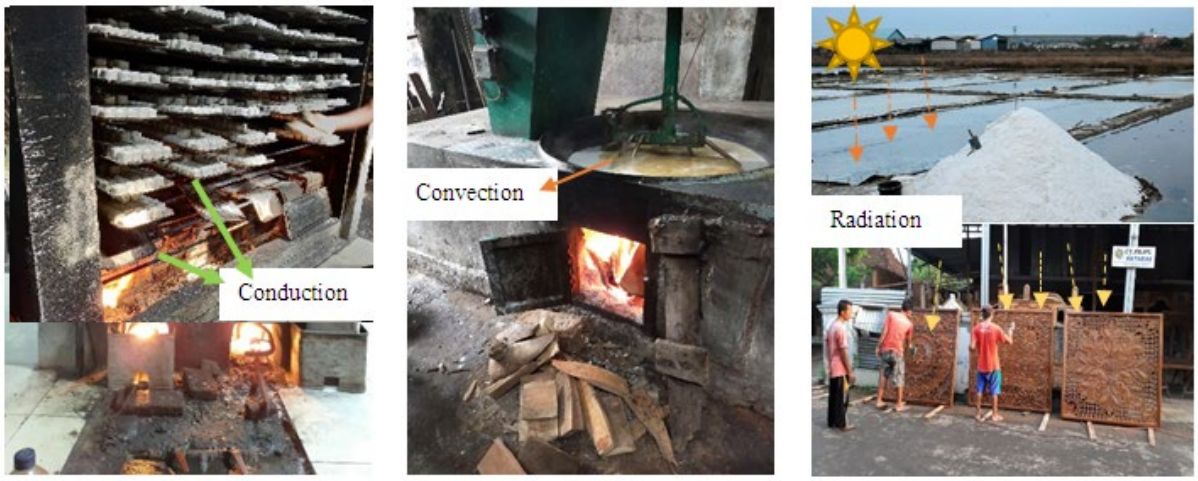
Heat Transfer

Heat transfer can occur by conduction, convection and radiation. Unwittingly, these events occur in everyday life. The heat transfer is also found in Indigenous knowledge in the making of salt, Jepara sculpture, batik and *jenang*. The following are the results of interviews with research subjects explaining heat transfer for Indigenous knowledge.

Interviewer : Is there any heat transfer that occurs in salt production?
Expert 8 : Heat is required in the making of salt. Sunlight is used to evaporate seawater to form salt crystals.
Expert 5 : The making of box salt also requires heat from the oven to prevent the box salt from cracking. The oven is heated on a gas stove.
Interviewer : Is heat needed in the production of Jepara sculpture?
Expert 3 : Heat is needed in the finishing process where varnish and paints are applied. After being painted, the sculpture is dried under the sun to obtain shine.
Interviewer : Does heat transfer occur in the making of *jenang*?
Expert 7 : *Jenang* dough is cooked on *krenyeh* (steel pan) on a wood stove. The dough is stirred in a stirring machine to cook. The heat from the wood stove touches the *krenyeh* and transferred to the dough and stirrer.
Interviewer : Does the process of making batik require heat?
Expert 1 : Heat is needed to melt the wax in a pan put on a stove. It is also needed during the colouring process, where the cloth is dipped into colouring water in a drum heated on a wood stove. Steel drum is used to contain more water, evenly distributing the dye. After being dyed, the cloth is dried under the sun.

The above responses reflect respondents' knowledge of heat transfer by convection, conduction and radiation. Experts did not yet understand about heat transfer as they were only aware of the heat needed in the process. The expert explained that *jenang* is cooked in a pan on a wood stove, wax is heated in a pan on a stove, colouring water is heated in a drum on a stove and salt beams are heated in an oven on a gas stove all of which bring heat transfer by conduction, convection and radiation. When a farmer makes salt in a patch of ponds under the sun, craftsmen complete the painting process under the sun, and the batik craftsperson dries the batik under the sun, therefore heat transfer occurs by radiation.

Figure 5. Heat transfer



Discussion and Conclusions

In general, Indigenous knowledge of teachers from public and private schools did not differ significantly. This means that they have equal understanding. In practice, teachers from state schools often attend trainings held by the Government. Public school teachers have more learning resources supported by the Government. This indicates that training and learning resources are less influential on the understanding of Indigenous knowledge possessed by public school teachers. Training and learning resources provided by the Government are not related to Indigenous knowledge in the area so that the information provided is still minimal. Most teachers understand Indigenous knowledge based on what they see, read or hear which may cause misconceptions. It is necessary to increase teachers' competence, knowledge, skills and practices. Educators must have the competencies (knowledge, performance and product) and qualifications to support their roles and functions (Prayogi & Estetika, 2019).

Improving teachers' competencies will support the continuity of the implementation of Indigenous knowledge regarding the concepts of Physics. The exploration of Indigenous knowledge in the Northern Coast of Java is based on its geographical location. Most of the population make a living from marine products. There are also several industrial areas and large industries in agriculture. Apart from geographical conditions, some people are also influenced by their religious beliefs. Indigenous knowledge has been formed based on the conditions of people regarding their respective regions that often share a similar belief. Indigenous knowledge illustrates the closeness of the community to the sea and its products, industry, agriculture and religion. The exploration of findings illustrates the closeness of traditional communities to nature (Parmin et. al., 2019).

This research explored several Indigenous knowledge bases in the Northern Coast related to the concept of Physics and The research subjects possessed knowledge related to various different fields based on Physics. Experts' knowledge is formed through daily life experiences, while teachers' knowledge is based on what is seen, read, learned or experienced. Expert explanations related to certain phenomena regarding Indigenous knowledge have not been explained based on the basic concepts of Physics. They perceived it as knowledge passed through generations. Their reasons are plausible. On the other hand, teachers linked some theoretical concepts of Physics, leading to misconceptions.

The exploration of Indigenous knowledge related to Physics potentially enhances public awareness, especially students, regarding the importance of understanding Indigenous knowledge and to love and preserve Indigenous knowledge. Improving the comprehension of Physics is necessary to continue utilise and properly apply the concepts in daily life. For instance, there are still many salt pond farmers in Pantura who prefer using traditional ponds without a base. Instead they use it to prevent the salt from being contaminated by non-environmentally friendly materials, thinking that soil is not as dangerous as plastic in harming the human body.

Exploration of Indigenous knowledge from a pedagogical perspective linked to the concept of Physics provides an opportunity for developers of the Science curriculum to include physical phenomena that are familiar to students. Therefore, it is necessary to link Scientific concepts in school and everyday life (Baquete, 2016; Belleau, Ross, & Otero, 2012; Costu, 2008; Irwanto et. al., 2018; Ng & Nguyen, 2006; Saputro et. al., 2019). Teachers must have a broader understanding related to Indigenous knowledge and concepts of Physics to create a bridge between students and experts in the field. Baquete (1998) believes that when scientific explanations are epistemologically different from cultural explanations, teachers, experts and students need to communicate further to find the correlation.

The current education system has been designed to support autonomous learning where students will have more direct experience in the field. Popular compulsory education should improve the scientific quality of Indigenous people, allowing them to easily accept the knowledge to be used in daily life (Wang, 2019). Indigenous learning is more fun (Syamsu & Fuadi, 2019). Students will be physically close to contextual events that occur in the community. Exploration of Indigenous knowledge related to the concept of Physics is expected to be well-understood by teachers and students to motivate them in further exploring other Indigenous knowledge related to the concept of Physics. Indigenous knowledge is expected to contribute to formal education. Hence, it should continue to be preserved along with the development of Science and Technology.

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